The Tropical Monitoring Avian Productivity and Survivorship (TMAPS) Program on Saipan, Commonwealth of the Northern Mariana Islands: 2011-2012 Report

Peter Pyle, James F. Saracco[1], Paul Radley[2], and Danielle R. Kaschube

The Institute for Bird Populations,
P.O. Box 1346, Point Reyes Station, CA 94956-1346

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[1] Corresponding author e-mail: jsaracco@birdpop.org
[2] CNMI Division of Fish & Wildlife, P.O. Box 10007, Saipan, MP 96950

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 focused on counts of birds with the principal goal of estimating trends (Bart 2005). Monitoring of demographic rates (productivity, recruitment, and survival) lends critical additional insight by providing data on causes of population changes (DeSante et al. 2005). Because demographic rates are directly affected by environmental stressors or management actions, they should more accurately and sensitively reflect short-term and local environmental changes than trends based on counts (Temple and Wiens 1989, DeSante and George 1994). In addition, demographic data can 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. 2008a). Finally, demographic data can be modeled as functions of environmental variables and incorporated into predictive population models to assess the viability of populations (Noon and Sauer 1992).

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). Such an effort was initiated in North America by The Institute for Bird Populations (IBP) in 1989 with the establishment of the Monitoring Avian Productivity and Survivorship (MAPS) program (DeSante 1992), a cooperative network of over 1,000 constant-effort mist-netting stations operated across North America that have provided demographic data for > 180 landbird species (DeSante and Kaschube 2007). Similar programs exist in Europe, which have become central components of national and international bird-monitoring efforts (e.g., Peach et al. 2004). The MAPS program was endorsed in 1991 by the Monitoring Working Group of Partners in Flight (PIF) and the USDI Bird Banding Laboratory, and has attracted participation from many U.S. agencies, including the National Park Service, Department of Defense, Texas Army National Guard, USDA Forest Service, and Fish and Wildlife Service, as well as hundreds of independent banding-station operators.

IBP, in collaboration with the Division of Fish and Wildlife of the Commonwealth of the Northern Mariana Islands, established and operated the first six "Tropical MAPS" (TMAPS) stations on the island of Saipan in April-July 2008 and continued operation of all six stations in April-July 2009, February-October 2010, and March 2011-March 2012. The overall goal of this effort is to provide baseline data on trends, vital rates, and habitat associations for up to nine populations of bird species indigenous to Saipan, upon which to base informed conservation strategies for this insular avifauna. Long-term goals of the TMAPS program on Saipan 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, survival rates, proportions of residents, and recruitment into the population (from capture-recapture data); (3) relate avian demographic data to weather and habitat; (4) identify population trends and proximate and ultimate causes of population change; (5) use these data to inform management; and (6) assess the success of management actions in an adaptive management framework. Saracco et al. (2008b) and Pyle (2009, 2010) provided summaries of TMAPS operation on Saipan in 2008-2010. Here we provide a summary of captures and indices of population size (capture rates) and productivity for TMAPS stations operated during 2011-2012 and provide average values of these indices during 2008-2012. We also provide data on breeding seasonality of four species (and all species pooled) now that we have operated stations year-round.

STUDY AREAS AND METHODS

In April 2008 we established six TMAPS stations in typical habitats utilized by landbirds on Saipan (Table 1; Fig. 1). We operated the six stations in April-July 2008 and again, in the exact same locations in which they were established in April-July 2009, February-October 2010, and March 2011-March 2012 (Table 1). Each year we expanded the length of the sampling season to gain further insight into breeding and molting seasonality of landbirds on Saipan. One station name was changed just after the 2008 season, from Naftan Point to Obyan, but the location remained the same in all five years. Each station consisted of a sampling area of about 20 ha. Within the central 8 ha of each station, ten 12-m long, 30-mm mesh, 4-tier nylon mist nets were erected at fixed net sites, in the exact same positions each year.

For the most part, stations were operated according to the standardized protocol established by The Institute for Bird Populations for use in the MAPS Program (DeSante et al. 2011). We operated each station once per ten-day period in 2008, 2009, 2010, and in March-July 2011. During July 2011 through March 2012 we operated stations on a different schedule according to our Monitoreo de Sobrevivencia Invernal (MoSI) program (DeSante and Saracco 2010). Under this scheme each station is operated for one pulse of three consecutive days, once per month, in order to be able to analyze survivorship with more precision using mark-recapture analyses between pulses rather than seasons. Overall in March 2011 through March 2012 we operated each station for 12 or 13 days during ten-day periods and 24 or 27 days during 8 or 9 one-month pulses (Table 1).

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 opening and closing times (to the nearest 10 min) for nets, as well as the time at which each net check commenced. We aimed to operate nets for six morning hours per day beginning 15 minutes after sunrise (on or near 05:30 AST). Inclement weather (mostly high sun and wind exposure) and very high capture rates at some sites, however, resulted in variable effort among stations (Table 1). Station operation was carried out by six IBP biologist interns (see Acknowledgments) who were experienced MAPS-station operators and were trained in TMAPS protocols, including molt patterns and ageing criteria of indigenous species of Saipan, by IBP staff biologists.

