Wildlife Restoration Grant Program
Final Performance Report

Avian Monitoring and Management
F21AF03860

Submitted by
The Commonwealth of the Northern Mariana Islands
Department of Lands and Natural Resources
Division of Fish and Wildlife
Manny Pangelinan, Director

Period Covered: October 01, 2021 – September 30, 2022

FINAL PERFORMANCE REPORT FISCAL YEAR 2022
Pittman and Robertson Wildlife Restoration

Commonwealth of the Northern Mariana Islands
Division of Fish and Wildlife
Department of Lands and Natural Resources

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12/13/22
Date

Annual Performance Report

1. **State:** Commonwealth of the Northern Mariana Islands

   Federal Grant Identifier: F21AF03860-00

   Grant Name: Avian Monitoring and Management FY 2022

   Project Name: Avian Monitoring and Management FY 2022

2. **Report Period**: October 1, 2021 through September 30, 2022

3. **Location of work**: Saipan, Tinian, and Rota, Commonwealth of the Northern Mariana Islands

4. **Costs**:

SOURCE	BUDGETED	ESTIMATED COST
Federal:	$ [redacted]	$[redacted]
State:	0	0
Other:	0	0
Total Federal:	$[redacted]	$[redacted]
Total Match:	0	0
TOTAL PROJECT:	$[redacted]	$[redacted]

5. **Objectives and Target Activities:**

   1. Conduct 1 investigation to determine the abundance of all native and non-native landbirds on Saipan, Tinian, and Rota by September 30, 2022.
   (**TRACS Strategy**: Research, Survey, Data Collection, and Analysis; **Activity Tag 1**: Fish and wildlife species data acquisition and analysis; **Unit of Measurement**: 1 investigation; **Target Species**: Rota bridled white-eye (*Zosterops rotensis*); Micronesian Starling (*Aplonis opaca*); Nightingale Reed-Warbler (*Acrocephalus luscinia*); Mariana Swiftlet (*Aerodramus bartschi*); Tinian Monarch (*Monarcha takatsukasae*); Mariana Fruit Dove (*Ptilinopus roseicapilla*); Golden White-eye (*Cleptornis marchei*); Mariana Crow (*Corvus kubaryi*); Rufous Fantail (*Rhipidura rufifrons*); Micronesian Myzomela (*Myzomela rubratra*); Micronesian Megapode (*Megapodius laperouse*); Eurasian Tree Sparrow (*Passer montanus*); Black Drongo (*Dicrurus macrocercus*); White-throated Ground-Dove (*Gallicolumba xanthonura*); White-collared Kingfisher (*Halcyon chloris*); Bridled White-eye (Zosterops *conspicillatus*); Philippine Collared Dove (*Streptopelia bitorquata*))

   2. Conduct 1 investigation to assess the population of all native and non-native forest birds on Rota by September 30, 2022.
   (**TRACS Strategy**: Research, Survey, Data Collection, and Analysis; **Activity Tag 1**: Fish and wildlife species data acquisition and analysis; **Unit of Measurement**: 1 investigation; **Target Species**: Rota bridled white-eye (*Zosterops rotensis*); Micronesian Starling (*Aplonis opaca*);

Mariana Fruit Dove (*Ptilinopus roseicapilla*); Mariana Crow (*Corvus kubaryi*); Rufous Fantail (*Rhipidura rufifrons*); Micronesian Myzomela (*Myzomela rubratra*); Eurasian Tree Sparrow (*Passer montanus*); Black Drongo (*Dicrurus macrocercus*); White-throated Ground-Dove (*Gallicolumba xanthonura*); White-collared Kingfisher (*Halcyon chloris*); Philippine Collared Dove (*Streptopelia bitorquata*))

3. Conduct 1 investigation to determine abundance of wetland-associated birds on Saipan, Tinian, and Rota by September 30, 2022.
   (**TRACS Strategy**: Research, Survey, Data Collection, and Analysis; **Activity Tag 1**: Fish and wildlife species data acquisition and analysis; **Unit of Measurement**: 1 investigation; **Target Species:** Yellow Bittern (*Ixobrychus sinensis*); Pacific Reef Heron (*Egretta sacra*); Mariana Common Moorehen (*Gallinula chloropus guami*)

4. Conduct 1 investigation to determine the abundance for seabirds at the I Chenchon colony on Rota by September 30, 2022.
   (**TRACS Strategy**: Research, Survey, Data Collection, and Analysis; **Activity Tag 1**: Fish and wildlife species data acquisition and analysis; **Unit of Measurement**: 1 investigation; **Target Species**: Great Frigatebird (*Fregata minor*); Red-footed Booby (*Sula sula*); Brown Booby (*Sula leucogaster*); Masked Booby (*Sula dactylatra*)

5. Conduct 1 investigation of Wedge-tailed Shearwater nest success on Mañagaha by September 30, 2022
   (**TRACS Strategy**: Research, Survey, Data Collection, and Analysis; **Activity Tag 1**: Fish and wildlife species data acquisition and analysis; **Unit of Measurement**: 1 investigation; **Target Species**: Wedge-tailed Shearwater (*Puffinus pacificus*))

6. Directly restore, enhance, remove, create, or manage four (4) structures, consisting of 4 exclusion fences along with informational signs to deter human disturbance to the Wedge-tailed Shearwater colonies on Mañagaha, by September 30, 2022.
   (**TRACS Strategy**: Direct Habitat and Species Management; **Activity Tag 1**: Terrestrial wildlife habitat structures; **Unit of Measurement**: 4 structures; **Target Species**: Wedge-tailed (*Puffinus pacificus*); **Target Primary Habitat**: Tropical forest and woodland)

7. Directly manage 3 species of rats at Mariana Swiftlet nesting/roosting sites by September 30, 2022
   (**TRACS Strategy**: Direct Habitat and Species Management; **Activity Tag 1**: Fish and wildlife predation management **Unit of Measurement**: 3 species; **Target Species**: Mariana Swiftlet (*Aerodramus bartschi*))

6. **If the work in this grant was part of a larger undertaking with other components and funding, present a brief overview of the larger activity and the role of this project.**

This grant provided funding for a one-year segment of a multi-year long term project. The work for the Rota Island wide surveys a shared effort between Avian Monitoring and the

State Wildlife Grant-FY2022 (F21AF03872). Breeding Bird Survey data was analyzed in part using R Studio code developed under the Biometrician WR grant (F20AF12003).

7. Accounting of Accomplishments:

Objective 1: Conduct 1 investigation to determine the abundance of all native and non-native landbirds on Saipan, Tinian, and Rota by September 30, 2022.

Breeding Bird Surveys (BBS) of native and non-native landbirds on Saipan, Tinian, and Rota

Fiscal year 2022 marks the 32-year anniversary of the Saipan Breeding Bird Surveys (BBS) making it one of the longest running monitoring programs in the CNMI. Avian point count surveys were conducted on Saipan and Rota in October, January, April, and July of FY2022. Tinian was surveyed in January, April, and July; however, surveys were not conducted on Tinian in October of FY2022 due to staff travel not being processed in time to complete surveys within the survey window protocol. Point counts were performed at 50 established roadside stations on all three islands from dawn until 10:30 AM or earlier. All species detected at the station visually or aurally within an unlimited distance were recorded for a three-minute period. Cloud cover, noise level and weather conditions were recorded and surveys were not conducted in adverse weather. Survey data was entered into the master BBS database and abundance (mean total detections) (Table 1) for the fiscal year was calculated for all native and introduced forest bird species.

Initial analyses of population trends for these species were modeled after the methods of Ha et al. (2018), where polynomial regression was employed to identify trends over a 20-year period from 1991 to 2010 on Saipan for 11 bird species. Expanding from this initial approach, generalized linear models (GLMs) for count data were applied to the BBS data sets in R Studio version 4.0.2. (Survey years for Saipan n = 32, Tinian n = 23, Rota n = 23) to bring the examination of population trends up to date for all three islands. Unlike Ha et al. 2018, we used non parametric distributions when the data did not fit the assumptions of normality (O'Hara and Kotze 2010). When stations were surveyed twice in one month, we chose the replicate survey with the observer who had conducted the most BBS surveys among years. For each bird species, a best-fitting model (null/intercept-only, linear, or quadratic) was identified through a combination of F-statistics, R^2 values, and AIC. The analyses that follow applied either Poisson or Negative Binomial generalized linear models (GLMs). Once again, a yearly trend of up to quadratic order was considered in the model selection process. In addition, in order to investigate for potential seasonality in the counts, all four quarterly surveys were included in the data set, and corresponding dummy variables were considered in the model selection process. Finally, the number of stations surveyed was included as a term to account for years where not all stations were surveyed. The expectation for this was that the resulting models should identify a positive correlation between the number of stations surveyed and bird counts, or at least not a significantly negative correlation unless the species is rare or only locally abundant in specific areas. The most parsimonious set of models were determined for each species using Akaike Information Criteria (AIC). Changepoint models were implemented to further explore changes in trends over time, and to compare those periods of change across species.

On Saipan, the average abundance of most native forest birds was higher in FY2022 than FY2021. Bridled White-eye, Micronesian Starling, Rufous Fantail and Mariana Kingfishers were the most abundant species (Table 1, Figure 1). This increase could be indicative of recovering populations post super typhoon Yutu. Seasonality significantly influenced detection rates for Mariana Fruit Dove, Mariana Kingfisher, and Nightingale Reed-warbler (Table 2).

From the modeling results it is immediately apparent that the majority of these species are currently in a state of decline on Saipan (Figure 2, Table 3). The only exception is the Eurasian Tree Sparrow, which appears to be stable or increasing in the last several years, after a previous period of decline. Ha et. al (2018) found Bridled White-eye, Rufous Fantail, Golden White-eye, Micronesian Starling, and Micronesian Myzomela (*Myzomela rubratra saffordi*) to be the most abundant bird species; however, the Golden White eye and Rufous Fantail populations were decreasing. Most of the current declining trends on Saipan begin to form somewhere between 2012 and 2015. Among the potential reasons for these declines were typhoons Soudelor and Yutu, which hit Saipan during August of 2015 and October of 2018, respectively (Figure 3, Appendix A). Change points occurred after these typhoon events for White Throated Ground Dove, Mariana Fruit Dove, Bridled White-eye, Golden White-eye, Micronesian Myzomela, and Micronesian Starling. In particular, the White-throated Ground-Dove, Nightingale Reed-Warbler, and Golden White-Eye exhibit particularly emphatic changes towards decline in 2015, coinciding with Soudelor. The Mariana Fruit-Dove and Island Collared-Dove also exhibit declines that appear to have begun sometime around 2013 and may have been either further exacerbated by Soudelor. Another notable grouping that emerges is the set of rather erratic trends observed for the Bridled White-Eye and Rufous Fantail in the earlier surveys prior to around 2006. During that time, several different observers were conducting the surveys, and may not have been equally skilled at sampling species that are more difficult to consistently detect. From a period of about 2006 to 2012, there was a consistent observer whose surveying ability may have produced more consistency than had been observed previously among those species, and so the trends observed in more recent years may be a more credible representation of fluctuations in those populations.

Table 1. Mean totals for native and introduced forest birds detected during BBS on Rota, Tinian, and Saipan in FY2021 and FY2022. Fifty stations are surveyed four times a year (*n* = 200) unless otherwise indicated. * Indicates introduced species.

		Mean Total Detections FY21			Mean Total Detections FY22		
Common Name	Scientific Name	Rota (n= 200)	Tinian (n= 150)	Saipan (n= 199)	Rota (n= 199)	Tinian (n= 149)	Saipan (n= 199)
Bridled White-Eye	*Zosterops conspicillatus saypani*		291	261		232	232
Golden White-Eye	*Cleptornis marchei*			29			48
Mariana Fruit Dove	*Ptilinopus roseicapilla*	36	28	54	22	31	51
Mariana Kingfisher	*Todiramphus albicilla*	48	62	64	54	61	63
Mariana Swiftlet	*Aerodramus bartschi*			19			135
Micronesian Megapode	*Megapodius laperouse*			1			
Micronesian Myzomela	*Myzomela rubratra saffordi*	52	17	36	43	16	57
Micronesian Starling	*Aplonis opaca guami*	189	127	130	204	123	135
Nightingale Reed-Warbler	*Acrocephalus hiwae*			10			8
Rota White-Eye	*Zosterops rotensis*	4			1		
Rufous Fantail	*Rhipidura rufifrons uraniae*	31	40	68	36	42	85
Tinian Monarch	*Monarcha takatsukasae*		24			15	
White-Throated Ground Dove	*Gallicolumba xanthonura*	3	12	21	4	14	25
Black Drongo*	*Dicrurus macrocercus*	71			72		
Eurasian Tree Sparrow*	*Passer montanus*	7	2	16	8	2	30
Philippine Collared-Dove*	*Streptopelia bitorquata*	10	44	26	18	60	41
Orange-cheeked Waxbill*	*Estrilda melpoda*		51	28		96	36

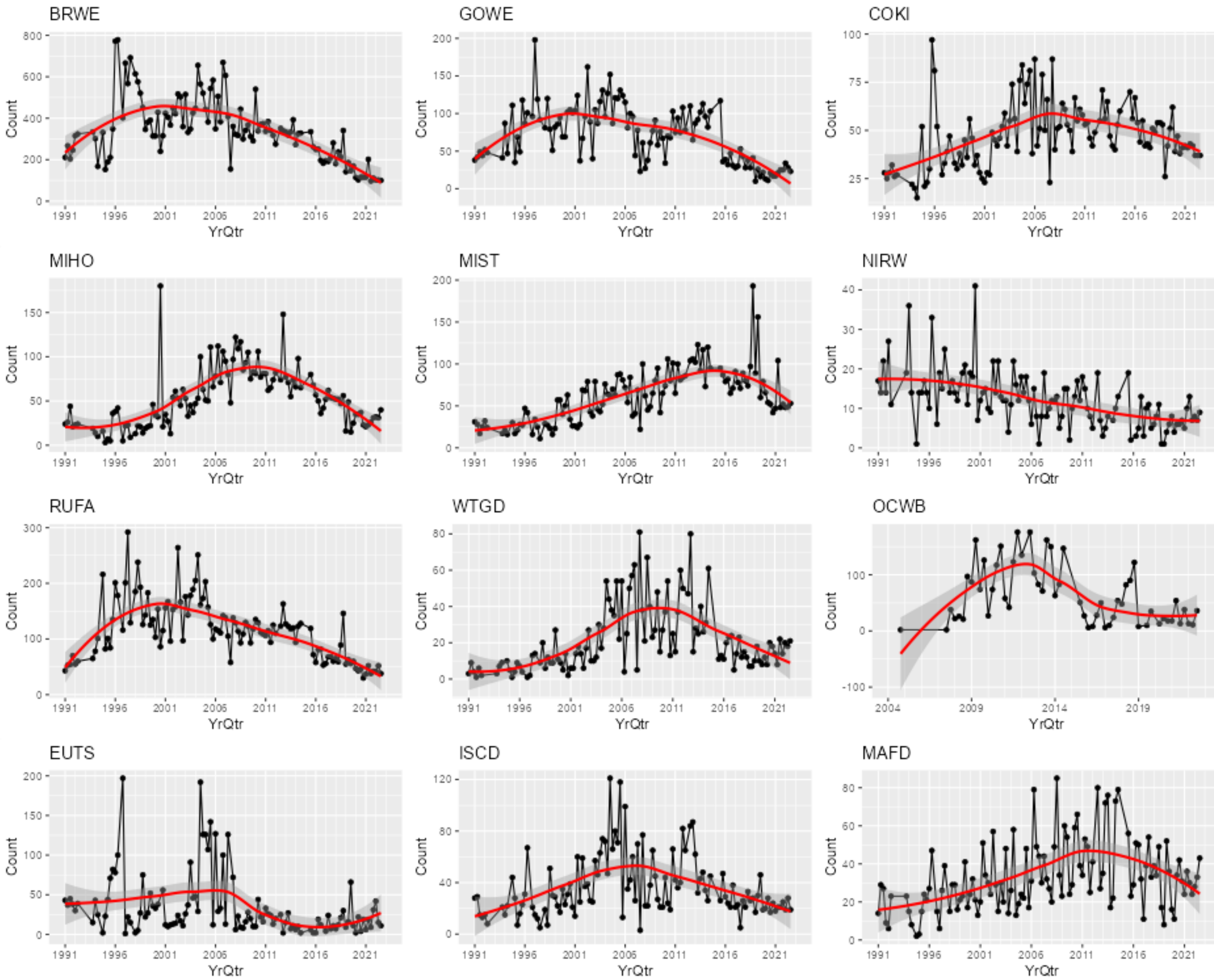

Figure 1. Total counts from Saipan aggregated across 50 stations for species Bridled White-eye (BRWE), Golden White-eye (GOWE), Mariana Fruit Dove (MAFD), Mariana Kingfisher (COKI), Micronesian Myzomela (MIHO), Micronesian Starling (MIST), Rufous Fantail (RUFA), Eurasian Tree Sparrow (EUTS), Philippine Collared Dove (ISCD), Orange-cheeked Waxbill (OCWB)

Table 2. GLM trend summary for Saipan, 1991-2022. Yearly trend, Seasonality and the number of stations were included as model variables influencing species' relative abundance. All species fit a negative binomial distribution. * Indicates non-native species

	GLM selection by AIC		
Species	Yearly Trend	Seasonality	# Stations
Bridled White-eye	Quadratic (dec)	N	Positive
Golden White-eye	Quadratic (dec)	N	Positive
Mariana Fruit Dove	Quadratic (dec)	Summer > Spring > Winter > Fall	Positive
Mariana Kingfisher	Quadratic (dec)	Fall > Summer > Winter > Spring	Positive
Micronesian Myzomela	Quadratic (dec)	N	Positive
Micronesian Starling	Quadratic (dec)	N	Positive
Nightingale Reed-warbler	Linear (dec)	Summer > Spring > Winter > Fall	Positive
Rufous Fantail	Quadratic (dec)	N	Positive
White-throated Ground Dove	Quadratic (dec)	N	N
Eurasian Tree Sparrow*	Quadratic (dec)	N	N
Philippine Collared Dove*	Quadratic (dec)	N	N
Orange-cheeked Waxbill*	Quadratic (dec)	N	Positive

Table 3. Saipan BBS population trend coefficients (1991 – 2022) from generalized linear models. * Indicates non-native species

