THE TROPICAL MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP (TMAPS) PROGRAM IN AMERICAN SAMOA: 2012 REPORT

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31 December 2012

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Suggested citation:

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.

Cover photographs by Rudy Badia and Ron Taylor

EXECUTIVE SUMMARY

Few data exist on the ecology, population status, and conservation needs of landbirds of American Samoa. In an effort to improve our understanding of this insular avifauna and to provide baseline population data for these species, we initiated a Tropical Monitoring Avian Productivity and Survivorship (TMAPS) program on Tutuila Island in 2012. Long-term goals of this project are to: (1) provide annual indices of adult population size and post-fledging productivity (from constant-effort capture data); (2) provide annual estimates of adult population densities, adult survival rates, proportions of residents, and recruitment into the adult population (from capture-recapture data); (3) relate avian demographic data to weather and habitat; (4) identify proximate and ultimate causes of population change; (5) use monitoring data to inform management; and (6) assess the success of managements actions in an adaptive management framework. Here we describe initial establishment of TMAPS stations on Tutuila and provide a summary of captures and indices of population size (capture rates) for seven TMAPS stations operated during the August-November 2012.

In July-August 2012 we established six TMAPS stations in typical habitats utilized by landbirds on Tutuila, American Samoa. All six stations were operated on three consecutive days (representing a "pulse"), once per month, during August-October 2012. Two stations were discontinued due to low capture rates and other factors, and these have been or will be replaced by new stations. Each station consisted of a sampling area within which 10 mist nets were erected and operated in a standardized manner according to protocols established by The Institute for Bird Populations for use in the MAPS Program. Birds captured were identified to species, age, and sex, and banded with USGS/BRD numbered aluminum leg bands. Detailed molt data and photographs were obtained to investigate molt seasonality and criteria for age determination.

During August-November 2012 we banded 196 birds, recorded 45 recaptures, and captured 8 birds that were released unbanded, for a total of 249 captures of nine species. The most commonly captured species by far was Wattled Honeyeater, followed by Collared Kingfisher, Samoan Starling, Cardinal Honeyeater, Polynesian Starling, Jungle Myna, White-rumped Swiftlet, Red-vented Bulbul, and Common Myna. Two species, Wattled Honeyeater and Collared Kingfisher, were captured in numbers that will likely be sufficient to calculate productivity and survivorship while two other species, Samoan Starling and Cardinal Honeyeater, may also fall into this category once more data are collected at more-productive replacement stations. The highest capture rate (birds per 600 net-hours) was recorded at the Mount Alava station, followed by Aoloau, Loto'asi, Amalau, Fagatele Bay, Malaeloa, and Olovalu Crater.

Our goal is to operate six stations on Tutuila continuously for 14 pulses (through September 2013) and then select the best three of these stations in terms of capture rates and logistical factors, for continued operation in future years. We also plan to establish three new stations on Ta'u Island. These six stations (three on Tutuila and three on Ta'u) will then be operated for four months per year, as determined by TMAPS data indicating peak breeding seasonality, for at least four more years. Thus far, two stations on Tutuila, Fagatele Bay and Olovalu Crater, have already been discontinued due to low capture rates and other factors. A newly established station,

Mount Alava, along with Aoloau, Loto'asi, and Amalau have higher capture rates and will be strongly considered for continued operation in the future. We anticipate that the three new stations on Ta'u will not only increase capture rates of most of the species currently targeted, but will hopefully add two new species, Blue-crowned Lory (*Vini australis*) and Fiji Shrikebill (*Clytorhynchus vitiensis*) to our list of species with adequate capture rates to assess demographics.

Continued monitoring at the TMAPS stations and the realization of TMAPS goals will aid identification of conservation needs and formulation of management approaches for Samoan landbirds. 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. We look forward to continuing this important work in the 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 (productivity, recruitment, survival) is needed to infer actual causes of population changes (DeSante et al. 2005). 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 (Green 1999; Peach et al. 1999; DeSante et al. 2001; 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). 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 in 1989 (DeSante 1992). The MAPS program is a cooperative network consisting of hundreds of constant-effort mist-netting stations operated across North America each summer (nearly 1,200 stations overall) that has provided demographic data for > 180 landbird species (DeSante and Kaschube 2007, Saracco et al. 2010b). 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, and ecology of the resident landbirds on this island (Radley et al. 2011, Junda et al. 2012, Pyle et al. 2012).