With few exceptions, all birds captured were identified to species, age, and sex based on criteria outlined by Pyle et al. (2008) and Radley et al. (2011) and, if unbanded, they 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. 2011):

- 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

Breeding (summer residency) status (confirmed breeder, likely breeder, non-breeder) 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 (see Appendix I). We used these data to classify each species at each station according to three residency categories: breeder, migrant, or transient (Appendix I). Data on habitat structure and floristics were also collected and will be incorporated as covariates in future analyses of bird data. John W. Shipman of Zoological Data Processing, Socorro, NM, entered banding data. IBP staff biologists entered effort data and proofed and verified digitized banding data. Verification of banding data involved running all records through a series of specialized computer programs. These programs included:

- 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 degree of skull pneumaticization, breeding condition (extent of cloacal protuberance and brood patch), extent of juvenal plumage, extent of body and flight-feather molt, extent of primary-feather wear, and presence of molt limits and plumage characteristics.
- Screening programs, which allow identification of unusual or duplicate band numbers or unusual band sizes for each species.
- Verification programs to screen banding and recapture data for inconsistent species, age, or sex determinations for each band number. Discrepancies or suspicious data identified by these programs were corrected if necessary. We used wing chord, body mass, fat content, date and station of capture, and pertinent notes as supplementary information for the correct determination of species, age, and sex.

In addition, digital images of the wing upper-surface were obtained for many captures to further refine our knowledge on molt patterns and ageing criteria for these species (see Pyle 2008). All digital images of open wings were also compared with banding data during the verification process to improve the accuracy of age and sex designations.

For each species and for all species pooled at each location, we calculated (1) numbers of newly banded birds, recaptured birds, and birds released unbanded; (2) numbers and capture rates (per 600 net-hours) of first captures (in each year) for individual adult and young birds; and (3) the ratio of young to adult birds ("reproductive index"; Peach et al. 1996). Capture rates and reproductive index were based on data collected in April-July 2011 to facilitate comparison of landbird dynamics between each of the four years. To further compare capture rates among stations and to values obtained by the MAPS program in North America, we also calculated four-year means for the numbers of adult and young birds captured per 600 net hours and the reproductive index for each individual species and for all species pooled at each of the six stations and for all six stations combined. These means were calculated based on data collected in April-July during each of 2008, 2009, 2010, and 2011.

In order to assess breeding seasonality we calculated the proportion of adult birds captured with "full" brood patches or cloacal protuberances (MAPS data scores 2-3) for each ten-day or 11-day period throughout the year.

RESULTS

We recorded 3,018 captures of 14 species of birds during the extended 2011-2012 TMAPS season on Saipan (Table 2). Of these, 1,797 (59.5%) were of newly banded birds, 1,094 (36.2%) were of recaptures, and 127 (4.2%) were of birds released unbanded (primarily due to escape before processing). The most commonly captured species was Rufous Fantail (see Appendix I for scientific names), of which 1,498 captures were recorded, representing 49.6% of all captures. This was followed by Bridled White-eye (583 captures), Golden White-eye (428), Micronesian Honeyeater (217), Orange-cheeked Waxbill (108), Collared Kingfisher (84), White-throated Ground-Dove (30), Nightingale Reed-Warbler (21), Micronesian Starling (20), Philippine Turtle-Dove (12), Mariana Fruit Dove (8), Eurasian Tree Sparrow (4), Yellow Bittern (3), and Red Junglefowl (2). Most of these species are endemic or indigenous to Saipan, whereas the waxbill, turtle-dove, tree sparrow, and junglefowl are non-native. Eleven additional species were recorded at stations but not captured (Appendix I), primarily consisting of waterbirds but also including the indigenous Micronesian Megapode and Mariana Swiftlet.

Among the six stations (Table 3) the greatest number of captures in 2011-2012 occurred at the Obyan station (894 captures), followed by Bird Island Conservation Area (755), Laderan Tangke (644), Sabana Talofofo (276), Kingfisher (239), and Mount Tapochau (210). Species richness was highest at Bird Island (13 species) and lowest at Kingfisher (9 species). In order to standardize the number of captures with respect to variation in mist-netting effort (see Table 1), we present capture rates (per 600 net-hours) of individual adult and young birds, as well as the reproductive index (young captured per adult), for each species and for all species pooled at each station during April-July 2011 (Table 4). These capture indices suggest that the total adult population size in 2011-2012 was greatest at Bird Island (124.3 adults/600 net hours), followed by Laderan Tanke (114.8), Obyan (114.3), Kingfisher (65.2), Sabana Talofofo (49.7), and Mount Tapochau (44.8).

Compared with April-July 2010, two stations showed lower capture rates (5.0% lower at Laderan Tangke and 26.1% lower at Mount Tapachou), and four stations showed higher rates, varying from 5.1% higher at Sabana Talofofo to 28.4% higher at Obyan. The capture rate of adults at the six stations combined was 90.9 adults per 600 net hours (Table 2), up 9.3% from the 83.2 per 600 net-hours records in 2010 but down 49.7% from the 180.7 per 600 net-hours recorded in 2009.

The most abundant indigenous breeding landbird at the six Saipan TMAPS stations in April-July 2011, as determined by adult capture rate, was Rufous Fantail (45.9 per 600 net-hours), followed in descending order by Golden White-eye (15.4), Bridled White-eye (11.9), Micronesian Honeyeater (7.9), Collared Kingfisher (2.6), White-throated Ground-Dove (2.0), Nightingale Reed-Warbler (1.3), Micronesian Starling (1.3), and Marianas Fruit-Dove (0.7). The capture rates of Collared Kingfisher and Bridled White-eye were lower than they were in 2010 (by 31.6% and 33.9%, respectively) whereas rates for the other seven species were higher, including 38.6% higher for Micronesian Honeyeater, 20.8% higher for Rufous Fantail, and 36.3% higher for Golden White-eye.