Species Common Name	Variable	Coefficient	Std. Error	*z*-value	*p*-value
Bridled White-eye	Year (Linear)	15.35	1.30	11.83	< 0.00
	Year (Quadratic)	-3.83e-03	3.23e-04	-11.85	2.08e-32
	# Stations	2.33e-02	4.75e-03	4.91	9.00e-07
Golden White-eye	Year (Linear)	19.13	1.95	9.83	< 0.00
	Year (Quadratic)	-4.78e-03	4.85e-04	-9.85	< 0.00
	# Stations	1.52e-02	7.00e-03	2.17	0.03
Mariana Fruit Dove	Year (Linear)	10.56	1.78	5.93	< 0.00
	Year (Quadratic)	-2.63e-03	4.44e-04	-5.92	< 0.00
	Spring	0.62	8.93e-02	6.94	< 0.00
	Summer	0.68	8.97e-02	7.58	< 0.00
	Fall	-0.01	9.41e-02	-0.10	0.92
	# Stations	2.09e-02	7.07e-03	2.96	3.08e-03
Mariana Kingfisher	Year (Linear)	8.43	1.38	6.10	< 0.00
	Year (Quadratic)	-2.10e-03	3.44e-04	-6.10	< 0.00
	Spring	-0.05	7.02e-02	-0.76	0.45
	Summer	2.15e-02	7.05e-02	0.31	0.76
	Fall	0.13	6.98e-02	1.88	0.06
	# Stations	2.30e-02	5.56e-03	4.14	< 0.00
Micronesian Myzomela	Year (Linear)	21.71	2.33	9.32	< 0.00
	Year (Quadratic)	-0.01	5.80e-04	-9.31	< 0.00
	# Stations	4.18e-02	9.31e-03	4.50	6.93e-06
Micronesian Starling	Year (Linear)	10.80	1.71	6.33	2.51e-10
	Year (Quadratic)	-2.68e-03	4.25e-04	-6.30	2.91e-10
	# Stations	2.33e-02	6.79e-03	3.42	6.15e-04
Nightingale Reed-warbler	Year (Linear)	-0.04	4.61e-03	-8.69	3.63e-18
	Spring	0.17	0.11	1.60	0.11
	Summer	0.34	0.11	3.10	1.96e-03
	Fall	-0.27	0.12	-2.33	0.02
	# Stations	1.74e-02	7.69e-03	2.26	0.02
Rufous Fantail	Year (Linear)	16.35	1.49	10.96	5.65e-28
	Year (Quadratic)	-4.08e-03	3.72e-04	-10.98	4.54e-28
	# Stations	1.35e-02	5.40e-03	2.49	0.01
White-throated Ground Dove	Year (Linear)	28.63	3.25	8.82	1.15e-18
	Year (Quadratic)	-0.01	8.08e-04	-8.81	1.25e-18
	# Stations	2.28e-02	1.26e-02	1.82	0.07
Eurasian Tree Sparrow*	Year (Linear)	9.20	4.49	2.05	0.04
	Year (Quadratic)	-2.30e-03	1.12e-03	-2.06	0.04
	# Stations	-0.02	1.79e-02	-1.14	0.25

Philippine Collared Dove*	Year (Linear)	17.56	2.62	6.69	2.21e-11
	Year (Quadratic)	-4.38e-03	6.54e-04	-6.69	2.20e-11
	# Stations	1.66e-02	9.73e-03	1.70	0.09
Orange-cheeked Waxbill*	Year (Linear)	92.16	19.24	4.79	1.67e-06
	Year (Quadratic)	-0.02	4.78e-03	-4.79	1.64e-06
	# Stations	9.16e-02	3.10e-02	2.96	3.10e-03

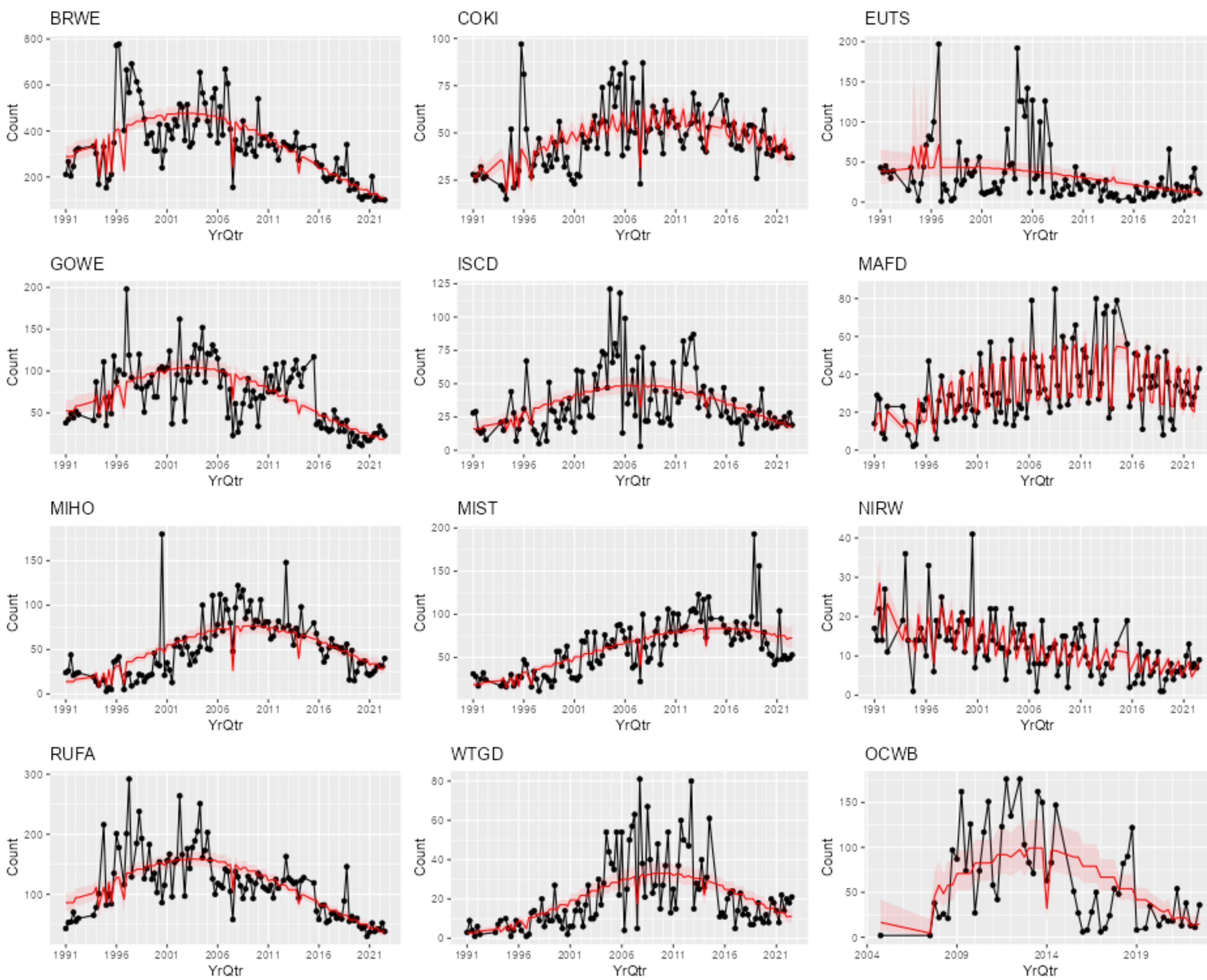

Figure 2. Fitted GLMs for Saipan, 1991-2022 (all surveys). Forest bird species codes are as follows: Bridled White-eye (BRWE), Golden White-eye (GOWE), Mariana Fruit Dove (MAFD), Mariana Kingfisher (COKI), Micronesian Myzomela (MIHO), Micronesian Starling (MIST), Rufous Fantail (RUFA), Eurasian Tree Sparrow (EUTS), Philippine Collared Dove (ISCD), Orange-cheeked Waxbill (OCWB).

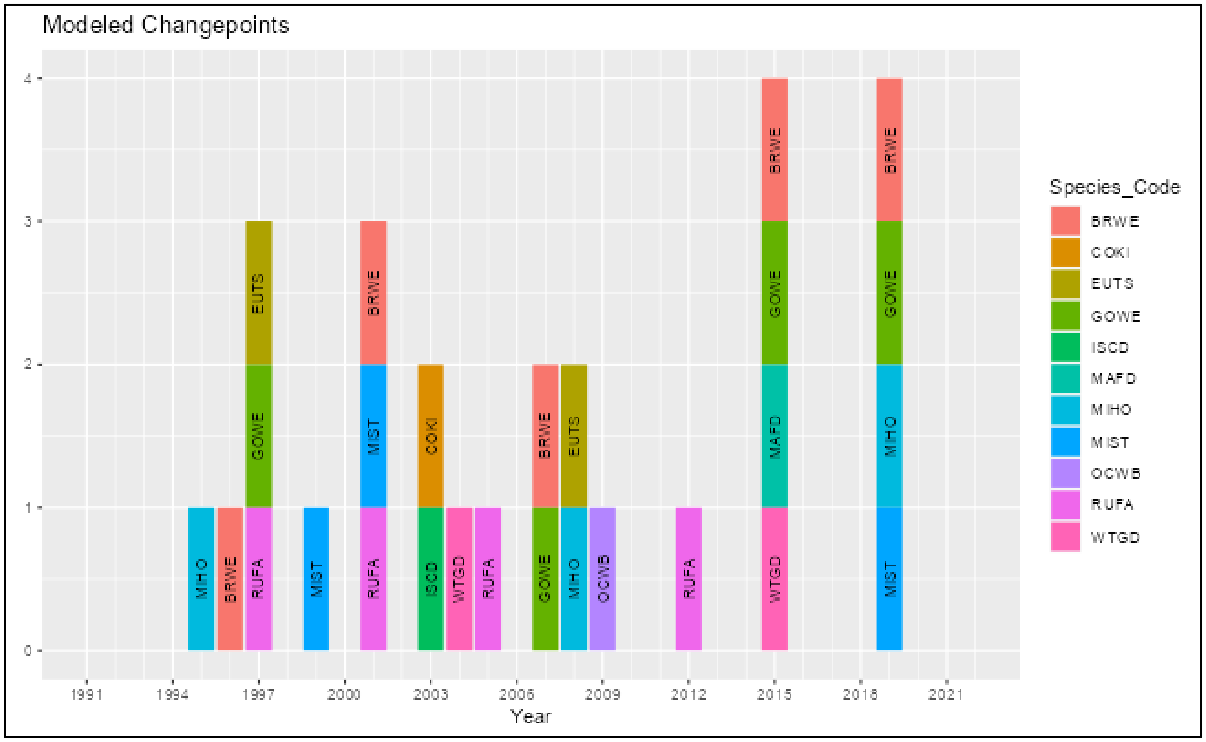

Figure 3. Distribution of estimated changepoints for Saipan (1991-2022). Forest bird species codes are as follows: Bridled White-eye (BRWE), Golden White-eye (GOWE), Mariana Fruit Dove (MAFD), Mariana Kingfisher (COKI), Micronesian Myzomela (MIHO), Micronesian Starling (MIST), Rufous Fantail (RUFA), Eurasian Tree Sparrow (EUTS), Philippine Collared Dove (ISCD), Orange-cheeked Waxbill (OCWB).

On Tinian, the average abundance of most native forest birds was similar in FY2022 to FY2021, however the Orange-cheeked Waxbill numbers almost doubled in FY2022 (Table 1, Figure 4) and they have an increasing population trend. Seasonality influenced the detectability of Mariana Fruit Dove and White-throated Ground Dove (Table 4) . Bridled White-eye, Micronesian Starling, Orange-cheeked Waxbill and Mariana Kingfisher were the most abundant species (Table 1); however, long-term trends suggest the Bridled White-Eye (*Zosterops conspicillatus saypani)*, Mariana Kingfisher, and other native forest bird populations are declining (Table 5, Figure 5). Notable change points occurred on Tinian after Super Typhoon Yutu for Tinian Monarch, Rufous Fantail, Orange-cheeked Waxbill, Micronesian Starling, Micronesian Myzomela, and Mariana Fruit Dove (Figure 6, Appendix B).

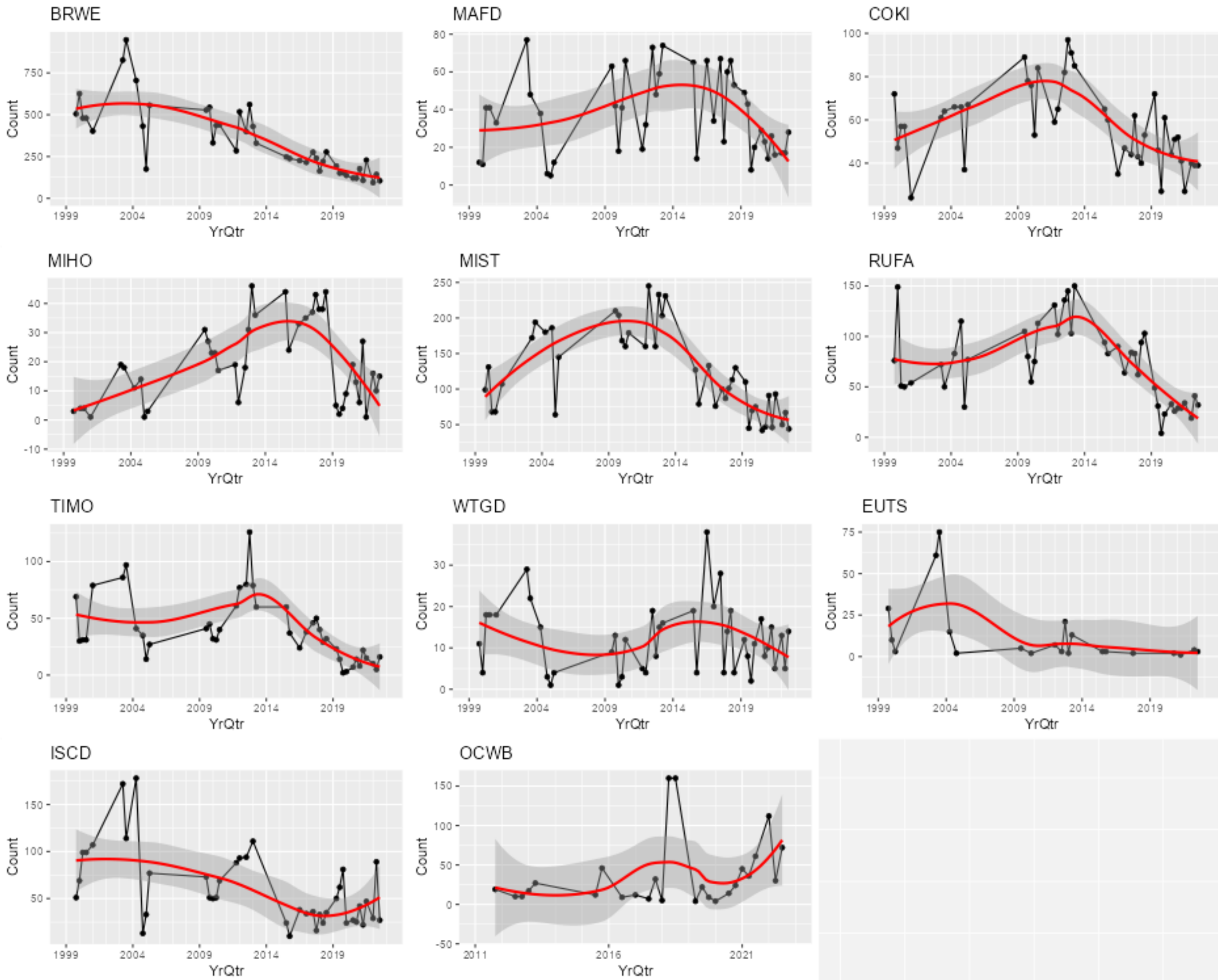

Figure 4. Total counts from Tinian aggregated across 50 stations for species Bridled White-eye (BRWE), Mariana Fruit Dove (MAFD), Mariana Kingfisher (COKI), Micronesian Myzomela (MIHO), Micronesian Starling (MIST), Rufous Fantail (RUFA), Tinian Monarch (TIMO)

Table 4. GLM trend summary for Tinian, 1999-2022. Yearly trend, Seasonality and the number of stations were included as model variables. All species fit a negative binomial distribution. * Indicates non-native species

	GLM selection by AIC		
Species	Yearly Trend	Seasonality	# Stations
Bridled White-eye	Quadratic (dec)	N	Positive
Mariana Fruit Dove	Quadratic (dec)	Summer > Spring > Winter > Fall	Positive
Mariana Kingfisher	Quadratic (dec)	N	Positive
Micronesian Myzomela	Quadratic (dec)	N	Positive
Micronesian Starling	Quadratic (dec)	N	Positive
Rufous Fantail	Quadratic (dec)	N	Positive
Tinian Monarch	Quadratic (dec)	N	Positive
White-throated Ground Dove	N	Summer > Spring > Winter > Fall	Positive
Eurasian Tree Sparrow	Linear (dec)	N	N
Island Collared Dove	Linear (dec)	N	N

Table 5. Tinian BBS population trend coefficients (1999 – 2022) from generalized linear models. * Indicates non-native species

Species Common Name	Variable	Coefficient	Std. Error	*z*-value	*p*-value
Bridled White-eye	Year (Linear)	17.52	3.23	5.42	0.00
	Year (Quadratic)	-4.38e-03	8.04e-04	-5.44	0.00
	# Stations	4.84e-02	9.55e-03	5.06	0.00
Mariana Fruit Dove	Year (Linear)	28.67	6.00	4.78	0.00
	Year (Quadratic)	-7.13e-03	1.49e-03	-4.78	0.00
	Spring	4.03e-01	1.85e-01	2.17	0.03
	Summer	4.84e-01	1.73e-01	2.80	0.01
	Fall	-4.62e-01	1.99e-01	-2.32	0.02
	# Stations	7.89e-02	2.40e-02	3.29	0.00
Mariana Kingfisher	Year (Linear)	16.06	3.31	4.85E+00	0.00
	Year (Quadratic)	-4.00e-03	8.23e-04	-4.86	0.00
	# Stations	2.50e-02	1.03e-02	2.43	0.02
Micronesian Myzomela	Year (Linear)	48.69	9.73	5.00	0.00
	Year (Quadratic)	-1.21e-02	2.42e-03	-5.00	0.00
	# Stations	1.01e-01	4.38e-02	2.30	0.02
	Year (Linear)	31.73	3.67	8.64	0.00
Micronesian Starling	Year (Quadratic)	-7.90e-03	9.13e-04	-8.65	0.00
	# Stations	4.08e-02	1.11e-02	3.68	0.00
Rufous Fantail	Year (Linear)	31.29	5.65	5.54	0.00
	Year (Quadratic)	-7.79e-03	1.40e-03	-5.54	0.00
	# Stations	5.03e-02	1.71e-02	2.93	0.00
Tinian Monarch	Year (Linear)	36.33	7.24	5.02	0.00
	Year (Quadratic)	-9.05e-03	1.80e-03	-5.03	0.00
	# Stations	6.29e-02	2.22e-02	2.83	0.00
White-throated Ground Dove	Spring	2.13e-01	2.63e-01	0.81	0.42
	Summer	4.22e-01	2.44e-01	1.73	0.08
	Fall	-5.33e-01	2.86e-01	-1.86	0.06
	# Stations	9.42e-02	4.45e-02	2.11	0.03
Eurasian Tree Sparrow*	Year (Linear)	-1.25e-01	3.08e-02	-4.05	0.00
	# Stations	7.21e-02	8.16e-01	0.09	0.93
Philippine Collared Dove*	Year (Linear)	-4.94e-02	1.11e-02	-4.46	0.00
	# Stations	3.90e-02	2.17e-02	1.79	0.07
Orange-cheeked Waxbill*	Year (Linear)	1.30e-01	5.55e-02	2.34	0.02
	# Stations	4.59E-01	5.71e-01	0.80	0.42