IBP, in collaboration with the Department of Marine and Wildlife Resources in American Samoa, established TMAPS stations on the island of Tutuila in August 2012 to initiate a five-year TMAPS program there. This effort aims to provide baseline data on landbird populations of American Samoa and a foundation for informing conservation strategies for this 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 of adult population size, adult survival rates, proportions of residents, and recruitment into the adult population (from capture-recapture data); (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 management actions in an adaptive management framework. Here we describe initial establishment of TMAPS stations on Tutuila

and provide an initial summary of captures and indices of population size (capture rates) for seven TMAPS stations operated during the August-November 2012.

STUDY AREAS AND METHODS

In July-August 2012 we established six TMAPS stations in typical habitats utilized by landbirds on Tutuila, American Samoa (Table 1; Fig. 1). All six stations were operated on three consecutive days (representing a "pulse"), once per month, during August-October 2012. In October the Fagatele Bay station was discontinued due to access problems and low capture rates, and a seventh station, Mount Alava, was established in November 2012 to replace the Fagatele Bay station. Locations, descriptions and a summary of effort for these seven stations are provided in Figure 1 and Table 1. In November 2012 the Olovalu Crater station needed to be discontinued for similar reasons as those that affected Fagatele Bay, and it will be replaced by an eighth station in December 2012.

Each station consisted of a sampling area of about 20 ha. Within the central 8 ha of each station, 10 12-m long, 30-mm mesh, 4-tier nylon mist nets were erected at fixed net sites. Stations were operated according to the standardized protocol established by The Institute for Bird Populations for use in the MAPS Program (DeSante et al. 2012). 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 resulted in truncate operation on a particular day, resulting in variable overall effort among stations (Table 1). Station operation was carried out by Lipp and Badia, who were extensively trained in TMAPS protocols by IBP staff biologist Taylor.

With few exceptions, all birds captured were identified to species, age, and sex based on criteria outlined by Pyle (2012), and, if unbanded, were banded with USGS/BRD numbered aluminum leg bands. 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. 2012):

- capture code (newly banded, recaptured, band changed, unbanded)
- band number
- species
- age and how aged
- 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, because molt seasonality and ageing criteria have not been fully established for American Samoan landbirds (Pyle 2012), detailed molt data and photographs were obtained for all molting birds and other birds in which age or sex determination was deemed problematic. Breeding (summer residency) status (confirmed breeder, likely breeder, non-breeder) of each species seen, heard, or captured at each MAPS station on each day of operation was recorded using techniques similar to those employed for breeding bird atlas projects. We will use these data to classify each species at each station according to three residency categories: breeder, migrant, or transient. Habitat data were or will be collected for each station following Nott et al. (2003), and using the vegetation classification system of Viereck et al. (1992). John W. Shipman of Zoological Data Processing, Socorro, NM, will enter banding data.

Verification of banding data will involve running all records through a series of specialized computer programs. These programs will include clean-up programs to check the validity of all codes entered and the ranges of all numerical data; cross-check programs to compare station, date, and net fields from the banding data with those from the effort and breeding status data; cross-check programs to compare species, age, and sex determinations against data such as skull pneumatization and breeding characters indicative of age and sex; and screening programs to 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 will be corrected by hand, if necessary. We will use wing chord, body mass, fat content, date and station of capture, and pertinent plumage criteria as supplementary information for the correct determination of species, age, and sex (Pyle 2012). All photographs will also be examined to verify age and sex determinations and to update determinations in the future once criteria are better established.

For each species and for all species pooled, we calculated (1) numbers of newly banded birds, recaptured birds, and birds released unbanded, and (2) numbers and capture rates (per 600 net-hours) of individual birds at each station. Once we have classified age groups with more confidence we will provide capture rates for adult and young birds and the ratio of young to adult birds representing a reproductive index (Peach et al. 1996). Once sufficient data are collected we will use sophisticated mark-recapture techniques (e.g., Hines et al. 2003) to estimate survivorship of target species with enough capture and recapture data.

RESULTS

An overall summary of captures of each species during the four TMAPS pulses in August-November on Tutuila, at all seven stations combined, is provided in Table 2 and a summary of captures (newly banded, recaptured, and released unbanded) at each station is provided in Table 3. We banded 196 birds, we recorded 45 recaptures, and an additional 8 birds were captured and released unbanded, for a total of 249 captures (Table 2). The most commonly captured species by far was Wattled Honeyeater (163 captures), followed in descending order by Collared