Captures of young of all species pooled (Table 4) showed a somewhat different order to captures of adults, being highest at Obyan (54.5 young/600 net hours), followed by Bird Island (54.3), Laderan Tangke (43.2), Mount Tapochau (24.6), Kingfisher (15.5), and Sabana Talofofo (15.0). The reproductive index in 2011, as determined by the number of young per adult, was 0.41 when all six stations were combined (Table 2), down (by 24.1%) from the 0.54 recorded in 2010 but up (by 356%) from the 0.09 recorded in 2009. The reproductive index was highest at Mount Tapochau (0.55), followed by Obyan (0.48), Bird Island (0.44), Laderan (0.38), Kingfisher (0.24), and Sabana Talofofo (0.30).

Mean numbers of individual adults (an index of adult population size) and young captured per 600 net-hours, and productivity (reproductive index) during April-July, averaged over the four-year period 2008-2011, are presented in Table 5 for each station and for all six stations combined. Values for all species pooled indicate that the largest breeding populations (adult captures) occurred at Laderan Tangke, followed by Bird Island, Obyan, Mount Tapachou, Kingfisher, and Sabana Talafofo. This order has remained consistent during all four years. Productivity over the four years was highest at Obyan, followed by Mount Tapachou, Bird Island, Laderan Tangke, Kingfisher, and Sabana Talafofo. This order was the same as that based on 2008-2010 data, which had varied before this. The highest capture rates during 2008-2011 for each of the indigenous landbird species were: Rufous Fantail (68.9 adults per 600 net hours overall and the highest rate at Laderan Tangke), Bridled White-eye (26.3 and Obyan), Golden White-eye (24.9 and Bird Island), Micronesian Honeyeater (10.6 and Sabana Talofofo), Collared Kingfisher (6.1 and Laderan Tangke), White-throated Ground-Dove (2.6 and Kingfisher), Micronesian Starling (2.0 and Sabana Talofofo), Nightingale Reed-Warbler (1.2 and Sabana Talofofo), and Mariana Fruit-Dove (0.6 and Sabana Talofofo). Thus, although Sabana Talofofo consistently has the lowest overall capture rates they show the highest rates for four of these nine species. For all six stations combined, the four-year capture rate was 147.0 adults per 600 net-hours and the reproductive index over the four years was 0.40 young/adults.

Proportions of adults in breeding condition (with full brood patches or cloacal protuberances) for four species and all species pooled, by 10-day or 11-day period throughout the year, are shown in Figure 2. The figure for all species pooled generally indicates prolonged bi-modal breeding seasons for landbirds on Saipan, with one season spanning February to May and a second season spanning June-November. Indications for similar breeding patterns were observed for Bridled White-eye, Micronesian Honeyeater, and Rufous Fantail, whereas Golden White-eye appeared to show a pattern indicating more consistent, year-round breeding (Fig. 2)

DISCUSSION

The first five years of the Tropical Monitoring Avian Productivity and Survivorship (TMAPS) program on Saipan have been highly successful. Specifically, we have (1) established six monitoring stations, representing a range of terrestrial habitats typical of the region, across the length of the island; (2) met mist-netting effort goals for all stations in all periods and pulses of station operation; and (3) registered over 7,000 captures of birds over the 5-year period. These first five years have also enabled us to collect extensive data on molt, plumage, breeding condition, skull pneumaticization, and morphometrics; and have provided a foundation for developing criteria for determining age and sex in these birds (Pyle et al. 2008, Radley et al. 2011) and the discovery of a unique bivariate molt pattern in Rufous Fantail (Junda et al. in press). Additional publications based on TMAPS data from Saipan are planned.

The 2011 breeding season (April-July) was marked by higher capture rates of adults but lower productivity rates (young/adult) than were recorded in 2010. This was opposite to the changes observed between 2009 and 2010 and may be related to affects of rainfall (dry vs. wet seasons) on landbird dynamics (Pyle et al. 2010). Alternatively, at MAPS stations in North America we often see an alternating pattern of high and low adult population sizes coupled with low and high reproductive rates, respectively, and suspect that this relates to density-dependent effects on breeding success and lower success by first-time breeders after high recruitment. It will be interesting to see if such dynamics are occurring on Saipan, with or without additional effects of rainfall, and a thorough analysis of this and other aspects of landbird breeding success and survival will be undertaken in 2013.

Given the dearth of data on Micronesian landbirds (Rodda et al. 1998, Mosher and Fancy 2002, Sachtleben et al. 2006, Camp et al. 2009), establishment of the TMAPS program on Saipan represents a significant advance in improving our understanding of this insular avifauna. The need for understanding the dynamics of landbird vital rates is pressing given the many threats to the persistence of these populations such as those associated with habitat loss the potential introduction of brown treesnake *Boiga irregularis* (Rodda et al. 1998; Camp et al. 2009), and the general vulnerability of insular endemic landbird taxa. Continued operation of these six stations on Saipan is planned through July 2012, after which data will be fully analyzed to understand where vulnerabilities may exist and to suggest management actions to counterbalance them. In coming years we will also set up TMAPS stations on nearby Rota to compare landbird dynamics there with those of Saipan. We look forward to continuing this important avian-conservation work in the future.

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Table 1. Summary of the TMAPS program on the island of Saipan, Commonwealth of the Northern Marianas Islands (CNMI), Micronesia from March 2011 through March 12012.