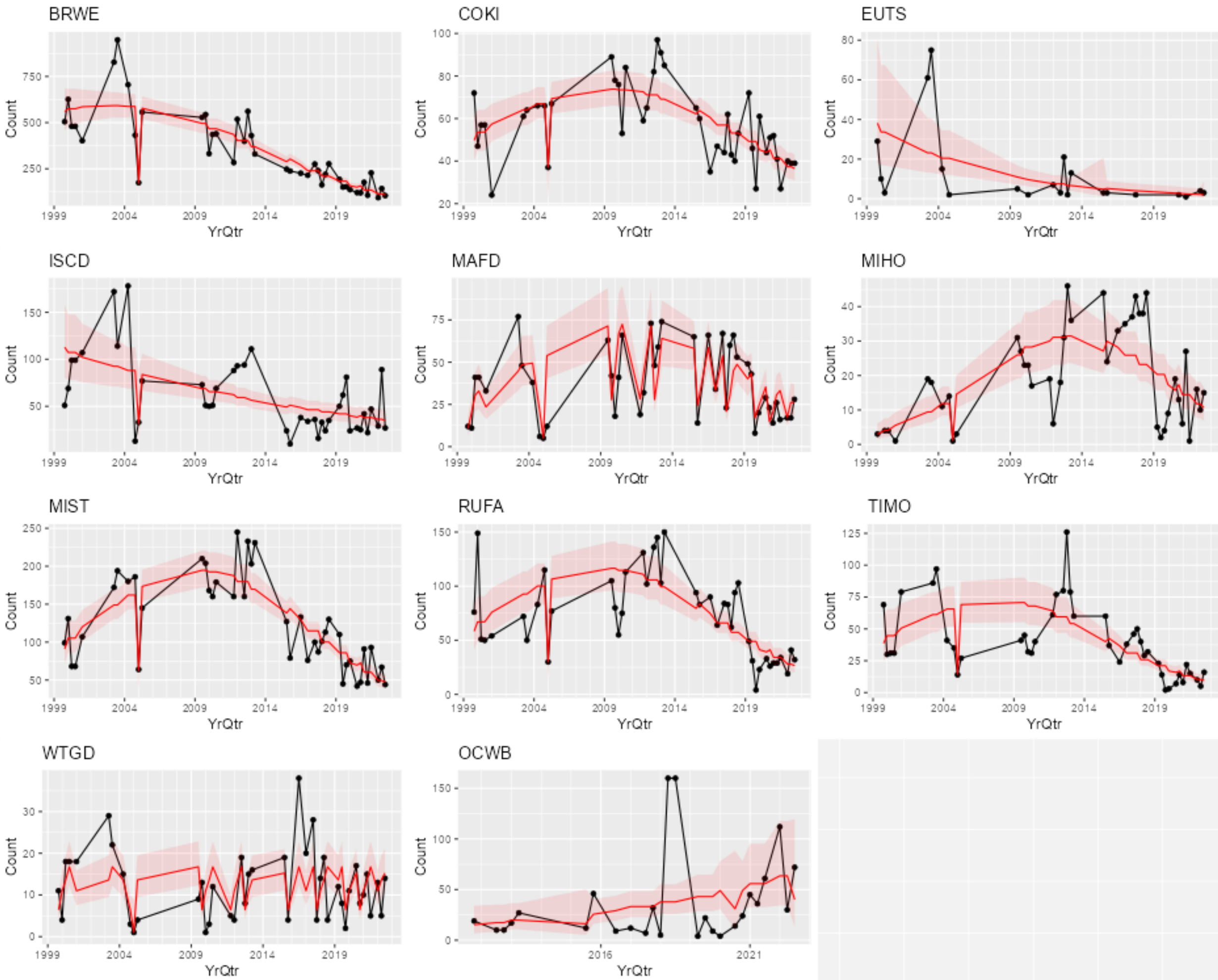

Figure 5. Fitted GLMs for Tinian, 1991-2022 (all surveys). Forest bird species codes are as follows: Bridled White-eye (BRWE), Mariana Fruit Dove (MAFD), Mariana Kingfisher (COKI), Micronesian Myzomela (MIHO), Micronesian Starling (MIST), Rufous Fantail (RUFA), Tinian Monarch (TIMO), Eurasian Tree Sparrow (EUTS), Philippine Collared Dove (ISCD).

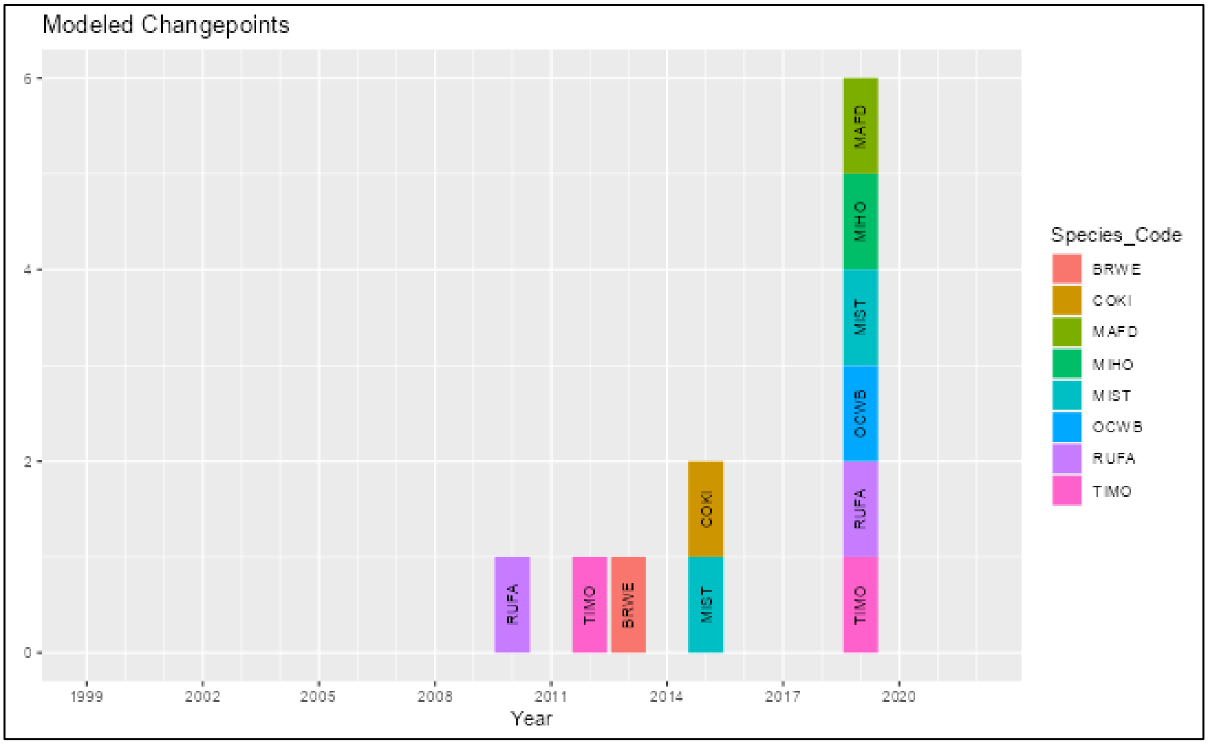

Figure 6. Distribution of estimated changepoints for Tinian (1999-2022). Forest bird species codes are as follows: Bridled White-eye (BRWE), Mariana Fruit Dove (MAFD), Mariana Kingfisher (COKI), Micronesian Myzomela (MIHO), Micronesian Starling (MIST), Rufous Fantail (RUFA), Tinian Monarch (TIMO).

On Rota, the average abundance of native forest birds was similar in FY2021 and FY2022 for most species (Table 1, Figure 7). The Micronesian Starling, Black Drongo, and Micronesian Myzomela were the most abundant bird species. Seasonality influenced the detectability of Mariana Fruit Dove, Mariana Kingfisher, White-throated Ground Dove, Black Drongo, and Eurasian Tree Sparrow (Table 6). Long-term trends of forest bird species on Rota show a slightly declining trend for Mariana Fruit Dove, Mariana Kingfisher, Micronesian Myzomela, Rufous Fantail, and a recent increasing trend for Rota White-eye (Table 7, Figure 8). The non-native Black Drongo and Philippine Collared Dove are also declining. Change points occurred for Rota forest bird species after Typhoon Mangkhut in 2018 for White-throated Ground Dove, Micronesian Starling, and Eurasian Tree Sparrow (Figure 9, Appendix C).

Figure 7. Total counts from Rota aggregated across 50 stations for species detected for forest bird species Mariana Fruit Dove (MAFD), Micronesian Myzomela (MIHO), Micronesian Starling (MIST), Rufous Fantail (RUFA), Rota White-eye (ROWE), White-throated Ground Dove (WTGD), Black Drongo (BLDR), Eurasian Tree Sparrow (EUTS), Philippine Collared Dove (ISCD).

Table 6. Rota BBS GLM trend summary for Rota, 1999-2022. Yearly trend, Seasonality and the number of stations were included as model variables influencing species' relative abundance. All species fit a negative binomial distribution. * Indicates non-native species

	GLM selection by AIC		
Species	Yearly Trend	Seasonality	# Stations
Mariana Fruit Dove	Quadratic (inc)	Summer > Spring > Fall > Winter	+
Mariana Kingfisher	Linear (dec)	Spring > Summer > Winter > Fall	+*
Micronesian Myzomela	Quadratic (inc)	N	+*
Micronesian Starling	Quadratic (dec)	N	+*
Rufous Fantail	Quadratic (inc)	N	+*
Rota White-eye	Quadratic (inc)	N	-*
White-throated Ground Dove	Quadratic (inc)	Fall > Summer > Winter > Spring	+
Black Drongo	Quadratic (dec)	Summer > Spring > Fall > Winter	+*
Eurasian Tree Sparrow	Linear (dec)	Spring > Summer > Winter > Fall	-*
Philippine Collared Dove	Quadratic (dec)	N	-

Table 7. Rota BBS population trend coefficients (1999 – 2022) from generalized linear models. * Indicates non-native species

Species	Variable	Coefficient	Std. Error	*z*-value	*p*-value
Black Drongo	Year (Linear)	14.94	3.73	4.01	6.16e-05
	Year (Quadratic)	-3.72e-03	9.28e-04	-4.01	6.00e-05
	Spring	2.37e-01	1.02e-01	2.32	2.06e-02
	Summer	2.92e-01	1.01e-01	2.89	3.81e-03
	Fall	1.44e-01	1.10e-01	1.32	1.88e-01
	# Stations	5.45e-02	1.45e-02	3.75	1.76e-04
Mariana Kingfisher	Year (Linear)	-6.01e-03	3.79e-03	-1.58	1.13e-01
	Spring	4.35e-02	7.07e-02	0.61	5.39e-01
	Summer	6.88e-03	7.02e-02	0.10	9.22e-01
	Fall	-1.56e-01	7.74-02	-2.02	4.33e-02
	# Stations	2.33e-02	1.02e-02	2.28	2.27e-02
Eurasian Tree Sparrow	Year (Linear)	-4.03e-02	1.02e-02	-3.96	7.42e-05
	Spring	4.08e-01	1.93e-01	2.11	3.46e-02
	Summer	8.61e-02	1.92-01	0.45	6.54e-01
	Fall	-1.51e-01	2.10e-01	-0.72	4.71e-01
	# Stations	-6.47e-02	2.32e-02	-2.79	5.29e-03
Philippine Collared Dove	Year (Linear)	19.62	6.59	2.98	2.89e-03
	Year (Quadratic)	-4.89e-03	1.64e-03	-2.99	2.83e-03
	# Stations	-3.33e-03	2.30e-02	-0.14	8.85e-01
Mariana Fruit Dove	Year (Linear)	-36.36	5.59	-6.50	8.03e-11
	Year (Quadratic)	9.04e-03	1.39e-03	6.50	8.20e-11
	Spring	7.53e-01	1.60e-01	4.72	2.40e-06
	Summer	7.75e-01	1.56-01	4.96	7.16e-07

	Fall	3.23e-01	1.73e-01	1.87	6.10e-02
	# Stations	2.21e-02	2.23e-02	0.99	3.21e-01
Micronesian Myzomela	Year (Linear)	-47.61	4.71	-10.11	4.79-24
	Year (Quadratic)	1.18e-02	1.17e-03	10.11	4.95e-24
	# Stations	4.08e-02	1.75e-02	2.33	1.97e-02
Micronesian Starling	Year (Linear)	19.47	2.52	7.73	1.10e-14
	Year (Quadratic)	-4.85e-03	6.27e-04	-7.73	1.05e-14
	# Stations	4.53e-02	9.42e-03	4.81	1.54e-06
Rufous Fantail	Year (Linear)	-7.05	3.66	-1.93	5.40e-02
	Year (Quadratic)	1.75e-03	9.09e-04	1.92	5.43e-02
	# Stations	4.23e-02	1.43e-02	2.96	3.07e-03
White-throated Ground Dove	Year (Linear)	-21.16	7.80	-2.71	6.68e-03
	Year (Quadratic)	5.26e-03	1.94e-03	2.71	6.67e-03
	Spring	-3.64e-02	2.45e-01	-0.15	8.82e-01
	Summer	4.18e-01	2.23e-01	1.88	6.00e-02
	Fall	5.10e-01	2.46e-01	2.08	3.76e-02
	# Stations	1.08e-02	2.82e-02	0.38	7.01e-01
Rota White-eye	Year (Linear)	-27.50	14.87	-1.85	6.44e-02
	Year (Quadratic)	6.84e-03	3.70e-03	1.85	6.42e-02
	# Stations	-1.94e-01	3.65e-02	-5.32	1.05e-07

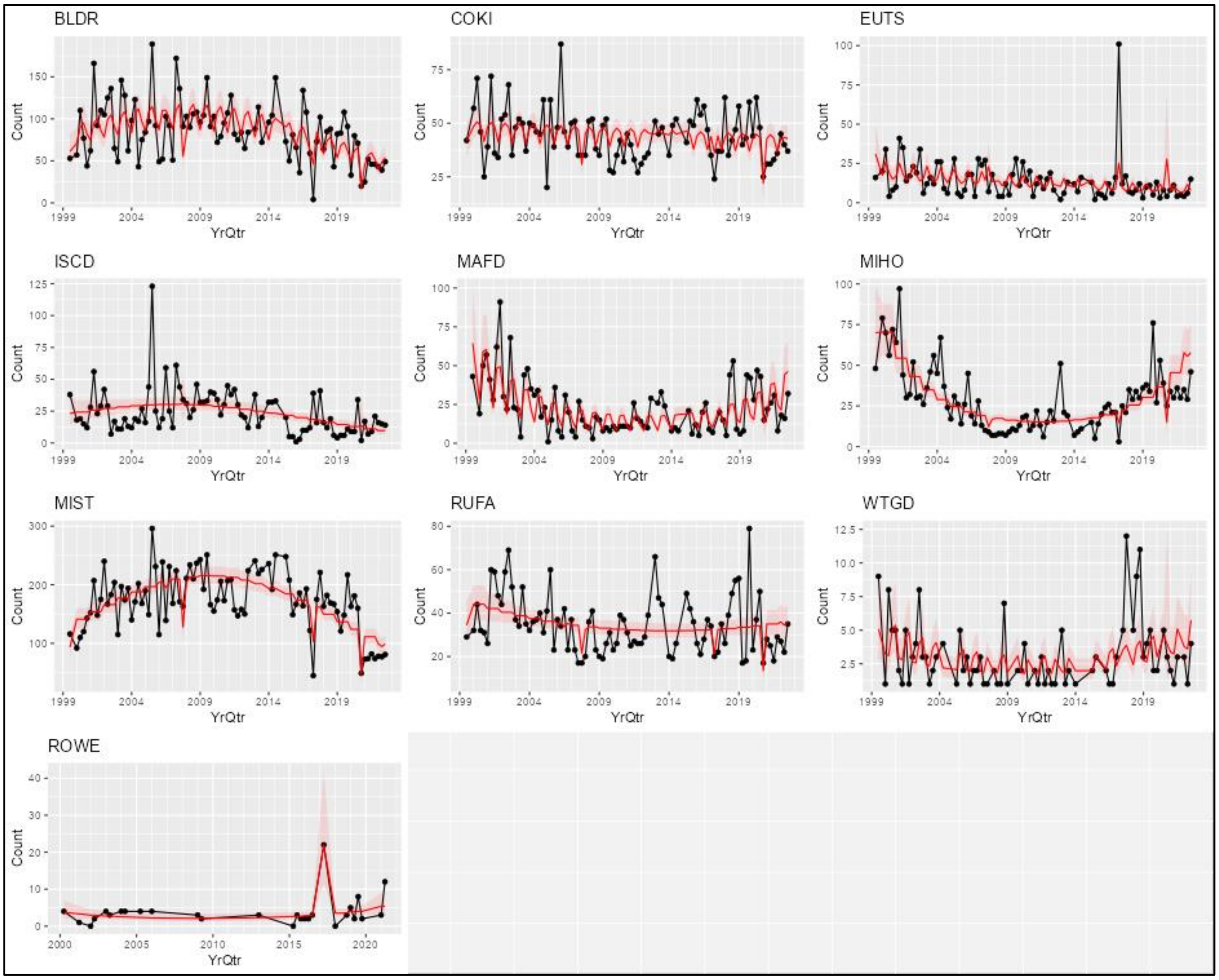

Figure 8. Fitted GLMs for Rota, 1999-2022 (all surveys). Forest bird species codes are as follows: Mariana Fruit Dove (MAFD), Micronesian Myzomela (MIHO), Micronesian Starling (MIST), Rufous Fantail (RUFA), Rota White-eye (ROWE), White-throated Ground Dove (WTGD), Black Drongo (BLDR), Eurasian Tree Sparrow (EUTS), Philippine Collared Dove (ISCD).