Kingfisher (31), Samoan Starling (18), Cardinal Honeyeater (16), Polynesian Starling (6), Jungle Myna (5), White-rumped Swiftlet (4), Red-vented Bulbul (4), and Common Myna (2). Three recaptures, one each of Collared Kingfisher, Wattled Honeyeater, and Samoan Starling were of birds previously banded on Tutuila as part of other projects and these will be treated as newly banded birds in our data set. Four other target landbird species on Tutuila, Many-colored Fruit-Dove (*Ptilinopus perousii*), Purple-capped Fruit-Dove (*Ptilinopus porphyraceus*), Pacific Pigeon (*Ducula pacifica*), and Long-tailed Cuckoo (*Eudynamis taitensis*), have not yet been captured at the TMAPS stations. The 196 captures of individual birds during 3,285.37 net-hours (Table 1) results in a capture rate of 35.80 individual birds per 600 net-hours (a standard index to compare across locations and stations), and this value ranged from 0.37 per 600 net-hours for Common Myna to 24.12 per 600 net-hours for Wattled Honeyeater (Table 2). This overall capture rate is lower than found at most MAPS stations but is adequate to estimate vital rates for at least Wattled Honeyeater and Collared Kingfisher, perhaps Cardinal Honeyeater and Samoan Starling once more data are collected at more-productive replacement stations, and all species pooled.

Among stations (Table 3), the highest number of captures occurred at Aolau (61 captures) followed by Loto'asi (50), Amalau (48), Fagatele Bay (30), Mount Alava (25), Malaeloa (21), and Olovalu Crater (15). Species richness was greatest at Loto'asi with 7 species, followed by Fagatele Bay with 5 species, four stations with 4 species, and Olovalu Crater with 3 species (Table 3). Because of variation in the number of net-hours (Table 1), especially regarding Fagatele Bay (run for only three instead of four pulses) and Mount Alava (only one pulse), it is best to compare stations in terms of capture rate (individual birds per 600 net-hours). Using this metric, the highest capture rate was recorded at Mount Alava (95.74 individuals per 600 net-hours), followed by Aoloau (79.97), Loto'asi (55.26), Amalau (49.24), Fagatele Bay (37.63), Malaeloa (24.15), and Olovalu Crater (16.21).

DISCUSSION

The first four months of the Tropical Monitoring Avian Productivity and Survivorship (TMAPS) program in American Samoa was an unqualified success. Seven monitoring stations, representing a range of terrestrial habitats typical of Tutuila Island, were established across the length of the island; goals for mist-netting effort were met; and 249 captures of nine species were recorded. Extensive data on molt, plumage, breeding condition, skull pneumaticization, and morphometrics were collected on all nine species, and will be coupled with preliminary data from museum specimens (Pyle et al. 2012) to provide comprehensive information on molt, age and sex determination criteria, and molt-breeding overlap for the resident birds of American Samoa.

Two species, Wattled Honeyeater and Collared Kingfisher, were captured in numbers sufficient to calculate productivity and survivorship, and it is possible that, with improved capture rates after station re-alignments, that we may also be able to calculate these rates for Samoan Starling and Cardinal Honeyeater. The establishment of at least two new stations on Tutuila this year and three new stations next year on Ta'u Island (see below) will likely result in other species added to this list. Given the dearth of data on the demographics of Samoan landbirds, establishment of the

TMAPS program on Tutuila represents a significant advance in improving our understanding of this insular avifauna.

Continuation of the current sampling protocol will yield critical data on the survival, recruitment, and population growth rates of several endemic species. Our goal is to operate six stations on Tutuila continuously for 14 pulses (through September 2013), assess capture rates and other factors, select the best three of these stations for continued operation in future years, and establish three new stations on Ta'u Island in 2013 or 2014. These six stations (three on Tutuila and three on Ta'u) will then be operated for four months per year, as determined by TMAPS data indicating peak breeding, for at least four more years. Thus far, two stations on Tutuila, Fagatele Bay and Olovalu Crater, have already been discontinued due to low capture rates (Table 3) and other factors, and the first new replacement station, Mount Alava, shows promise in recording the highest individual capture rates of any of the stations during the first pulse of operation. Along with this station, Aoloau, Loto'asi, and Amalau have higher capture rates than the other stations and Loto'asi shows the highest species richness, so these stations will likely be strongly considered for continued operation in the future. We anticipate that the three new stations on Ta'u will not only increase capture rates of most of the species currently targeted, but we hope will add two new species, Blue-crowned Lory (*Vini australis*) and Fiji Shrikebill (*Clytorhynchus vitiensis*) to our list of species with adequate capture rates to assess their demographics.