Station					March 2011- March 2012 operation		
Name	Code	Major Habitat Type	Latitude-longitude	Avg Elev. (m)	Number of net-hours period/pulse	No. of periods/ pulses	Inclusive dates
Bird Island Conservation Area	BICA	Lowland tropical evergreen tangantangan forest	15°15'45"N,145°48'50"E	30	738.7	13	03/28/11 – 07/26/11
					1329.3	8	08/13/11 – 03/19/12
Laderan Tangke	LATA	Lowland tropical evergreen tangantangan forest and lowland tropical rainforest	15°15'10"N,145°47'54"E	207	713.3	13	03/29/11 – 07/28/11
					1385.0	8	08/22/11 – 03/27/12
Sabana Talofofo	SATA	Tropical *Casuarina* savannah with dense swordgrass thicket	15°13'07"N,145°45'44"E	161	536.0	12	03/23/11 – 07/10/11
					1247.0	9	07/20/11 – 03/04/12
Kingfisher	KIFI	Lowland tropical broad-leaf evergreen rainforest with riparian zone	15°13'02"N,145°46'37"E	23	591.2	13	03/26/11 – 07/25/11
					1098.7	8	08/09/11 – 03/14/12
Mount Tapochau	MTAP	Submontane tropical mixed broad-leaf evergreen rainforest	15°11'01"N,145°44'04"E	274	607.3	13	03/25/11 – 07/24/11
					1032.5	8	08/04/11 – 03/10/12
Obyan	OBYA	Lowland tropical evergreen tangantangan forest	15°06'31"N,145°43'49"E	1	724.3	13	03/27/11 – 07/27/11
					1381.0	8	08/18/11 – 03/23/12
ALL STATIONS					3910.8	13	03/23/11 – 07/28/11
					7473.5	8	07/20/11 – 03/27/12

[1] Total net-hours for the months March 2011 through March 2012. From March 2011 through July 20, 2011 stations were operated one day per 10 day period. From July 20, 2011 through March 2012 stations were operated in 3 day pulses once per month.

Table 2. Summary of combined results for all six Saipan TMAPS stations. Number of captures for March 2011 through March 2012 and number of birds per 600 net hours for the peak breeding period, April through July 2011.

	Birds captured			Birds/600 net-hours		
Species[1]	Newly banded	Un-banded	Recap-tured	Adults	Young	Prop. Young
Red Junglefowl		2				
Yellow Bittern	3			0.0	0.0	und.[2]
Philippine Turtle-Dove	10	2		0.2	0.0	0.00
Mariana Fruit-Dove	8			0.7	0.0	0.00
White-throated Ground-Dove	24	4	2	2.0	0.3	0.17
Collared Kingfisher	45		39	2.6	1.8	0.69
Micronesian Honeyeater	147	14	56	7.9	3.5	0.44
Rufous Fantail	681	33	784	45.9	16.7	0.37
Nightingale Reed-Warbler	10		11	1.3	0.0	0.00
Bridled White-eye	459	41	83	11.9	5.6	0.47
Golden White-eye	297	14	117	15.4	8.4	0.55
Micronesian Starling	18	2		1.3	0.3	0.25
Orange-cheeked Waxbill	92	14	2	1.5	0.2	0.11
Eurasian Tree Sparrow	3	1		0.2	0.0	0.0
ALL SPECIES POOLED	1797	127	1094	90.9	36.9	0.41
Total Number of Captures		3018				
Number of Species	13	10	8	12.0	8.0	
Total Number of Species		14			12.0	

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

Table 3. Capture summary for the six individual TMAPS stations operated on the island of Saipan, Commonwealth of the Northern Marianas Islands (CNMI), Micronesia, in March 2011 – March 2012. N = Newly banded, U = Unbanded, R = Recaptures of banded birds.

	Bird Island Cons. Area			Laderan Tangke			Sabana Talofofo			Kingfisher			Mount Tapochau			Obyan		
Species[1]	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Red Junglefowl		1			1													
Yellow Bittern	1						1									1		
Philippine Turtle-Dove	1			3	1					1						5	1	
White-throated Ground-Dove	3	1		4			3			8	2	1	3	1	1	3		
Mariana Fruit-Dove	2			1			1						2			2		
Collared Kingfisher	12		10	10		19	8			4		6	5		3	6		1
Micronesian Honeyeater	40	5	16	15	2	5	40	1	29	18	3	2	19	2	3	15	1	1
Rufous Fantail	134	8	177	189	13	200	25	3	23	52	2	68	43	3	17	238	4	299
Nightingale Reed-Warbler	3		1	3			2		10				1			1		
Bridled White-eye	103	14	22	80	12	12	33	3	15	10	1		22		3	211	11	31
Golden White-eye	129	6	59	44	4	18	7		8	39		18	60	2	14	18	2	
Micronesian Starling		1		5			6	1		1			2			4		
Orange-cheeked Waxbill	6			3			45	6	2	3			2	2		33	6	
Eurasian Tree Sparrow							3	1										
ALL SPECIES POOLED	434	36	285	357	33	254	174	15	87	136	8	95	159	10	41	537	25	332
Total Number of Captures		755			644			276			239			210			894	
Number of Species	11	7	6	11	6	5	12	6	6	9	4	5	10	5	6	12	6	4
Total Number of Species		13			12			12			9			10			12	

[1] Scientific names given in Appendix.

Table 4. Numbers of aged individual birds captured per 600 net-hours and proportion of young in the catch at the six individual TMAPS stations operated on the island of Saipan, Commonwealth of the Northern Marianas Islands (CNMI), Micronesia, in April through July, 2011.