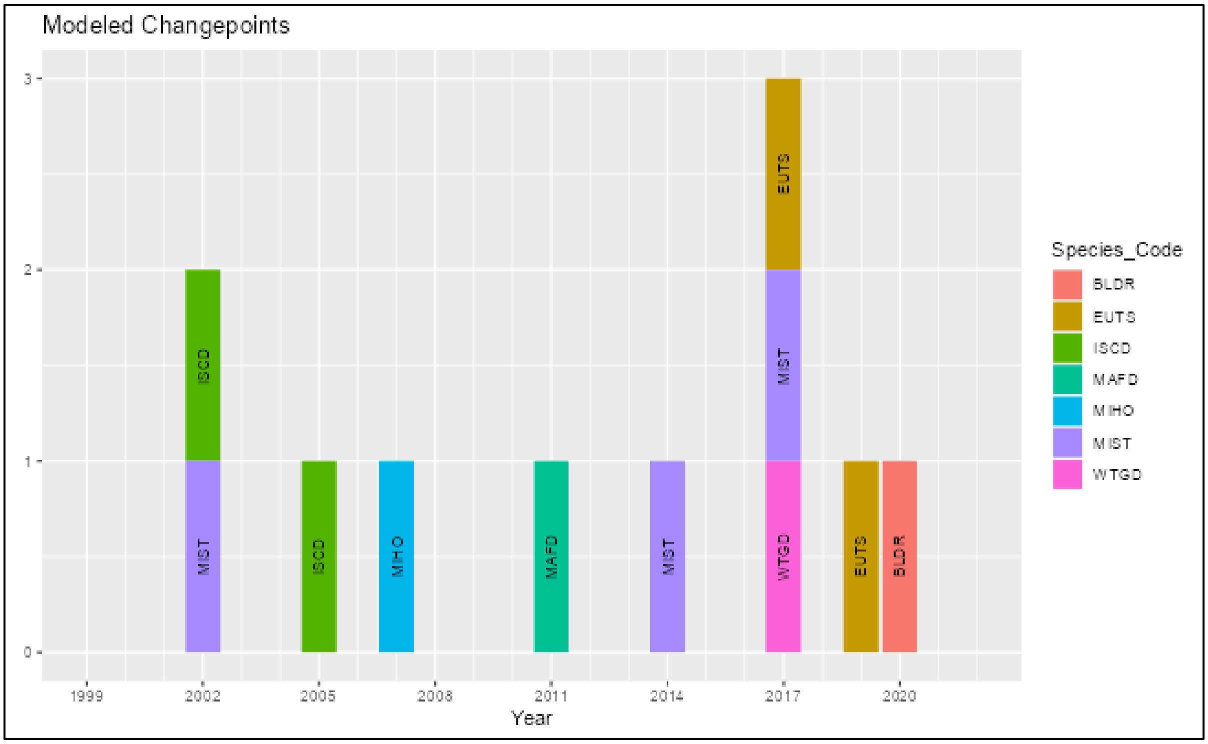

Figure 9. Distribution of estimated changepoints for Rota (1999-2022). Forest bird species codes are as follows: Black Drongo (BLDR), Mariana Fruit Dove (MAFD), Micronesian Myzomela (MIHO), Micronesian Starling (MIST), White-throated Ground Dove (WTGD), Eurasian Tree Sparrow (EUTS), Philippine Collared Dove (ISCD).

Our survey results mirror the Camp et al. 2015 study on Rota; however, our analysis indicates Mariana Kingfisher, Mariana Fruit Dove, Rufous Fantails and Micronesian Starlings are also declining. New management strategies may be needed for endangered species that are continuing to decline, such as the Nightingale Reed-warbler.

Many factors may be contributing to the decline of native forest bird species. Applications for commercial and residential land clearing permits have been on the rise since 2010 (Technical Guidance and Disaster Readiness Report 2021), indicating habitat loss as one possible cause on Saipan. Two super typhoon events have happened within the last 10 years and the short recovery time between the storms could be contributing to the population declines. Frugivores like the Mariana Fruit Dove are more impacted by tropical cyclone events due to destruction of their food sources (Askins and Ewert 2020). The climate data suggests the frequency and intensity of tropical cyclones will increase in the future (Bender et al. 2010; Knutson et al. 2010). Future research should examine the land use changes that have occurred on the islands over time as a possible cause of species' declines.

Many of the forest bird species in the CNMI are protected under local or federal laws; however, Golden White-eye, Bridled White-eye Tinian Monarch and Rufous Fantail are not protected species. It is standard practice for the Division of Fish and Wildlife to require that developers wait to remove nests until nestlings have fledged; however, there is no legal backing for this requirement. Locally listing these forest bird species and giving them protections similar to those extended to species under the Migratory Bird Treaty Act would be a proactive step to possibly improving declining population trends and preventing the need to federally list these species in the future.

Some non-native bird species continue to exhibit an increasing population trend. Columbidae species like the Philippine Collared Dove are invasive in many countries (Romagosa and McEneaney 1999, Blancas-Calva et al. 2014, Bendjoudi et al. 2015). They are carriers of parasites and disease (Terregino et al. 2003, Panella et al 2013, Donati et al. 2015), aggressive towards native birds (Kasner and Pyeatt 2016, Chablé-Santos et al. 2012), disperse invasive plants (Mokotjomela et al. 2015) and compete for food resources (Poling and Hayslette 2006; Bonter et al. 2010). Invasions could be particularly problematic in island ecosystems with limited available habitat and resources. Philippine Collared Dove populations continue to increase on Saipan and it is unknown if the doves are having adverse effects on native species of the Mariana Islands. An easy management strategy would be to set a No Bag Limit on the doves and to open the hunting season to year-round. Additional public outreach to encourage the hunting of Philippine Collared Doves could curb the population growth and educate hunters about how to correctly identify the non-native doves.

Statistical Analysis Workshop

Attendance of this workshop was not possible due to Covid-19 travel restrictions.

Christmas Bird Count

The 122nd annual Christmas Bird Count (CBC) was held 27 December 2021 on Saipan, 5 January 2022 on Tinian and 28 December 2021 on Rota. This was the 22nd year the CNMI has participated in the annual event. The event was announced by the local paper the Saipan Tribune and featured on the DFW Facebook page. DFW staff were interviewed by the Humanities Half Hour radio show to advertise the event and to talk about the cultural importance of native birds (https://youtu.be/vYNa3TzzVuk). On Saipan, 11 participants counted 47 species (2770 birds total), on Tinian 2 participants counted 21 species (463 birds total), and on Rota, 10 participants counted 31 species (1694 birds total). The three most abundant species per island included: Saipan – White Tern (n = 437), Brown Noddy (*Anous stolidus*, n = 388), and Bridled White-eye (n = 325); Tinian – White Tern (n = 122), Orange-cheeked Waxbill (n = 68), Bridled White-eye (n = 54); Rota – White Tern (n =365), Micronesian Starling (n =337), and Black Drongo (n =179). Twenty-six migrant waterbird species (shorebirds, waders, gulls, and terns) were recorded for the three islands. The total number of migrants across islands was 614 individuals, 57% of which were counted on Saipan (n = 350), 32% on Rota (n = 198), the remaining 11% on Tinian (n = 66). All CBC data was entered into the online database at the Audubon website in January 2022. The Christmas Bird Count continues to be a positive outreach event for DFW.

Mariana Swiftlet Counts

Mariana Swiftlet (*Aerodramus bartschi*) surveys are conducted at the end of the peak breeding season (October) and at the beginning of the peak breeding season (April). All caves were surveyed in October FY2022; however, seven of the nine known swiftlet-occupied caves were surveyed in April of FY2022 due to accessibility issues. Ownership of the land changed and DFW's permission to access Ladder and Hospital caves through their property was not granted.

Evening arrival counts for the Mariana Swiftlet were conducted at each location on a single night by at least two observers. Arrival surveys were conducted from outside the cave beginning at 17:00 hrs and continued until it was too dark for observers to reliably detect or identify the birds (~19:00 hrs) (Cruz et al. 2008, Brindock 2013, Radley 2013, Johnson et al. 2018). Observers did not enter the caves before surveys began as was done in historic surveys in order to minimize the disturbance to birds. Instead, pre-survey arrival counts beginning at 16:30 hrs were used to estimate the number of birds inside the cave at the start of the survey. Observers recorded the number of entering swiftlets and exiting swiftlets (one observer counted entering birds and one counted exiting birds) seen every 10 minutes. The number of exiting swiftlets was subtracted from the number of entering swiftlets, and the difference of each 10-minute interval was summed. When the light levels were low, aural detection of the swiftlet's echolocation clicks (a rapid series of accelerating clicks as they enter the cave) was used in combination with visual observation to count individuals. No night vision or thermal imaging equipment was available for these surveys.

Survey effort of swiftlet caves on Saipan has fluctuated in some years. Swiftlet caves have been surveyed on Saipan since the late 1980's, however, all of the nine known occupied caves were not surveyed regularly until 1999. Because the range of birds per cave varies by magnitudes of hundreds, it is important to survey all of the known caves annually to compare the population among years. Only four caves were surveyed correctly in October 2008 and protocol confusion issues caused two caves to be surveyed incorrectly in April 2010. Some caves were not surveyed or were surveyed incorrectly in FY2012. Only seven caves were surveyed in 2014 and 2020 and swiftlet caves were not surveyed in FY 2015.

The mean total swiftlets for FY2022 were 3293 birds (SD=535) (October n = 2914, April n= 3390) (Figure 10). The mean totals represent the minimum number of swiftlets on Saipan as some swiftlet-occupied caves may yet be discovered.

The population trends of annual swiftlet colony surveys from 1998 to 2022 and the last decade (2011-2022) were analyzed using a general linear model with a negative binomial distribution in R Studio version 3.4.3. McFadden pseudo R2 value was calculated. The swiftlet population over the last three decades appears to be stable (β = 0.007137, p = 0.366) (Table 8). The swiftlet population appears to be declining slightly in the last decade (β = -0.04) however, not significantly (p = 0.19) (Table 8).

Based on the caves we survey annually; the population appears to be stable; however, the slight decline of the population in recent years should be closely monitored (Figure 10). The population appears to decrease the years following two super typhoons in 2015 and 2018. The factors limiting the population from increasing on Saipan are unknown. It is possible that we have reached the island's carrying capacity. Future research should identify cave characteristics that are indicators of suitable roosting and nesting habitat for Mariana Swiftlets. This would allow us to identify suitable caves for translocations and allow us to quantify the carrying capacity of the caves. If carry capacity is not limiting the population, DFW can investigate other causes preventing the population from increasing such as inadequate foraging habitat, predation, nest success, and environmental contamination. It has long been suspected that undiscovered swiftlet-occupied caves exist on Saipan, however, locating these caves has not been successful. Banding and radio telemetry could provide insights into swiftlet population numbers, survival, body condition, foraging habitat, dispersal, and roosting and nesting locations.

Landowner permission to access swiftlet caves is one challenge for conducting annual swiftlet surveys. DFW lost access routes to two caves this year, but DFW will explore an alternate route to Hospital cave in October FY23. Exploring the possibility to purchase Ladder cave is recommended. Land development close to caves is another issue facing swiftlet habitat management. Land was cleared close to the entrance of two caves in the past year. Land clearing around caves can bring invasive plant and predator species in closer proximity to caves. Loss of foraging habitat close to caves may cause birds to spend more time and energy foraging further away from nests during important nestling provisioning periods. Noise disturbance is also a concern. No laws regarding buffer zones around swiftlet caves currently exist, so land acquisition may be the only management tool available to DFW.

Table 8. Saipan Mariana Swiftlet population trend results from 1998-2022.

Years	Coefficient	Std. Error	*z*-value	*p*-value	Pseudo r^2
1998-2022	0.007137	0.007891	0.904	0.366	1.25^-4
2011-2022	-0.04171	0.03173	-1.315	0.189	8.54^-4

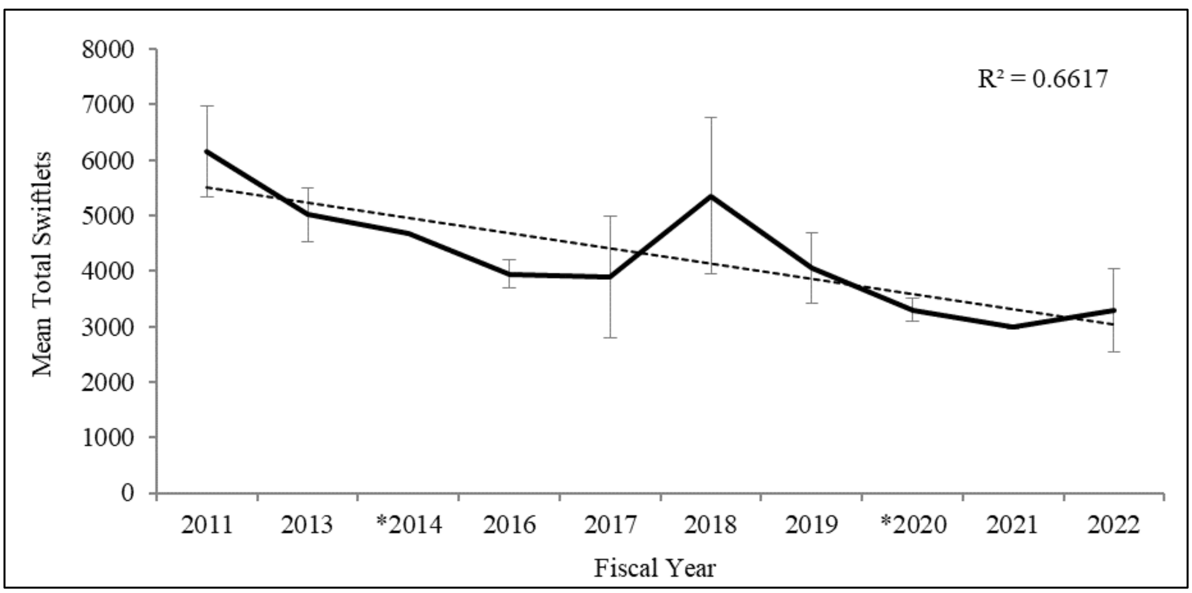

Figure 10. Mean total number of Mariana Swiftlets (*Aerodramus bartschi*) surveyed per fiscal year from 2011-2022. Nine inhabited caves are surveyed bi-annually on Saipan. Data was not collected in FY 2015 and data collection quality issues affected FY 2012, so it was not included. * Indicates years where fewer than nine caves were surveyed.

Rota White-eye Surveys

Rota White-Eye (*Zosterops rotensis*) were surveyed at 44 stations across 5 transects in March and September 2022 on Rota. Surveys were not completed in Sept 2012, 2014 or 2015 and both surveys in 2018 were not fully completed. The mean number of detections in FY2022 was 145 birds (March n = 132; September n = 158) (Figure 11). Detections appear to be higher in September. Overall, the population appears to have increased over the last five years regardless of the incomplete years of data collection. This increase is also reflected in the population trend calculated from the Rota BBS surveys (Appendix C).

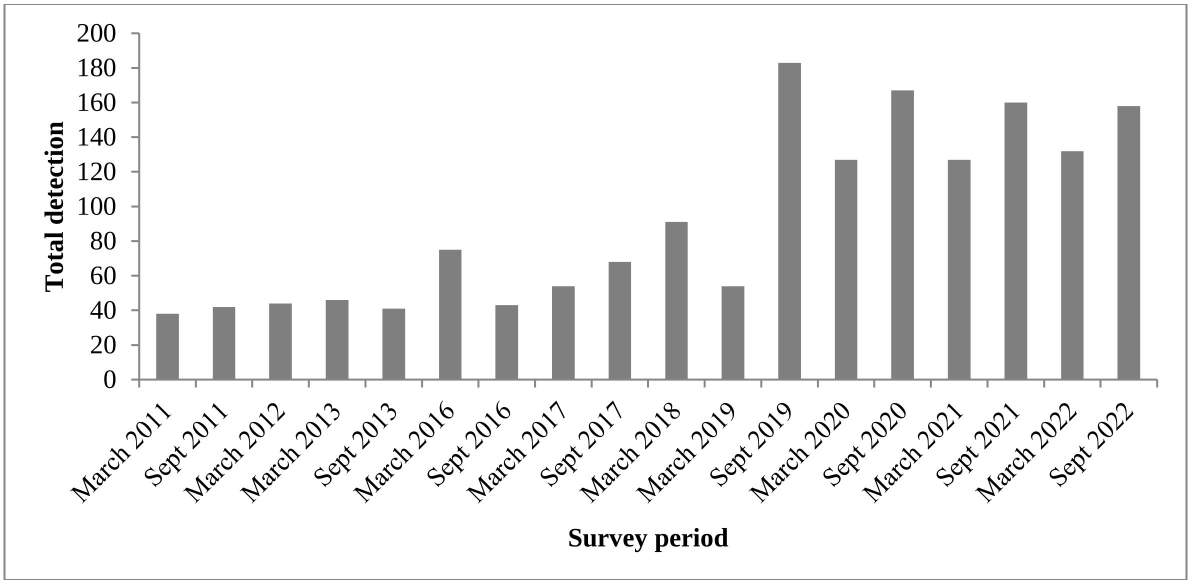

Figure 11. Total number of detections for Rota White-Eye on Rota from 2011-2022 based on point count data collected by DFW. No surveys were conducted in September 2012, FY 2014 or FY 2015.

Objective 2. Conduct 1 investigation to assess the population of all native and non-native forest birds on Rota by September 30, 2022.

Rota forest bird surveys

Avian surveys began in April 2022 and all 294 surveys were completed by the end of September 2022 (Figure 12). Using the Variable Circular Plot (VCP) method (Amar et al. 2008), all birds actively using the area were counted visually or aurally within five-minute period and the lateral distance to each detection was estimated (Reynolds et al. 1980). Birds flushed while approaching a station were recorded using the distance from the station to where they were first observed as the detection distance (Reynolds et al 1980). Prior to the count at each station, the date, station number, time, the observer's initials, and weather conditions were documented. Surveys were conducted from sunrise until 10:30 hours or earlier.

Micronesian Starlings were the most abundant species detected during surveys on average (μ = 4.46 per station, CI = 0.36) and occurred the most frequently at survey stations (90%) (Table 9). Mariana Fruit Dove had the second highest average abundance (μ= 1.52, CI = 0.16) and occurrence per station (69%), followed by Micronesian Myzomela (μ = 1.38, CI= 0.16, occurrence = 67%). Black Drongo were the most abundant non-native species on average (μ = 1.44, CI = 0.19) and occurred at 57% of stations. Eurasian Tree Sparrows were the second most abundant non-native species on average (μ = 0.33, CI = 0.22) and occurred at 6% of stations. Philippine Collared Doves were less abundant than Eurasian Tree Sparrows on average (μ = 0.31, CI = 0.11), however, they occurred at more stations (16%).