Continued monitoring at the TMAPS stations and the realization of TMAPS goals will aid identification of conservation needs and formulation of management approaches for Samoan landbirds. 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 thank the U.S. Fish and Wildlife Service (USFWS) for providing funding through a State Wildlife Grant to American Samoa. Shelly Kremer was instrumental in instigating funding for TMAPS in the Pacific, including American Samoa, and Lainie Berry, formerly of Department of Marine and Wildlife Resources in American Samoa, and Ruth Utzurrum of USFWS in Honolulu greatly helped us secure funding by drafting and reviewing initial proposals for TMAPS work on Tutuila. Matthew Toilolo and Siafoi Naôaumu assisted us in the field and Sene (Olovalu Crater), Tom and Easter Bruce (Lotoôasi), Junior (Fagatele Bay), Wesley (Malaeloa), Richard (Amalau) and Walter Utu (Aoloau) granted us permission to establish TMAPS stations on their lands. Danielle Kaschube of the The Institute for Bird Populations (IBP) helped us create Figure 1. This is Contribution No. 454 of IBP.

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Table 1. Summary of the 2012 TMAPS program on the island of Tutuila, American Samoa (AMSA).

Station					August-November 2012 operation		
Name	Code	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Total number of net-hours	No. of pulses	Inclusive dates
Fagatele Bay	FABA	Old-growth moderate-slope, lowland tropical evergreen forest	14°21'51"S, 170°45'27"W	79	478.40	3	08/10 ï 10/12
Loto'asi	LOTO	Secondary, lowland, tropical forest and open-field edge	14°21'42"S, 170°46'27"W	12	542.92	4	08/07 ï 11/08
Olovalu Crater	OLOV	Mixed old-growth tropical forest and encroaching banana plantation	14°20'41"S, 170°45'29"W	70	555.15	4	08/03 ï 11/03
Malaeloa	MALA	Old-growth moderate-slope, lowland tropical evergreen forest; ephemeral wetlands	14°19'50"S, 170°46'26"W	43	521.82	4	08/15 ï 11/20
Aoloau	AOLO	Ridge-spine, secondary, tropical forest	14°19'03"S, 170°46'01"W	451	457.67	4	08/27 ï 11/27
Mount Alava	MTAL	Old-growth steep-slope, tropical forest; some secondary forest and plantation	14°17'05"S, 170°42'46"W	215	156.67	1	11/12 ï 11/14
Amalau	AMAL	Mixed, old-growth and secondary lowland tropical forest; some plantation	14°15'19"S, 170°39'32"W	35	572.74	4	08/21-11/23
ALL STATIONS					3,285.37	4	08/03 ï 11/27

Table 2. Summary of combined results for all seven American Samoan TMAPS stations operated in August-November 2012.

Species (Common and Scientific Names)	Birds captured: Newly banded	Un-banded	Re-captured	Birds/600 net-hours[1]
White-rumped Swiftlet, *Aerodramus spodiopygia*	3	1		0.55
Collared Kingfisher, *Todiramphus chloris*	17	1	13	3.10
Red-vented Bulbul, *Pycnonotus cafer*	4			0.73
Wattled Honeyeater, *Foulehaio carunculata*	132	3	28	24.12
Cardinal Honeyeater, *Myzomela cardinalis*	14		2	2.56
Polynesian Starling, *Aplonis tabuensis*	4	1	1	0.73
Samoan Starling, *Aplonis atrifusca*	15	2	1	2.73
Common Myna, *Acridotheres tristis*	2			0.37
Jungle Myna, *Acridotheres fuscus*	5			0.91
ALL SPECIES POOLED	196	8	45	35.80
Total Number of Captures		249		
Total Number of Species		9		

[1]Calculated based on individual birds, excluding recaptures.

Table 3. Capture summary for the seven individual TMAPS stations operated on the island of Tutuila, American Samoa (AMSA), in August-November 2012. N = Newly banded, U = Unbanded, R = Recaptures of banded birds.

	Fagatele Bay			Loto'asi			Olovalu Crater			Malaeloa			Aoloau			Mount Alava			Amalau		
Species[1]	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
White-rumped Swiftlet										3	1										
Collared Kingfisher	3		1	5	1	3	3		1	1		2	1			1		1	3		5
Red-vented Bulbul	1			3																	
Wattled Honeyeater	19		3	22	1	7	9		1	11		2	36		6	13	2	5	22		4
Cardinal Honeyeater				1									13		2						
Polynesian Starling										1			2		1		1		1		
Samoan Starling	2				1		1									2			10	1	1
Common Myna	1			1																	
Jungle Myna				5																	
ALL SPECIES POOLED	26		4	37	3	10	13		2	16	1	4	52		9	16	3	6	36	1	10
Total Number of Captures	30			50			15			21			61			25			47		
Captures/600 net-hours	37.63			55.26			16.21			24.15			79.97			95.74			49.24		
Total Number of Species	5			7			3			4			4			4			4		

[1] Scientific names given in Table 2.

Figure 1. Locations of the seven Tropical Monitoring Avian Productivity and Survivorship (TMAPS) stations operated during August-November 2012 on Tutuila Island, American Samoa. Station codes are listed in Table 1.