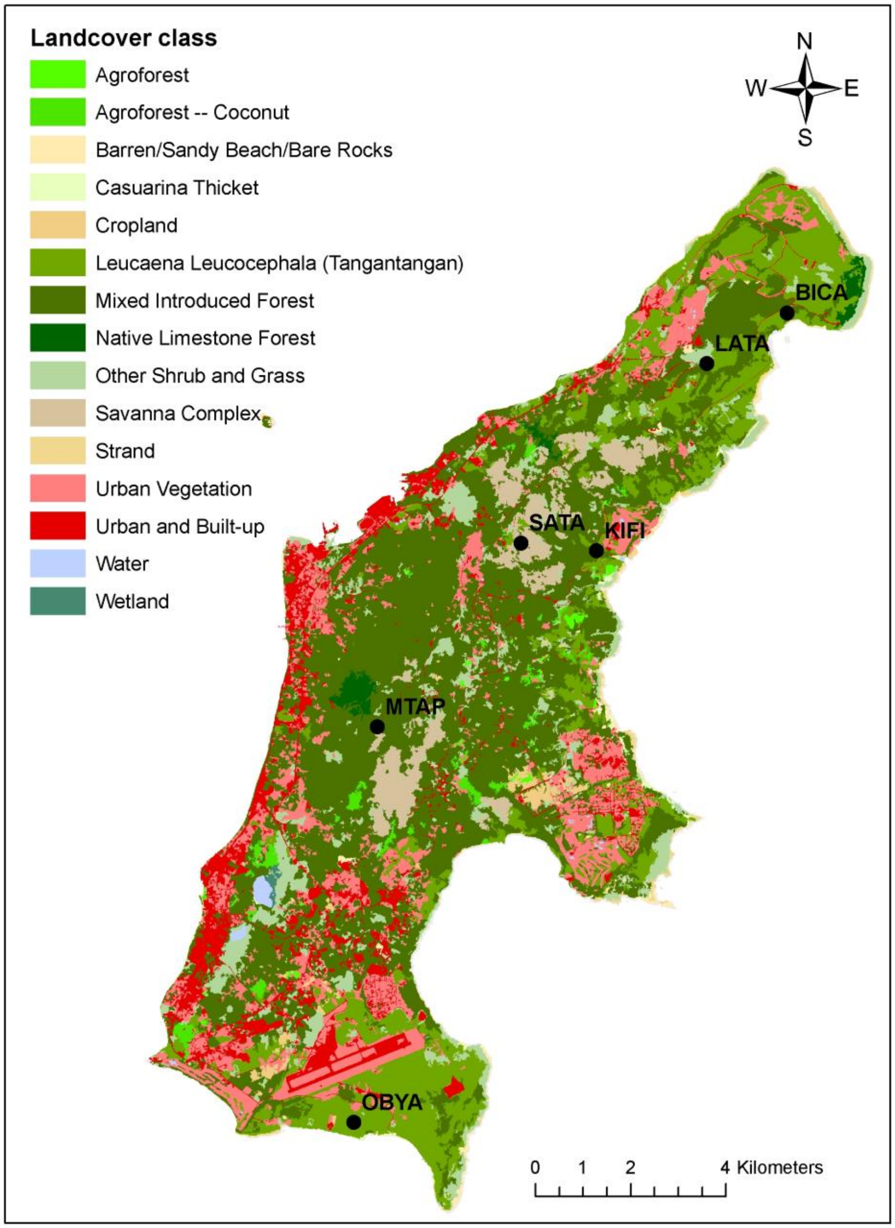
	Bird Island Cons. Area			Laderan Tangke			Sabana Talofofo			Kingfisher			Mount Tapochau			Obyan		
Species[1]	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.	Ad.	Yg.	Prop. Yg.
Yellow Bittern	0.0	0.0	0.00															
Philippine Turtle-Dove				0.0	0.0	0.00										0.9	0.0	0.00
White-throated Ground-Dove	1.8	0.9	0.50	0.9	0.9	1.00	0.9	0.0	0.00	5.5	0.0	0.00	3.2	0.0	0.00			
Mariana Fruit-Dove	0.9	0.0	0.00										2.1	0.0	0.00	0.9	0.0	0.00
Collared Kingfisher	4.4	6.1	1.40	3.7	1.8	0.50	0.9	0.0	0.00	4.4	0.0	0.00	1.1	0.0	0.00	0.9	1.8	2.00
Micronesian Honeyeater	12.3	0.9	0.07	3.7	5.5	1.50	20.6	7.5	0.36	4.4	0.0	0.00	2.1	2.1	1.00	1.8	3.6	2.00
Rufous Fantail	48.2	23.6	0.49	76.2	18.4	0.24	10.3	1.9	0.18	33.1	6.6	0.20	12.8	11.7	0.92	76.8	31.3	0.41
Nightingale Reed-Warbler	2.6	0.0	0.00	0.0	0.0	0.00	3.8	0.0	0.00				1.1	0.0	0.00			
Bridled White-eye	15.8	3.5	0.22	12.9	6.4	0.50	6.6	2.8	0.43	2.2	3.3	1.50	4.3	0.0	0.00	24.1	15.2	0.63
Golden White-eye	38.5	19.3	0.50	14.7	9.2	0.63	2.8	1.9	0.67	15.5	5.5	0.36	16.0	10.7	0.67	0.9	1.8	2.00
Micronesian Starling				2.8	0.9	0.33	1.9	0.9	0.50				2.1	0.0	0.00	0.9	0.0	0.00
Orange-cheeked Waxbill	0.0	0.0	0.00	0.0	0.0	0.00	0.9	0.0	0.00							7.1	0.9	0.13
Eurasian Tree Sparrow							0.9	0.0	0.00									
ALL SPECIES POOLED	124.3	54.3	0.44	114.8	43.2	0.38	49.7	15.0	0.30	65.2	15.5	0.24	44.8	24.6	0.55	114.3	54.5	0.48
Number of Species	8	6		7	7		10	5		6	3		9	3		9	6	
Total Number of Species		8			7			10			6			9			9	