Figure 12. Bird surveys were conducted at 294 stations at sites on Rota.

Table 9. Occurrence and average abundance of Rota forest birds detected at 294 stations. *Indicates non-native species

Common Name	Mean	CI	% Occurrence
Mariana Fruit Dove	1.52	0.16	69.39
Mariana Kingfisher	1.08	0.12	62.24
Micronesian Myzomela	1.38	0.16	66.67
Micronesian Starling	4.46	0.36	90.14
Rota White-eye	0.43	0.15	11.90
Rufous Fantail	1.28	0.16	59.86
White-throated Ground Dove	0.32	0.08	21.77
Black Drongo*	1.44	0.19	57.14
Eurasian Tree Sparrow*	0.33	0.22	5.78
Philippine Collared Dove*	0.31	0.11	16.67

Micronesian Starlings had the highest abundance and widest distribution. This is a similar pattern reported by Camp et al. (2014). Average abundance and occurrence were similar among the Mariana Fruit Doves, Micronesian Myzomela, and Rufous Fantail. The Mariana Kingfisher had a lower abundance, but a relatively high occurrence which was also noted by Camp et al. (2014). The low abundance of Eurasian Tree Sparrows is also similar to the findings by Camp et al. (2014).

Habitat and vegetation surveys

Habitat and vegetation data were collected at 143 vegetation plots randomly sub-sampled from the bird sampling stations to proportionally represent distinct vegetation types on Rota (Figure 13). Plots that were inaccessible due to topography or other access issues were substituted with replacement plots as needed. Species composition and structure in addition to substrate cover were measured within 10-m x 10-m plots (100 m^2) for forest/woodland communities. Substrate cover within each plot was estimated by eye for rocks, coarse woody debris, leaf litter, or bare soil. Herbaceous vegetation cover was estimated by eye for grass, herbs, vines, and other (i.e., ferns, mosses, etc.) to the nearest 5 percent. Approximate height and cover for each vegetation strata (herbaceous (H), shrub (S), canopy (T2), and emergent canopy (T1) were also estimated by eye to the nearest meter and percent.

Woody vegetation ≥ 1.3 m in height within each plot were identified to species and measured for diameter-at-breast height (DBH). If the measured tree's DBH was under 5.0 centimeters, it was counted/tallied as a stem with the species recorded and DBH was not measured. Otherwise, the DBH was measured and recorded for each individual tree. Data was collected for all trees with a portion of the stem/trunk base (above the roots) within the plot boundaries. Dead standing stems ≥ 1.3 m tall were labeled as "snags". If a trunk split below 1.3 m, then all portions of the split were treated as separate stems. DBH was converted to basal area (BA) by multiplying the square of the measured radius by pi ($(DBH/2)^2\pi$).

Dominance for each species measured within each plot was calculated from basal area and density. Relative density (RD) for each woody species was calculated by dividing the species' abundance over the sum of stems for all species within a plot. Relative basal area (RBA) was calculated for tree and shrub species by dividing a species basal area by the sum of all species' basal area within a plot. Importance values (IV) were calculated for woody plant species to summarize the dominance of each species within the respective plots by summing the RBA and RD and dividing by 2 (IV = (RBA+RD)/2)), which produces an index of species dominance per plot that ranges from 0.0 to 1.0.

Vegetation plots were classified into potential plant communities based on species importance values using a hierarchical cluster analysis. A dissimilarity matrix was calculated using the Bray-Curtis distance measure and the relative IV for species per vegetation plot. Cluster analyses using the Bray-Curtis distance measure was used to classify plots into groups based on IV for woody species using Ward's objective function in R software. Only plots with tree species (n=134) were included within the cluster analysis since zero values produce erroneous model results. The remaining plots were classified as grassland plots due to lack of woody species (n=9). Silhouette width and partana ratio combinations were used as criteria for selecting the number of groups for the cluster analysis, which was determined to be fourteen clusters since both the partana ratio and silhouette width were maximized at this threshold (Figures 14 and 165.

Figure 13. Habitat and vegetation data were collected at 143 vegetation survey stations randomly sub-sampled from the bird survey stations to proportionally represent distinct vegetation types on Rota.

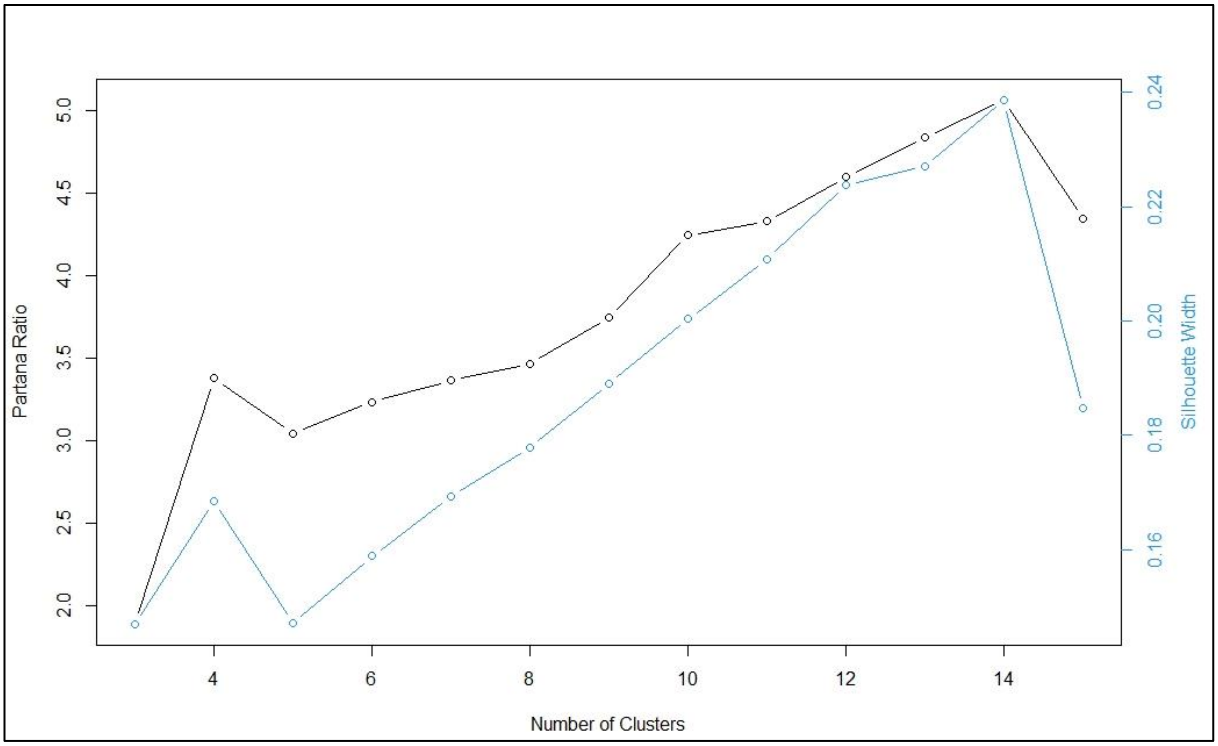

Figure 14. Partana ratio and silhouette width for hierarchical cluster thresholds using Bray-Curtis dissimilarity matrix of tree species importance values sampled for the Rota Island-wide survey in 2022.

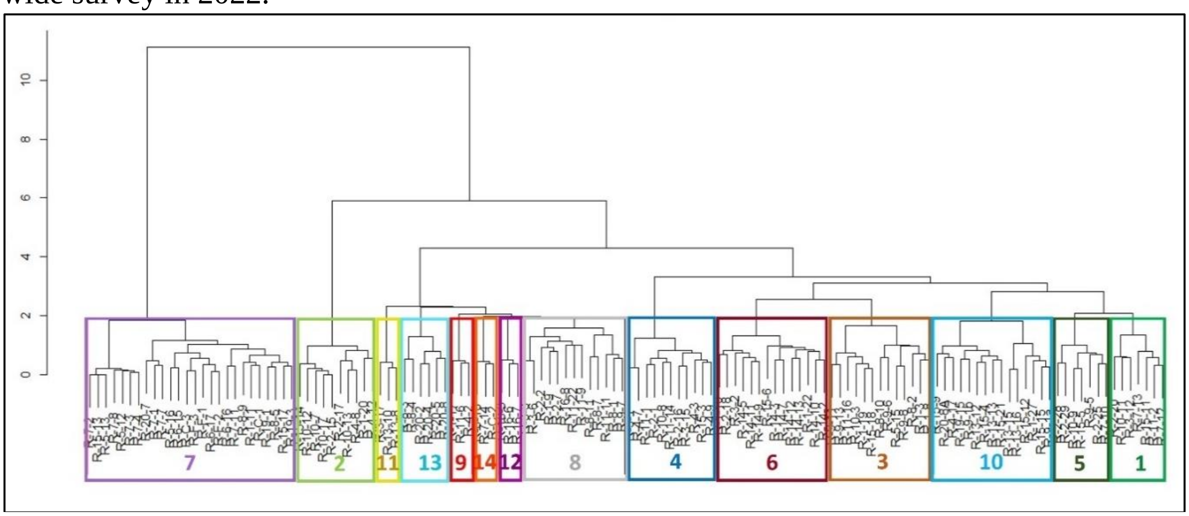

Figure 15**.** Dendrogram of fourteen groups/clusters identified from hierarchical cluster analysis of Rota Island-wide vegetation plots based on Bray-Curtis dissimilarity matrix of tree species importance values sampled in 2022.

After plots were grouped into clusters, mean importance values were calculated to determine dominant species within each plant community cluster (Figure 15). Cluster 1 was dominated by fingersop/paipai (*Meiogyne cylindrocarpa*), screw pine/påhong/påhon (*Pandanus dubius*), and ifit/ifil (*Intsia bijuga*); cluster 2 by coconut/niyok (*Cocos nucifera*); cluster 3 by fingersop/paipai and twin-apple/fagot/fago' (*Ochrosia oppositifolia*); cluster 4 by false elder/åhgao (*Premna serratifolia*) and fingersop/paipai; cluster 5 by strangler fig/nunu (*Ficus* *prolixa*) and cedar bay cherry/a'abang (*Eugenia reinwardtiana*); cluster 6 by beach cordia/niyoron (*Cordia subcordata*), fingersop/paipai, luluhut (*Maytenus thompsonii*), and northern yellow boxwood (*Pouteria obovata*); cluster 7 by screw pine/kaffo'/fatsao (*Pandanus tectorius*); cluster 8 by hibiscus/pågo (*Talipariti tiliaceum*), citrus (*Citrus* spp.), papåya (*Carica papaya*), and hopbush/lampauye (*Dodonaea viscosa*); cluster 9 by ironwood/gågo/gågu (*Casuarina equisitifolia*); cluster 10 by limeberry/lemon di China (*Triphasia trifolia*), breadfruit/dukduk (*Artocarpus mariannensis*), false elder/åhgao, and fingersop/paipai (*Meiogyne cylindrocarpa*); cluster 11 by hedge acacia/tångantångan (*Leucaena leucocephala*); cluster 12 by faniok (*Merrilliodendron megacarpum*); cluster 13 by dyer's fig/hodda/hoda (*Ficus tinctoria*) and jack-in-a-box/nonak/nonag (*Hernandia sonora*); and cluster 14 by oschal (*Hernandia labyrinthica*) and hibiscus/pågo.

Since the cluster analysis categorizes vegetation plots by dominance of specific tree species, more than one cluster can be representative of larger plant communities or assemblages and can therefore be combined into higher level plant community types. For example, several clusters were classified based on varying dominance of co-occurring species that are typically found in a native limestone forest complex. In order to classify vegetation plots into ecologically significant plant communities, clusters were combined based on similar species associations and seven plant communities were delineated: coconut forest (cluster 2), faniok-dominated forest (cluster 12), ironwood/gågo/gågu-dominated forest (cluster 9), native limestone forest (clusters 1, 3, 4, 5, 6, 10, 13, and 14), mixed introduced forest (cluster 8), screw pine/kaffo'/fatsao thicket (cluster 7), and tångantångan-dominated forest (cluster 11) (Figure 15).

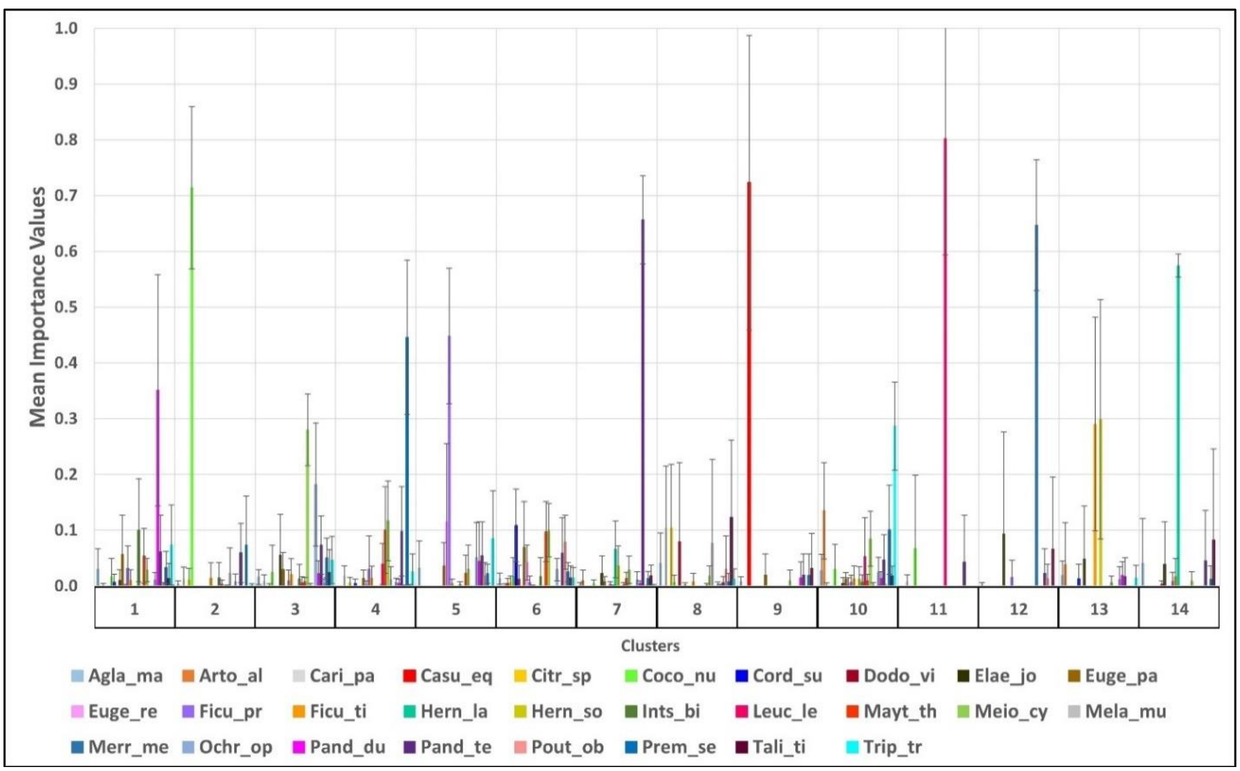

Figure 16. Mean importance values for select species per cluster identified from hierarchical cluster analysis of Rota Island-wide vegetation plots sampled in 2022. Agla_ma = mapunyao

(*Aglaia mariannensis*), Arto_al = breadfruit/dukduk (*Artocarpus mariannensis*), Cari_pa = papåya (*Carica papaya*), Casu_eq = ironwood/gågo (*Casuarina equisitifolia*), Citr_sp = citrus (*Citrus* spp.), Coco_nu = coconut/niyok (*Cocos nucifera*), Cord_su = beach cordia/niyoron (*Cordia subcordata*), Dodo_vi = hopbush/lampauye (*Dodonaea viscosa*), Elae_jo = blue marble tree/yoga (*Elaeocarpus joga*), Euge_pa = agatelang/aghotoleng (*Eugenia palumbis*), Euge_re = cedar bay cherry/a'abang (*Eugenia reinwardtiana*), Ficu_pr = strangler fig/nunu (*Ficus prolixa*), Ficu_ti = dyer's fig/hodda/hoda (*Ficus tinctoria*), Hern_la = oschal (*Hernandia labyrinthica*), Hern_so = jack-in-a-box/nonak (*Hernandia sonora*), Ints_bi = ifit/ifil (*Intsia bijuga*), Leuc_le = hedge acacia/tångantångan (*Leucaena leucocephala*), Mayt_th = luluhut (*Maytenus thompsonii*), Meio_cy = fingersop/paipai (*Meiogyne cylindrocarpa*), Mela_mu = ålum/ålum (*Melanolepis multiglandulosa*), Merr_me = faniok (*Merrilliodendron megacarpum*), Ochr_op = twin-apple/fagot/fago' (*Ochrosia oppositifolia*), Pand_du = screw pine/påhong/påhon (*Pandanus dubius*), Pand_te = screw pine/kaffo'/fatsao (*Pandanus tectorius*), Pout_ob = northern yellow boxwood (*Pouteria obovata*), Prem_se = false elder/åhgao (*Premna serratifolia*), Tali_ti = hibiscus/pågo (*Talipariti tiliaceum*), and Trip_tr = limeberry/lemon di China (*Triphasia trifolia*).