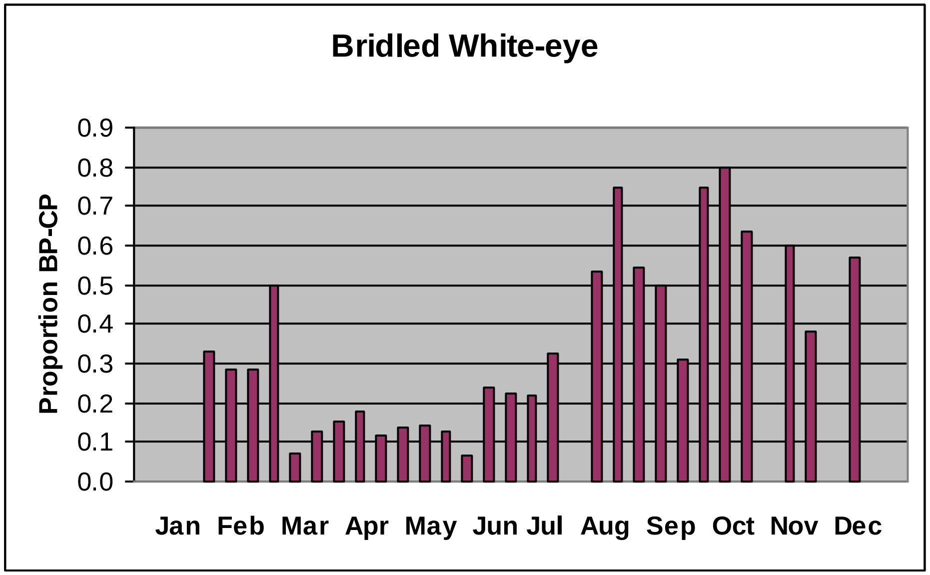
[1] Scientific names given in Appendix.

Table 5. Mean numbers of aged individual birds captured per 600 net-hours and reproductive index at the six individual MAPS stations operated the island of Saipan, Commonwealth of the Northern Marianas Islands (CNMI), Micronesia, averaged over the four years, 2008-2011, including only the months April through July.

	Bird Island Cons. Area			Laderan Tangke			Sabana Talofofo			Kingfisher			Mount Tapochau			Obyan			All stations pooled		
Species	Ad.	Yg.	Repr. Ind.	Ad.	Yg.	Repr. Ind.	Ad.	Yg.	Repr. Ind.	Ad.	Yg.	Repr. Ind.	Ad.	Yg.	Repr. Ind.	Ad.	Yg.	Repr. Ind.	Ad.	Yg.	Repr. Ind.[2]
Yellow Bittern	0.0	0.2	und.				0.0	0.3	und.	0.0	0.3	und.				0.2	0.0	0.00	0.0	0.1	und.
Philippine Turtle-Dove	0.7	0.0	0.00	1.4	0.0	0.00				0.6	0.0	0.00	0.4	0.0	0.00	1.2	0.4	0.67	0.7	0.1	0.50
White-thrtd. Grd.-Dove	4.1	1.0	0.28	1.3	0.7	0.75	1.5	0.0	0.00	7.0	0.8	0.22	1.1	0.3	0.33	0.9	0.7	0.67	2.6	0.6	0.32
Mariana Fruit-Dove	0.5	0.0	0.00	0.5	0.0	0.00	1.3	0.0	0.00				1.1	0.0	0.00	0.2	0.2	1.00	0.6	0.0	0.06
Collared Kingfisher	8.0	3.1	0.64	12.3	1.3	0.11	0.3	0.9	2.00	9.2	0.6	0.08	4.4	0.0	0.00	2.0	1.2	0.92	6.1	1.2	0.25
Micronesian Honeyeater	17.0	9.0	0.60	5.7	3.2	0.69	23.9	7.1	0.33	7.9	3.3	0.46	9.4	3.7	0.50	2.0	4.7	2.63	10.6	5.1	0.54
Rufous Fantail	87.3	31.4	0.41	122.7	28.3	0.27	13.1	3.6	0.24	42.0	9.3	0.25	31.9	17.2	0.59	95.9	48.0	0.60	68.9	24.2	0.40
Nightingale Reed-Warb.	2.4	0.2	0.17	1.3	0.3	0.33	3.1	0.6	0.33				0.6	0.0	0.00				1.2	0.2	0.13
Bridled White-eye	28.4	8.8	0.34	37.0	13.2	0.50	14.7	3.9	0.30	3.9	0.8	0.25	15.9	5.8	0.44	50.0	27.7	0.67	26.3	10.6	0.48
Golden White-eye	55.6	23.2	0.55	26.1	12.8	0.68	4.7	0.9	0.17	22.1	4.2	0.28	32.1	12.4	0.45	5.0	3.8	2.67	24.9	9.9	0.53
Micronesian Starling	1.9	0.2	0.08	2.0	0.7	0.33	4.5	0.3	0.05	1.7	0.9	0.67	2.0	0.0	0.00	0.7	0.2	0.33	2.0	0.4	0.19
Orange-cheeked Waxbill	1.5	0.0	0.00	0.9	0.0	0.00	7.5	0.0	0.00	0.3	0.0	0.00	0.5	0.0	0.00	5.0	0.4	0.12	2.5	0.1	0.02
Eurasian Tree Sparrow							3.5	0.3	0.08										0.5	0.0	0.08
ALL SPECIES POOLED	207.3	77.0	0.42	211.2	60.4	0.33	78.0	17.8	0.22	94.7	20.2	0.23	99.4	39.4	0.44	163.0	87.5	0.62	147.0	52.7	0.40
Number of Species	11	9		11	8		11	9		9	8		11	5		11	10		12	11	
Total Number of Species		12			11			12			10			11			11			13	

Figure 1. Locations of the six Tropical Monitoring Avian Productivity and Survivorship (TMAPS) stations operated during 2008-2010 on Saipan, Commonwealth of the Northern Mariana Islands, and distribution of land cover classes on the island. Station codes are listed in Table 1. Land cover data were obtained from the US Forest Service (for detail on methodology, see: http://www.fs.fed.us/r5/spf/fhp/fhm/landcover/islands/CNMI_Report.pdf).