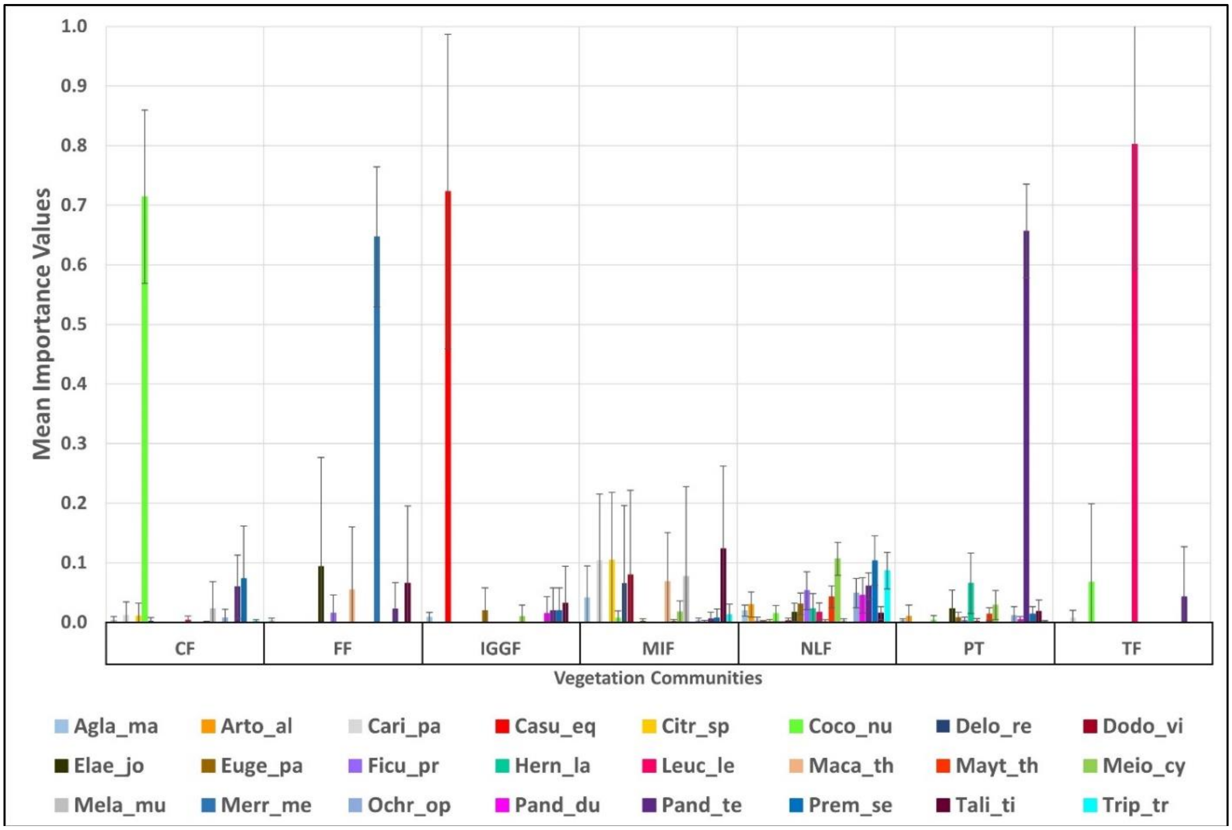

Figure 17. Mean importance values for select species per merged plant community classes identified from hierarchical cluster analysis of Rota Island-wide vegetation plots sampled in 2022. CF = coconut forest, FF = faniok forest, IGGF = ironwood/gågo/gågu-dominated forest, MIF = mixed introduced forest, NLF = native limestone forest, PT = screw pine/kaffo'/fatsao thicket, TF = tångantångan-dominated forest, Agla_ma = mapunyao (*Aglaia mariannensis*), Arto_al = breadfruit/dukduk (*Artocarpus mariannensis*), Cari_pa = papåya (*Carica papaya*), Casu_eq = ironwood/gågo (*Casuarina equisitifolia*), Citr_sp = citrus (*Citrus* spp.), Coco_nu = coconut/niyok (*Cocos nucifera*), Delo_re = flame tree/atbut (*Delonix regia*), Dodo_vi = hopbush/lampauye (*Dodonaea viscosa*), Elae_jo = blue marble tree/yoga (*Elaeocarpus joga*), Euge_pa = agatelang/aghotoleng (*Eugenia palumbis*), Ficu_pr = strangler fig/nunu (*Ficus prolixa*), Hern_la = oschal (*Hernandia labyrinthica*), Leuc_le = hedge acacia/tångantångan (*Leucaena leucocephala*), Maca_th = pengua (*Macaranga thompsonii*), Mayt_th = luluhut (*Maytenus thompsonii*), Meio_cy = fingersop/paipai (*Meiogyne cylindrocarpa*), Mela_mu = ålum/ålum (*Melanolepis multiglandulosa*), Merr_me = faniok (*Merrilliodendron megacarpum*), Ochr_op = twin-apple/fagot/fago' (*Ochrosia oppositifolia*), Pand_du = screw pine/påhong/påhon (*Pandanus dubius*), Pand_te = screw pine/kaffo'/fatsao (*Pandanus tectorius*), Prem_se = false elder/åhgao (*Premna serratifolia*), Tali_ti = hibiscus/pågo (*Talipariti tiliaceum*), and Trip_tr = limeberry/lemon di China (*Triphasia trifolia*).

Forest bird habitat associations

Of the vegetation plots sampled, 135 were able to be associated with data from the forest bird surveys. Habitat types were classified into seven categories: Casuarina-Dominated Forest (*n* = 3); Coconut Forest (*n* = 10); Grassland (*n* = 8); Mixed Introduced Forest (*n* = 14); Native Limestone (*n* = 76); Pandanus Thicket (*n* = 21); tångantångan-dominated forest (*n* = 3). The habitat type with the highest average relative abundance of birds was tångantångan-dominated forest (μ = 15.67, CI = 10.21) followed by mixed introduced forest (μ = 14.71, CI = 3.56) and casuarina-dominated forest (μ = 14.67, CI = 4.57) (Table 10). Pandanus thicket had the lowest mean abundance (μ = 9.43, CI = 1.81). Mariana Kingfishers abundance was highest in casuarina-dominated forests (μ = 2.33, CI = 0.65), followed by native limestone forest (μ = 1.36, CI = 0.25) and mixed introduced forest (μ = 1.29, CI = 0.75) (Table 11). Mariana Fruit Doves were most abundant in casuarina-dominated forest (μ = 2.33, CI = 1.73), followed by native limestone forest (μ = 1.83, CI = 0.36) and mixed introduced forest (μ = 1.57, CI = 0.57). Micronesian Myzomela were most abundant in tångantångan-dominated forest (μ = 2.33, CI = 2.85), followed by grassland (μ = 2.25, CI =1.37) and casuarina-dominated forest (μ = 2.00, CI = 1.96). Micronesian Starlings were most abundant in mixed introduced forest (μ = 6.79, CI = 1.81), followed by tångantångan-dominated forest (μ = 5.33, CI = 3.97), and native limestone forest (μ = 4.47, CI = 0.64). Rota White-eye were most abundant in grassland (μ = 0.88, CI = 1.72) followed by native limestone forest (μ = m = 0.75, CI = 0.39) and pandanus thicket (μ = m = 0.19, CI = 0.37). However, Rota white-eye occurred in native limestone forest more frequently (20%) than grassland (13%). Rota White-eye we not detected in the other habitat types. Rufus Fantail were most abundant in mixed introduced forest (μ = 1.71, CI = 0.86) followed by native limestone forest (μ = 1.64, CI = 0.86) and pandanus thicket (μ = 1.24, CI = 0.52). White-throated Ground Dove were most abundant in casuarina-dominated forest (μ = 0.67, CI = 1.31), followed by tångantångan-dominated forest (μ = 0.67, CI = 1.31) and native limestone forest (μ = 0.43, CI = 0.16). The average mean abundance of Black Drongo was highest in tångantångan-dominated forest (μ = 4, CI = 4.93) followed by Casuarina-dominated forests (μ = 33.33, CI = 2.36) and grasslands (μ = 3.13, CI = 1.59). Eurasian Tree Sparrow were only detected in native limestone forest (μ = 0.14, CI = 0.15, however, they occurred in only 5% of the plots. Philippine Collared Doves were most abundant in coconut forest (μ = 1.70, CI = 2.34), followed by grassland (μ = 0.88, CI = 0.94) and mixed introduced forest (μ = 0.29, CI = 0.32).

The small sample size for every habitat type, except native limestone forest and pandanus thicket, should be taken into consideration when interpreting the results of the habitat associations. Most of the results suggested expected associations like Rota White-eye occurring more commonly in native limestone forest. The higher abundances of some frugivore species in the casuarina-dominated forest were unexpected for species like the Mariana Fruit Dove. One conclusion from finding higher birds detections in habitats that do not coincide with what is known about the specie's life histories is that the birds are primarily foraging and reproducing in adjacent suitable habitat. The source-sink model where some habitats have a reproductive rate higher than mortality (source) and others have mortality that exceeds the reproductive rate (sink) may be applicable. Another possibility is that some forest bird species exhibit more diet plasticity than previously thought. Camp et al. 2014 occupancy models did not find significant differences in forest bird habitat associations for any species except the White-throated Ground Dove. Future work will include making a classified map of Rota's vegetation and evaluating trends in forest bird population abundance and distribution between 1982 and 2022.

Table 10. Mean abundance of birds per station per habitat type

Habitat type	Mean	CI
Casuarina-Dominated Forest (*n* = 3)	14.67	4.57
Coconut Forest (*n* = 9)	12.56	4.44
Grassland (*n* = 8)	13.13	5.85
Mixed Introduced Forest (*n* = 14)	14.71	3.56
Native Limestone Forest (*n* = 76)	13.41	1.41
Pandanus Thicket (*n* = 21)	9.43	1.81
tångantångan Forest (*n* = 3)	15.67	10.21

Table 11. Occurrence and mean abundance of forest bird species detected in each habitat type

Common Name	Habitat Type	Mean	CI	% Occurrence
Mariana Fruit Dove	Casuarina-Dominated Forest	2.33	1.73	100
	Coconut Forest	1.40	0.78	70
	Grassland	1.38	1.38	50
	Mixed Introduced Forest	1.57	0.57	86
	Native Limestone Forest	1.83	0.36	74
	Pandanus Thicket	1.19	0.58	62
	Tångantångan Forest	1.00	0.00	100
Mariana Kingfisher	Casuarina-Dominated Forest	2.33	0.65	100
	Coconut Forest	1.00	0.51	70
	Grassland	0.63	0.63	38
	Mixed Introduced Forest	1.29	0.75	64
	Native Limestone Forest	1.36	0.25	70
	Pandanus Thicket	0.95	0.29	76
	Tångantångan Forest	1.33	1.73	67
Micronesian Myzomela	Casuarina-Dominated Forest	2.00	1.96	67
	Coconut Forest	1.90	0.94	90
	Grassland	2.25	1.37	88
	Mixed Introduced Forest	1.21	0.59	71
	Native Limestone Forest	1.32	0.30	64
	Pandanus Thicket	0.67	0.31	52
	Tångantångan Forest	2.33	2.85	67
Micronesian Starling	Casuarina-Dominated Forest	4.00	1.13	100
	Coconut Forest	4.10	1.74	80
	Grassland	3.00	1.39	88
	Mixed Introduced Forest	6.79	1.81	100
	Native Limestone Forest	4.47	0.64	92
	Pandanus Thicket	3.90	1.13	90
	Tångantångan Forest	5.33	3.97	100
Rota White-eye	Casuarina-Dominated Forest	0	0	0
	Coconut Forest	0	0	0
	Grassland	0.88	1.72	13
	Mixed Introduced Forest	0	0	0
	Native Limestone Forest	0.75	0.39	20
	Pandanus Thicket	0.19	0.37	5
	Tångantångan Forest	0	0	0
Rufous Fantail	Casuarina-Dominated Forest	0	0	0
	Coconut Forest	0.30	0.30	30
	Grassland	0.75	1.03	25
	Mixed Introduced Forest	1.71	0.86	57

	Native Limestone Forest	1.64	0.36	74
	Pandanus Thicket	1.24	0.52	71
	Tångantångan Forest	1.00	1.13	67
White-throated Ground Dove	Casuarina-Dominated Forest	0.67	1.31	33
	Coconut Forest	0.40	0.43	30
	Grassland	0.25	0.32	25
	Mixed Introduced Forest	0.14	0.28	7
	Native Limestone Forest	0.43	0.16	33
	Pandanus Thicket	0.19	0.26	10
	Tångantångan Forest	0.67	1.31	33
Black Drongo*	Casuarina-Dominated Forest	3.33	2.36	100
	Coconut Forest	0.50	0.44	40
	Grassland	3.13	1.59	88
	Mixed Introduced Forest	1.71	0.88	64
	Native Limestone Forest	1.18	0.29	55
	Pandanus Thicket	0.90	0.71	43
	Tångantångan Forest	4.00	4.93	100
Eurasian Tree Sparrow*	Casuarina-Dominated Forest	0	0	0
	Coconut Forest	0	0	0
	Grassland	0	0	0
	Mixed Introduced Forest	0	0	0
	Native Limestone Forest	0.14	0.15	5
	Pandanus Thicket	0	0	0
	Tångantångan Forest	0	0	0
Philippine Collared Dove*	Casuarina-Dominated Forest	0	0	0
	Coconut Forest	1.70	2.34	30
	Grassland	0.88	0.94	50
	Mixed Introduced Forest	0.29	0.32	21
	Native Limestone Forest	0.28	0.18	16
	Pandanus Thicket	0.19	0.22	14
	Tångantångan Forest	0	0	0

Objective 3: Conduct 1 investigation to determine abundance of wetland-associated birds on Saipan and Rota by September 30, 2022.

Shorebird, Wader, Waterfowl (SWW) surveys were conducted in November (wet season) and May (dry season) of FY 2022 on Saipan and Rota. Counts were conducted at 30 wetland areas on Saipan and three on Rota. The SWW surveys are in part intended to document abundance of the endangered Mariana Common Moorhen (*Gallinula chloropus guami*) on these two islands. They are also intended to assess the diversity and abundance of migrants stopping over or overwintering on these islands throughout the year. Each survey is a minimum of either 10 or 20 minutes depending on the size of the site and take place between the hours of 6:00 AM and 10:00 AM. All shorebird, waterfowl, and wader species detected visually or aurally are recorded and the life stage of the Mariana Common Moorhen observed.

Some migrant bird species winter in the CNMI and 14 species were detected on Saipan in FY2022. A greater number of migrants are typically detected in the wet season as it coincided with the end of fall migration. Pacific Golden Plovers (*Pluvialis fulva*) had the greatest total detections per sampling period on Saipan (*n* = 98) followed by Ruddy Turnstone (*Arenaria interpres*) (*n* = 23), Sharp-tailed Sandpiper (*Calidris acuminata*) (*n* = 10). On Rota, eight migrant species were detected. Pacific Golden Plovers had the greatest total detections (*n* = 119) followed by Whimbrels (*Numenius phaeopus*) (*n* = 18), Wandering Tattlers (*Tringa incana*) (*n* = 5). Several resident waterbird species were also detected during surveys including Yellow Bittern (*n* = 45), Pacific Reef-heron (*n* = 20), Intermediate egret (*n* = 9) and Little Egret (*n* = 5).

Mariana Common Moorhens

Surveys were conducted at three sites on Rota in the wet season (November) and dry season (May). Historically, waterbird surveys were conducted four times per year, therefore replicate surveys were averaged within the season. Moorhens were detected at the water hazard ponds at the Rota Resort Golf Course and the sewage treatment ponds in past years, however, moorhens were only detected at the golf course site in FY 2022. The number of moorhen increased slightly in FY 2022 from FY 2021. Survey data were used to calculate an index of abundance (mean total detections) for five of the past six years (Figure 18). The data suggest a decline in the number of moorhen on Rota, however moorhen have not been detected in large numbers historically (Takano & Haig 2004).

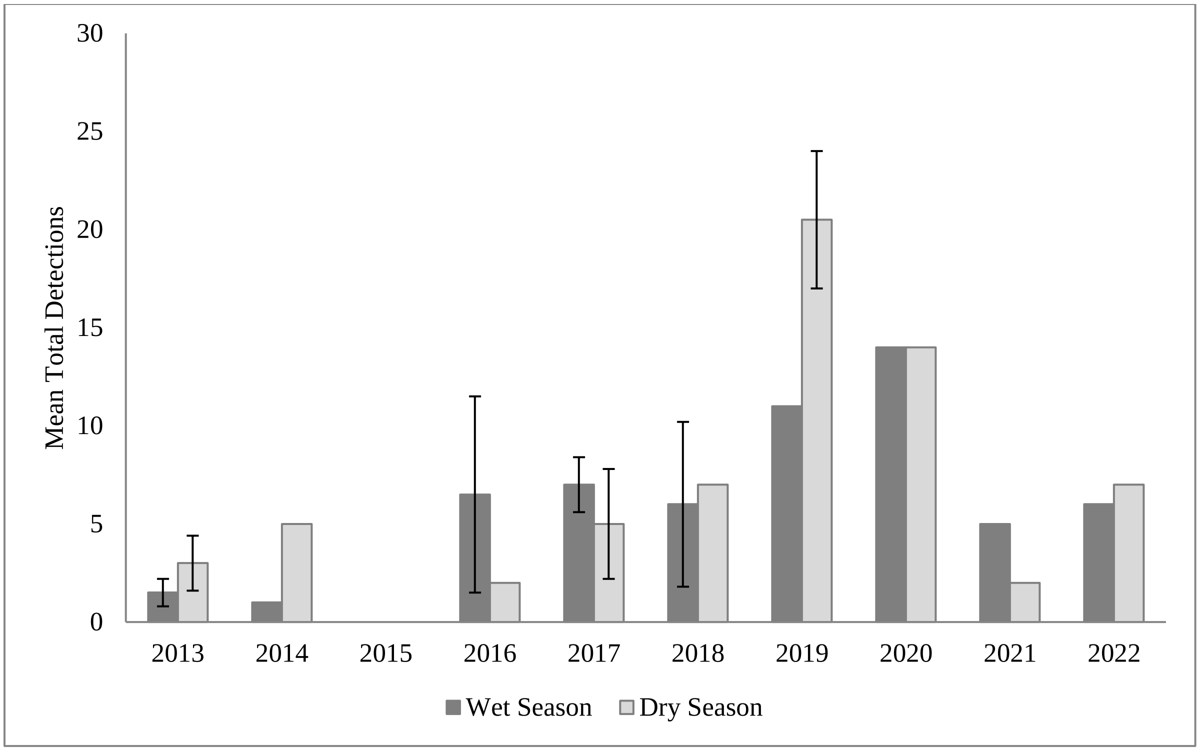

Figure 18. Mean total detections for Common Moorhen on Rota from fiscal years 2013-2022. Historically, waterbird surveys were conducted four times per year, therefore replicate surveys were averaged within the season. No error bars indicate only one survey was conducted that season.

In FY2022, SWW surveys were conducted at 30 sites on Saipan in November (wet season) and May (dry season), however, two sites are not included when evaluating moorhen numbers as they are coastal mudflat areas not frequented by moorhens.

Moorhens were detected at 18 sites: 59 were detected in the dry season and 62 in the wet season (Figure 19). Survey data were used to calculate the total number of detections for the past seven years. These totals reflect the minimum number of moorhens in the CNMI as some heavily-used wetlands such as Chalan Kanoa (CK) Potholes on Saipan and Lake Hagoi on Tinian are not surveyed on a regular basis by DFW staff because of the difficulty in regularly accessing those sites. We did not investigate the reproductive success of moorhen; however, we did record the abundance of juveniles as a coarse measure of recruitment. Moorhen recruitment was slightly higher in FY2022 (n = 23) than in FY 2021 (n = 17).