Bridled White-eye
Proportion BP-CP
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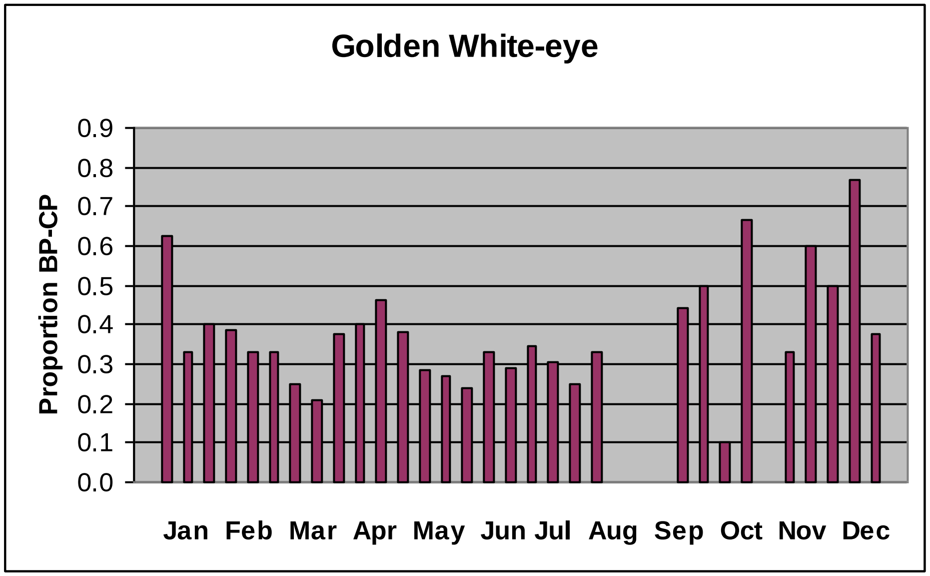
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Golden White-eye
Proportion BP-CP
0.9
0.8
0.7
0.6
0.5
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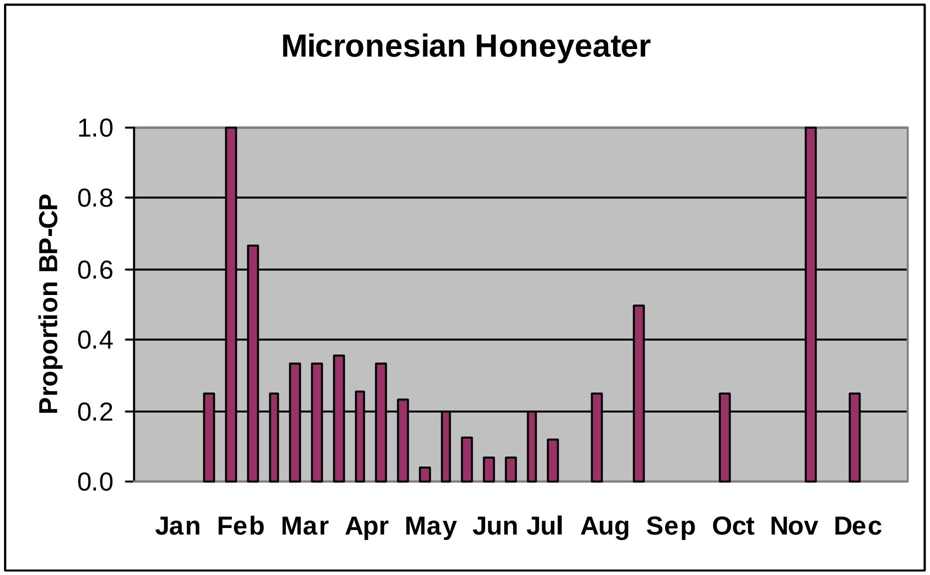
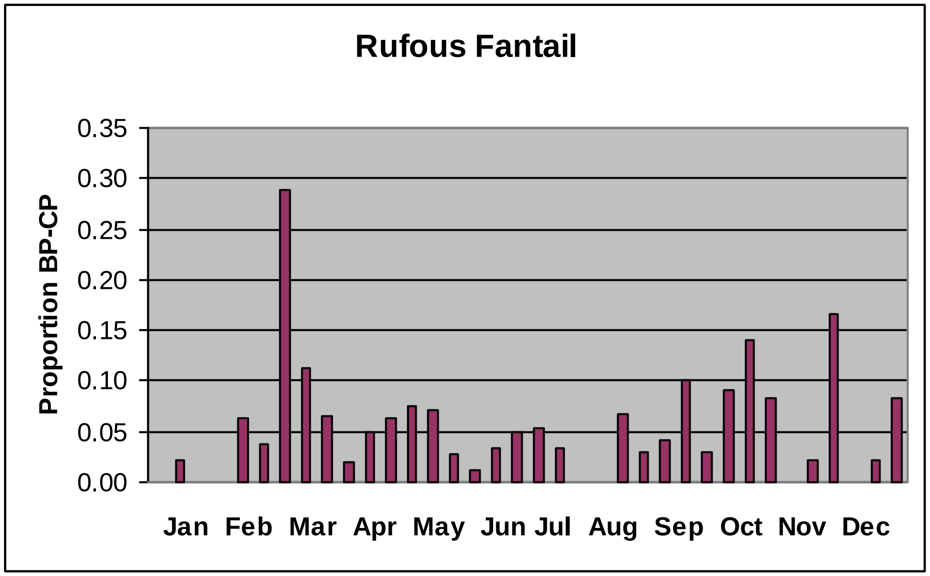
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Micronesian Honeyeater
Proportion BP-CP
1.0
0.8
0.6
0.4
0.2
0.0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Rufous Fantail
Proportion BP-CP
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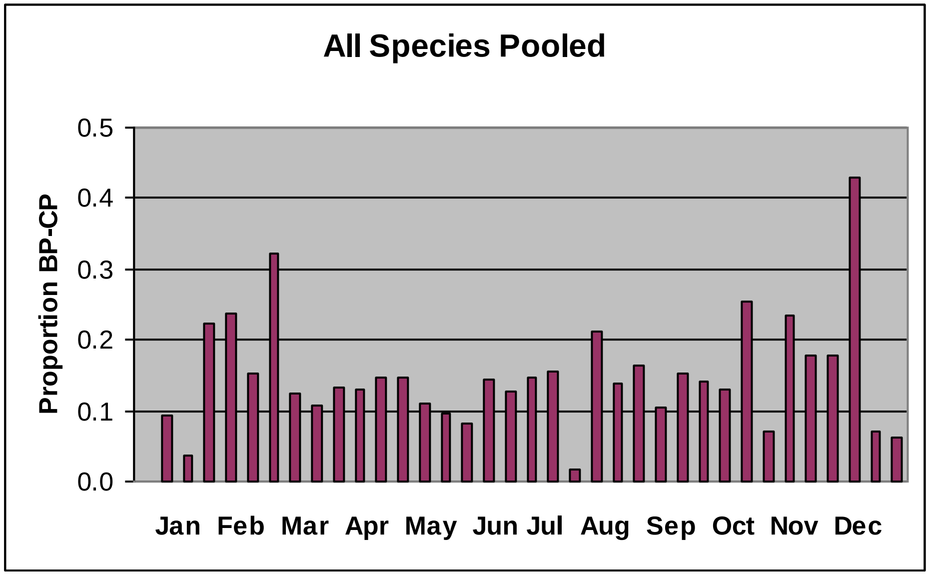