The areas with the most detections were man-made water features, likely due to water being consistently available. More moorhen were detected in FY 2022 than in FY 2021 however, we continued to be unable to survey the golf course ponds of the Mariana Resort because it was used as a Covid-19 quarantine facility. In May of FY 2022, access to Flores Pond was not possible due to landownership changes. The new lessors could not be identified to ask for permission to access the pond through their land and a new route into the pond could not be achieved. The inability to survey the same sites annually makes among year comparisons difficult. Nevertheless, the FY2022 detection numbers are only slightly higher than the FY2021 number which were then lowest in the last five years. The spatial variation in moorhen detections can be partially explained by ephemeral wetlands like Flores Pond drying in May. Additionally, it is hypothesized that some moorhen migrate to the island of Tinian at the onset of the wet season (Takano and Haig 2004).

Invasive plants like pond apple (*Annona glabra*), kang kong (*Ipomoea aquatica*) and water hyacinth (*Eichhornia crassipes*) continue to compromise the functionality of some wetlands on Saipan. The plants alter the foraging habitat and use more water than the native plants, drying the wetland. At least several wetland areas will need to be restored to become suitable moorhen habitat again. Occasionally, moorhen who are killed by cars are found near roads that are adjacent to or bisect wetlands. In FY 2022, eight moorhen roadkill carcasses were recovered by DFW. Reduced speed limits around wetlands and signage to alert the public to moorhen crossing could be an effective tool for reducing mortalities.

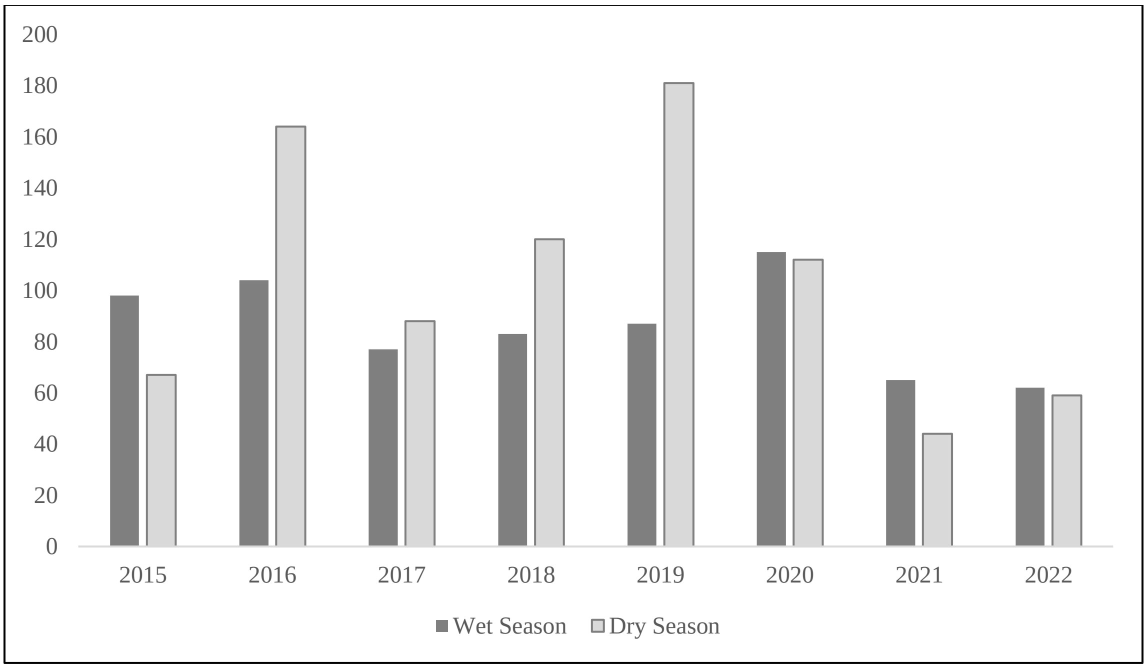

Figure 19. Total detections for Common Moorhen on Saipan from 2015-2022.

Objective 4: Conduct 1 investigation to determine the abundance for seabirds at the I Chenchon colony on Rota by September 30, 2022.

In FY2022, seabird surveys were completed in February, May, and August at the I Chenchon colony on Rota (Access point for survey stations 1-4 UTMs N 312980 E 1565411, access point for stations 5-8 UTMs N 312842 E 1565685). We adjusted the timeframe of our data collection to capture peak adult Red Footed Booby (*Sula Sula*), occupancy (February) based on patterns detected in past surveys and peak subadult presence (May) in an attempt to capture breeding effort and annual recruitment rates. We only included the February, May, and August quarters in the analysis because the November quarter has historically been surveyed the least frequently; however, it typically has the lowest number of birds and was therefore lowering the average for the years when surveys were conducted in the November.

Point counts were conducted from 11 pre-established stations on a cliff edge overlooking the colony (Appendix D). The unobstructed viewshed from the cliff edge survey stations allows us to count all nests, determine contents of exposed nests, determine nest tree substrate and count roosting adults and subadults. Each section of the colony is scanned from the cliff top survey station looking down into the colony. Observers use binoculars or spotting scope to scan the colony and call out survey figures to a data recorder. Only birds at rest are counted (sitting in a tree, nest, or cliff side). Data collected on nest numbers, nest contents and nest tree species will be analyzed for future publication on the seabird colony ecology.

Mean total detections for Red-Footed Booby, Brown Booby (*Sula leucogaster*), and Great Frigatebird (*Fregata minor)* were calculated and compared among years. The average number of adult Red-Footed Boobies in FY2022 is 839 individuals (Figure 20), which is lower than the previous 5-year average for the same survey quarters (2016-2020 n=1,181). The number of Red-Footed Booby subadults recorded in FY2022 was about the same as previous years. Brown Booby numbers are also stable (Figure 21). Eight adult Great Frigatebirds were detected in February 2022 (Figure 22). Three juveniles were recorded in May 2022 and three subadults were recorded during the August 2022 survey. In FY2022, 387 Red-footed Booby subadults (Figure 23), three Brown Booby subadults and zero Great Frigatebird juveniles were detected. The Red-footed Booby subadult numbers are more than double the number detected in FY2021. We will continue to survey during peak colony occupation in February and May 2023; however, climate change has the potential to shift the breeding season of boobies and reevaluating the timing and frequency of the surveys may be needed to correctly monitor the colony.

The lower-than-average number of booby adults in the colony this year could be a result of a three year La Niña climate event (Tompkins & Anderson 2021, Catry et al. 2013, Ancona et al 2011). While the Division of Fish and Wildlife cannot directly manage seabird food resources, protecting important nesting habitat in the CNMI from invasive mammal browsing (Miyaki & Kaji 2022) and predation is critical for preventing seabird population declines (Spatz et al. 2017, Bellingham et al. 2010). Additionally, managing the colony for typhoon resiliency could include ensuring nest tree recruitment is occurring (Campbell & Atkinson 2002) and exploring the use of artificial nesting platforms (Rauzon & Drigot 1999).

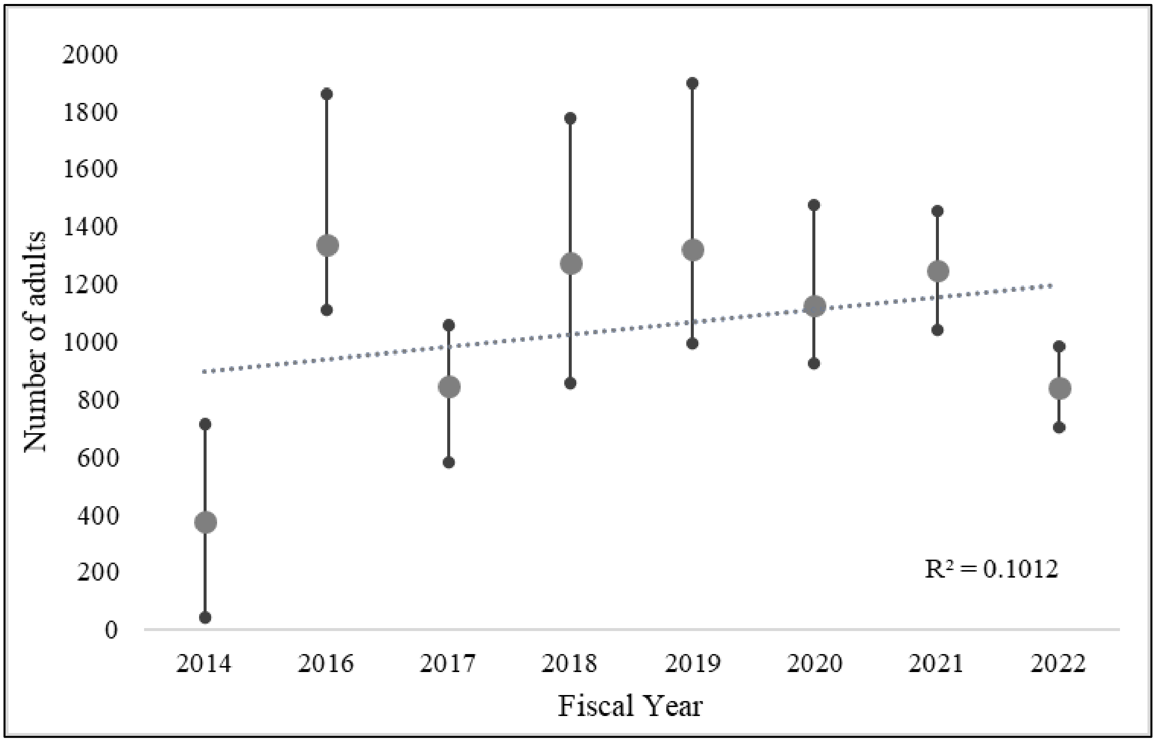

Figure 20. Minimum, maximum and mean total detections of adult Red-Footed Booby on Rota at I Chenchon Seabird Sanctuary from fiscal years 2010-2022; data collected by DFW staff.

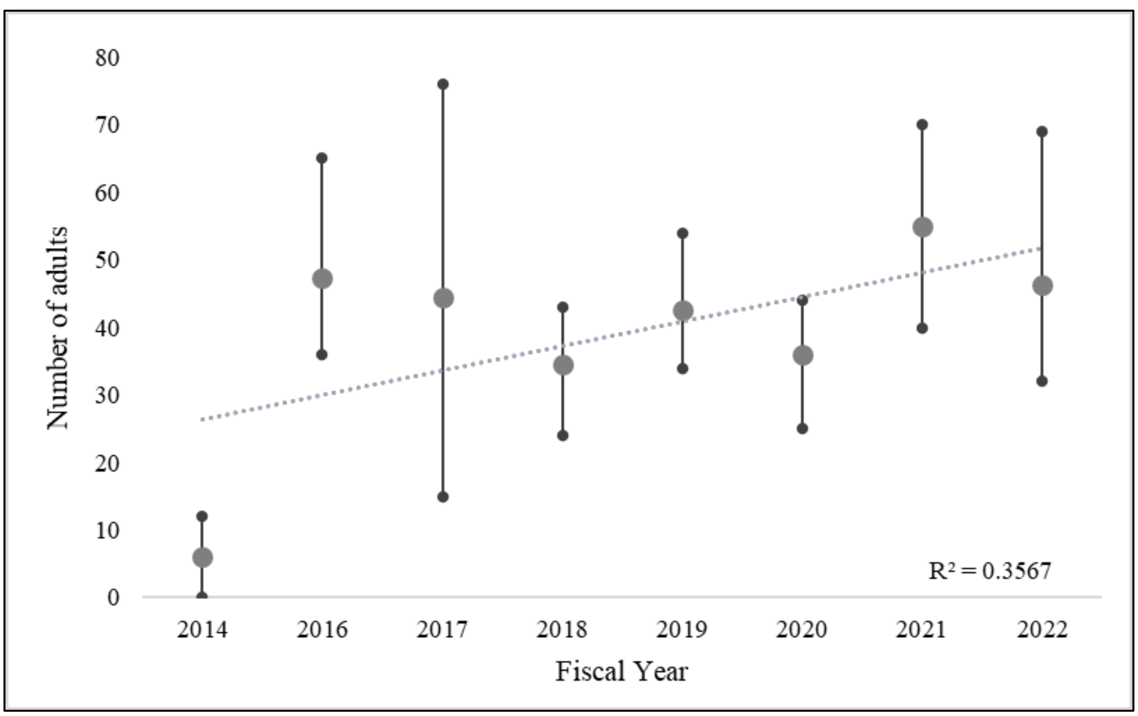

Figure 21. Minimum, maximum and mean total detections of adult Brown Booby on Rota at I Chenchon Seabird Sanctuary from fiscal years 2010-2022; data collected by DFW staff.

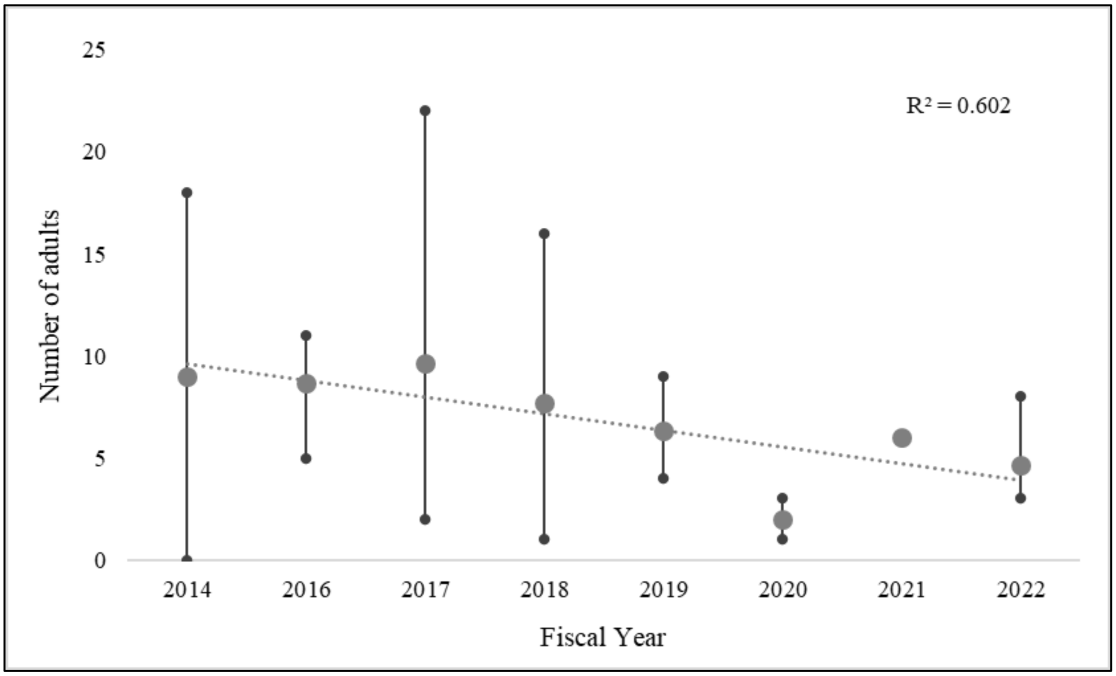

Figure 22. Minimum, maximum and mean total detections of Great Frigatebird (GRFR) at I Chenchon Seabird Sanctuary, Rota from fiscal years 2010-2022; data collected by DFW staff.

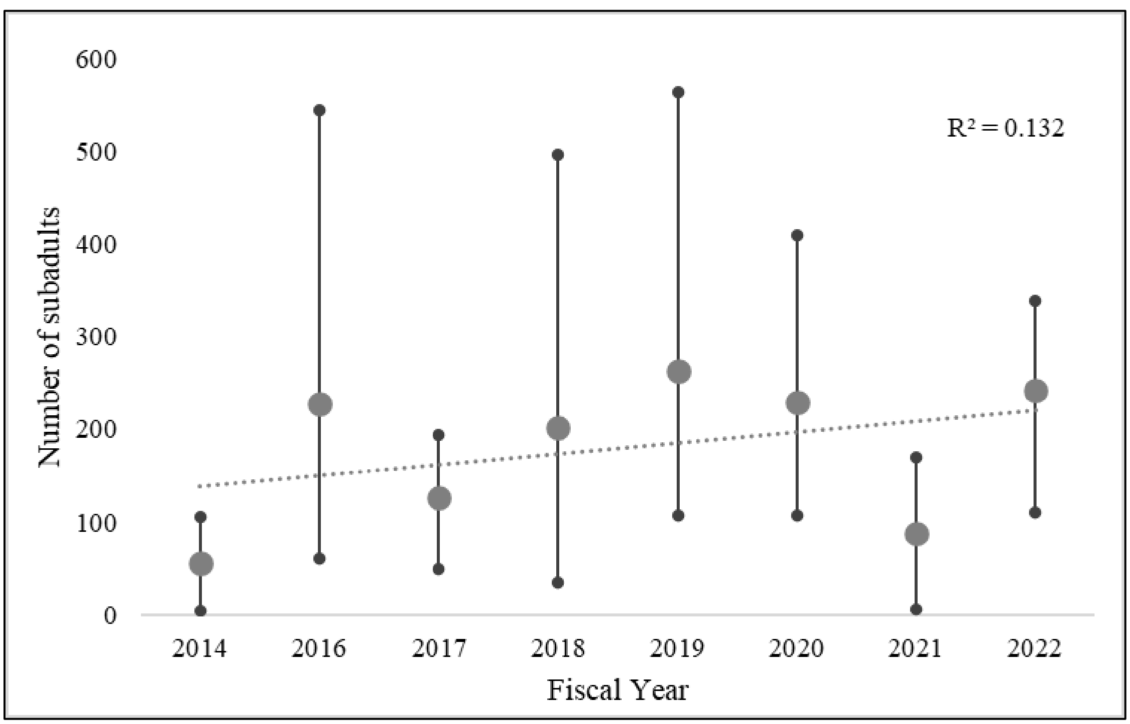

Figure 23. Minimum, maximum and mean total detections of subadult Red-Footed Booby on Rota at I Chenchon Seabird Sanctuary from fiscal years 2014-2022; data collected by DFW staff.

Objective 5: Conduct 1 investigation of Wedge-tailed Shearwater nest success on Mañagaha by September 30, 2022

Mañagaha, a small islet in the Saipan lagoon, Northern Mariana Islands hosts one of few known colonies of breeding Wedge-tailed Shearwaters (Lifa'ru; *Ardenna pacifica*) in the CNMI. In 1999, the CNMI-Division of Fish and Wildlife identified introduced cat (*Felis catus*) and rat (*Rattus rattus*) populations on Mañagaha as the most pressing threat to the survival of this colony, and began eradication efforts in late 2003. In 2004 the island was declared predator free, and trails were rerouted and signs posted to make visitors aware of shearwater nesting sites. Division of Fish and Wildlife nest success monitoring on Mañagaha began on 2003, and has continued to the present.

Three censuses (mid-June, late July, and late October) were conducted in 2022. The June surveys determined adult occupancy, the July surveys identified the number of hatched chicks, and the October surveys determined the number of chicks that fledged. Burrow occupancy was confirmed by either (1) visual inspection, (2) playback recordings, (3) dowel rod insertion, (4) flexible inspection camera, or (5) standing toothpicks upright in the burrow entrance to see if they are knocked down by incoming or outgoing birds.