Figure 2. Proportion of adult birds with either a brood patch (BP) or cloacal protuberance (CP) indicating active breeding at the time of capture. The year is divided into 36 periods of 10 or 11 days each.

Appendix I. Numerical listing (in AOU checklist order) of species sequence numbers, species alpha codes, and species names for birds banded or encountered during the four years (2008-2011) of the TMAPS Program at the six stations on Saipan, Commonwealth of the Northern Marianas Islands (CNMI), Micronesia. Cumulative breeding status for all years in which each station was operated are also included (B = Regular Breeder (all years); U = Usual Breeder (>½, not all, years); O = Occasional Breeder (<½ years); T = Transient; M = Migrant; ? = Uncertain Species ID

NUMB	SPEC	SPECIES COMMON NAME	GENUS SPECIES	Bird Island Cons. Area (BICA)	Laderan Tangke (LATA)	Sabana Talofofo (SATA)	Kingfisher (KIFI)	Mount Tapochau (MTAP)	Obyan (OBYA)
99054	MIME	Micronesian Megapode	*Megapodius laperouse*	T	T			T	
02900	REJU	Red Junglefowl	*Gallus gallus*	U	U	O	U	U	U
00730	WTTR	White-tailed Tropicbird	*Phaethon lepturus*	T	T	T	T	T	
00750	RTTR	Red-tailed Tropicbird	*Phaethon rubricauda*		T				
00920	GREF	Great Frigatebird	*Fregata minor*			T			
00960	YEBI	Yellow Bittern	*Ixobrychus sinensis*	O	U	O	O	T	U
99080	PRHE	Pacific Reef Heron	*Egretta sacra*	T	T	T	T	T	T
03520	COMO	Common Moorhen	*Gallinula chloropus*				T		
03690	PAGP	Pacific Golden-Plover	*Pluvialis fulva*	T		T			
05090	BRNO	Brown Noddy	*Anous stolidus*	T		T			T
05100	BLNO	Black Noddy	*Anous minutus*	T	T	T	T	T	T
05120	WHTT	White Tern	*Gygis alba*	O	O	B	U	O	U
99007	PHTD	Philippine Turtle-Dove	*Streptopelia bitorquata*	B	B	B	B	B	B
99073	WTGD	White-throated Ground-Dove	*Gallicolumba xanthonura*	B	B	B	B	B	B
99006	MAFD	Mariana Fruit-Dove	*Ptilinopus roseicapilla*	U	B	B	B	B	U
07490	MASW	Mariana Swiftlet	*Aerodramus bartschi*	T	T	T	O	O	T
99057	COLK	Collared Kingfisher	*Todiramphus chloris*	B	B	B	B	B	B
99062	MIHO	Micronesian Honeyeater	*Myzomela rubratra*	B	B	B	B	B	B
99063	RUFA	Rufous Fantail	*Rhipidura rufifrons*	B	B	B	B	B	B
99053	NIRW	Nightingale Reed-Warbler	*Acrocephalus luscinia*	B	B	B	B	O	B
99064	BRWE	Bridled White-eye	*Zosterops conspicillatus*	B	B	B	B	B	B

Appendix I. continued.

NUMB	SPEC	SPECIES COMMON NAME	GENUS SPECIES	BICA	LATA	SATA	KIFI	MTAP	OBYA
99065	GOWE	Golden White-eye	*Cleptornis marchei*	B	B	B	B	B	B
99066	MIST	Micronesian Starling	*Aplonis opaca*	B	B	B	B	B	B
19990	OCHW	Orange-cheeked Waxbill	*Estrilda melpoda*	O	U	B	U	B	B
19930	ETSP	Eurasian Tree Sparrow	*Passer montanus*	T		B			