During the 2022 breeding season, 206 active Wedge-Tailed Shearwater nests were identified, 99 (48%) of which produced fledglings (offspring >103 days old) (Figure 24). Most identified nest failures were due to collapsed nests, possibly due to large waves causing erosion. This was the first-year breeding numbers have exceeded over 200 pairs of Wedge-Tailed Shearwaters. The number of visitors on Mañagaha has drastically decreased over the past 2 years due to the Covid-19 pandemic and lack of reliable boat transportation, resulting in a decrease in disturbance around nesting sites. Identified nests were concentrated within the known nesting sites which are fenced with only about 7% of burrows outside of these fenced nesting areas. Burrows found on the banks of two of the three nesting sites were completely eroded away or collapsed and the erosion will likely continue with rising sea levels.

Fences were observed to be in poor condition, and tourists were seen attempting to cross the breeding area during several of our surveys. Trash has become an issue on Mañagaha, since there was no concessionaire on Mañagaha to properly clean the trash that is left behind and manage trashcan deployment. This could potentially lead to a new rat introduction on the island which would likely adversely impact the shearwater population.

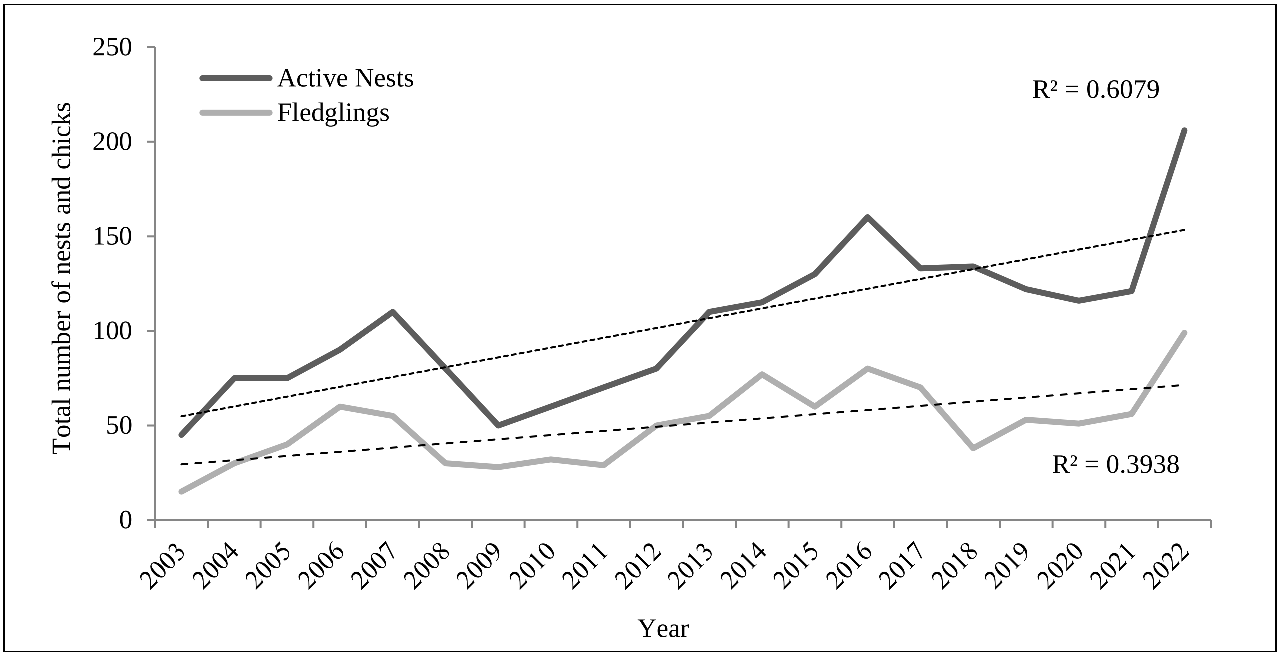

Figure 24. The total number of Wedge-Tailed Shearwater (*Ardenna pacifica*) active nests and chicks that fledged on Mañagaha (2003-2022).

Objective 6: Directly restore, enhance, remove, create, or manage four (4) structures, consisting of 4 exclusion fences along with informational signs to deter human disturbance to the Wedge-tailed Shearwater colonies on Mañagaha, by September 30, 2022.

DFW initiated conversations with the Department of Public Lands (DPL) in March 2022 to replace fencing around the shearwater nesting areas. DFW staff met with DPL's surveyor staff on Mañagaha in June 2022 to identify areas of the fence that required immediate repair. DPL patched the areas of fence and promised that DPL rangers will monitor the colony to prevent visitors from crossing the fence. DFW will continue to work with DPL to move forward with the shearwater colony fence replacement in FY23.

Objective 7: Directly manage 3 species of rats at Mariana Swiftlet nesting/roosting sites by September 30, 2022

The Goodnature trap company changed their shipping policy and will no longer ship to the CNMI. DFW submitted several requests to freight forwarders to send the shipment to the CNMI, however, no quote was obtained. We have not found a suitable alternative to the A24's, so we will wait until the supplier is able to fulfill our order. In the meantime, we continue to record rat detections at caves while we conduct our biannual Mariana Swiftlet surveys.

8. Project outputs and outcomes:

Population GLM and change point models (Appendices A-C) and/or population growth rate coefficients of long-term population trends for each bird species on Saipan, Tinian, and Rota were calculated using updated monitoring data collected in FY2022. Endangered species monitoring of Mariana Swiftlets, Mariana Common Moorhen and Nightingale Reed-warbler assists in meeting species management and recovery goals. The Rota Island wide surveys were last conducted in 2012. The full 2022 dataset will be analyzed in a future report in FY23.

9. **Evaluation of project implementation:**

   Work was completed as expected with the exception of areas we could not access due to Covid-19 related restrictions and work on Tinian related to Objective 1. We were also unable to begin managing rats at swiftlet caves due to A24 rat trap shipping issues from the manufacturer.

10. **Project Staff:** Emilie R. Kohler, Amanda M. Santos, Dacia R. Wiitala, Robert S. Ulloa, Charles A. Mendiola, Ellie Roark, Chicko Arurang, Brad Eichelberger, Frances Sablan, Lee Roy Sablan, Bronson Curry, Steve Mullin

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APPENDIX A: Forest Bird Population Trends on Saipan Based Upon BBS Data

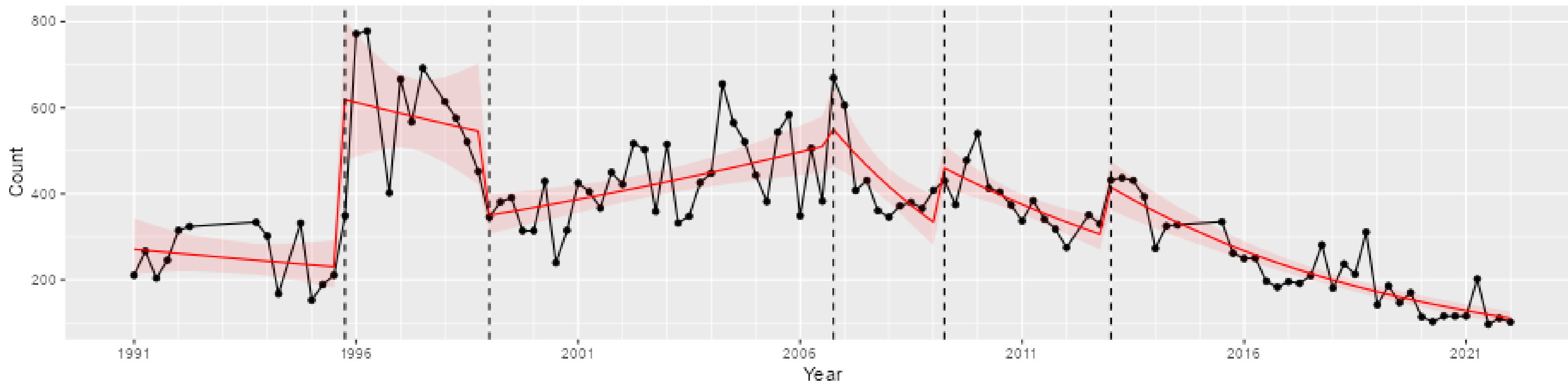

Figure 1. Changepoint model depicting the Bridled White-Eye (*Zosterops conspicillatus saypani*) population trend from Saipan BBS data (1991 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

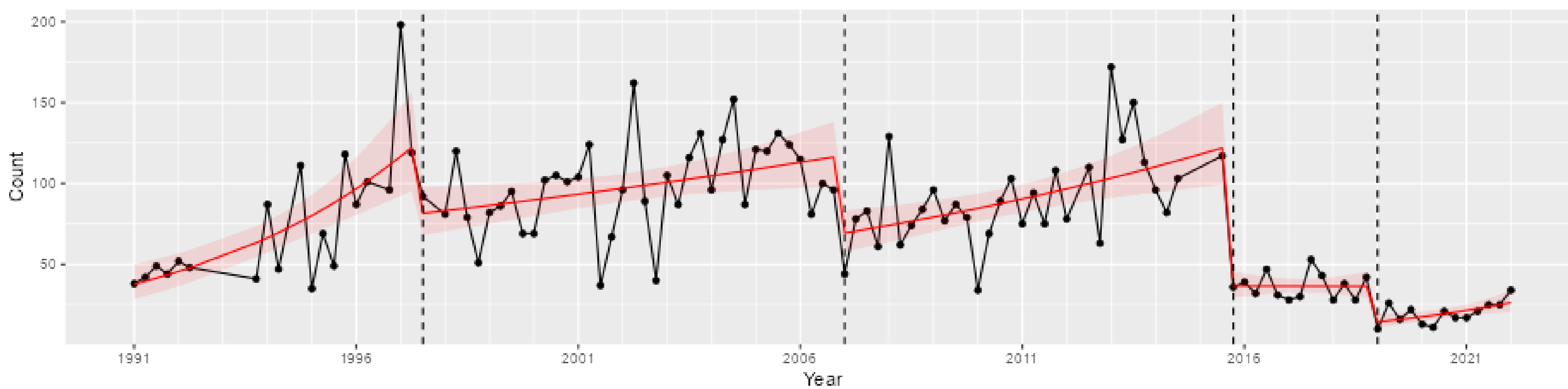

Figure 2. Changepoint model depicting the Golden White-Eye (*Cleptornis marchei*) population trend from Saipan BBS data (1991 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

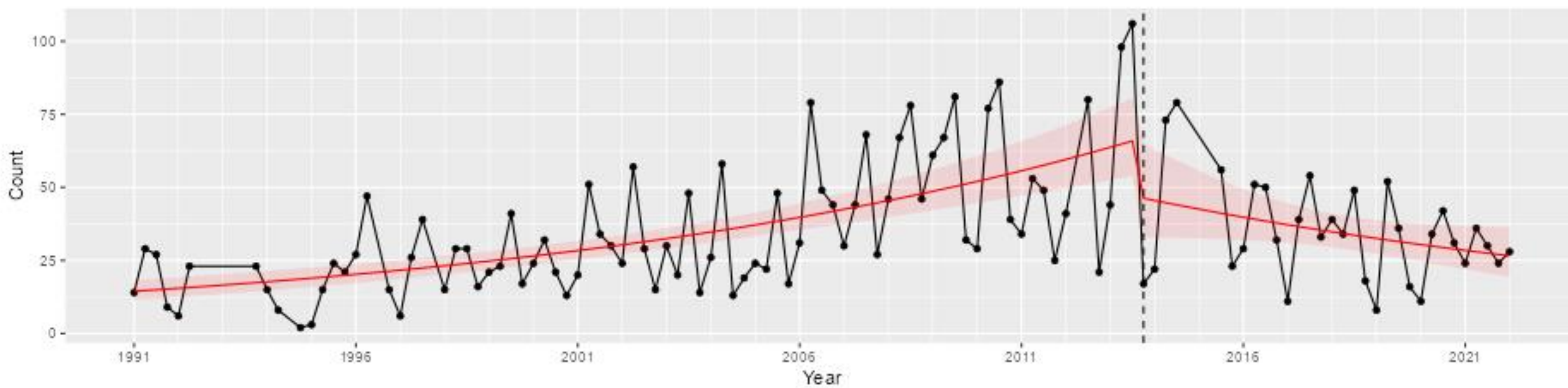

Figure 3. Changepoint model depicting the Mariana Fruit Dove (*Ptilinopus roseicapilla*) population trend from Saipan BBS data (1991 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

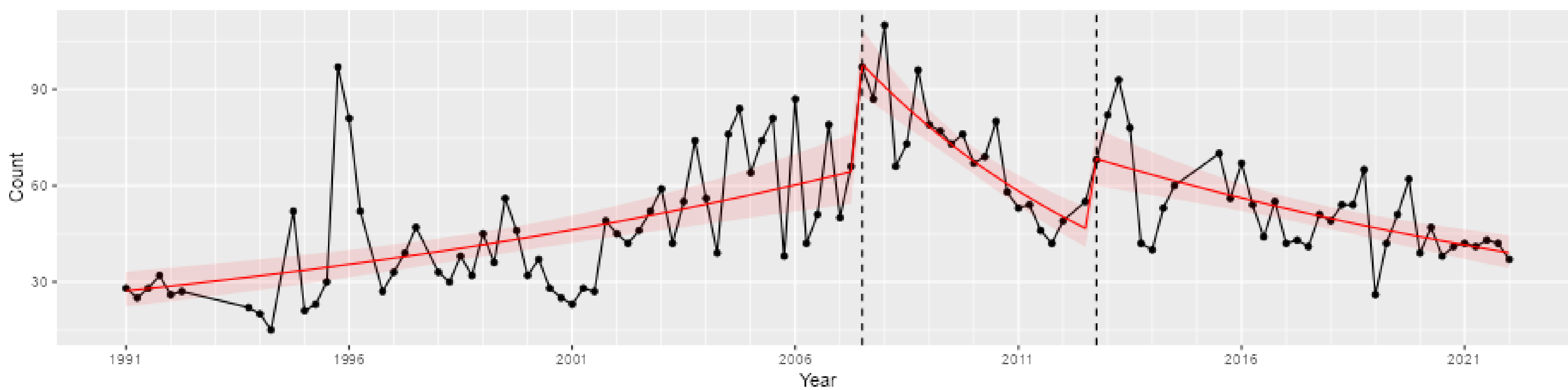

Figure 4. Changepoint model depicting the Mariana Kingfisher (*Todiramphus albicilla*) population trend from Saipan BBS data (1991 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

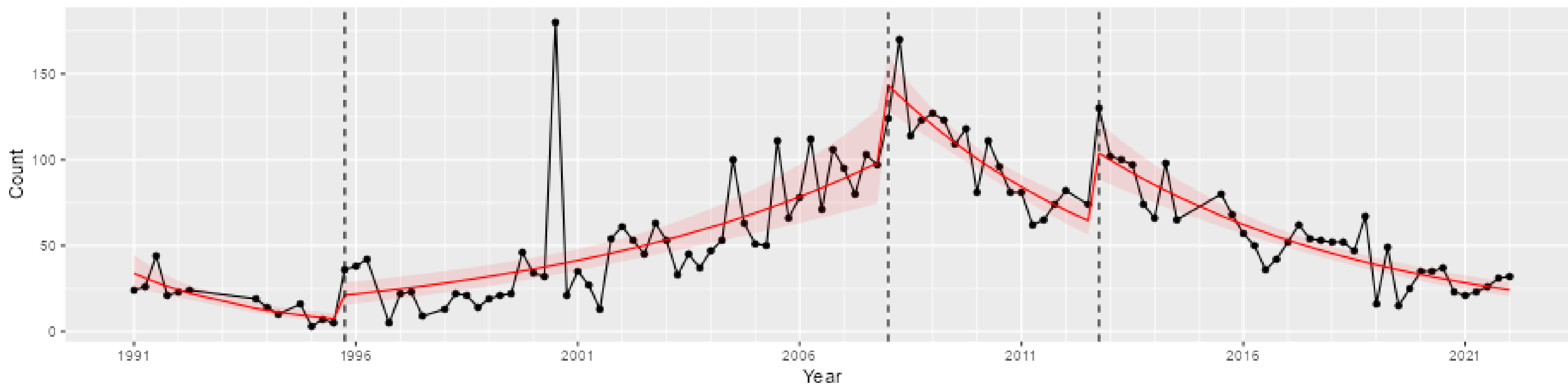

Figure 5. Changepoint model depicting the Micronesian Myzomela (*Myzomela rubratra saffordi*) population trend from Saipan BBS data (1991 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

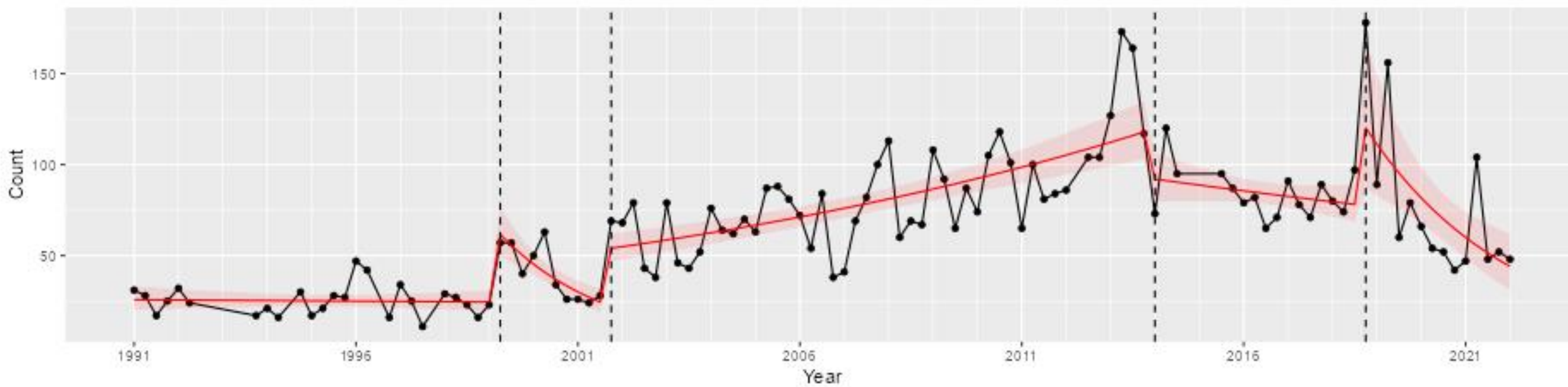

Figure 6. Changepoint model depicting the Micronesian Starling (*Aplonis opaca*) population trend from Saipan BBS data (1991 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

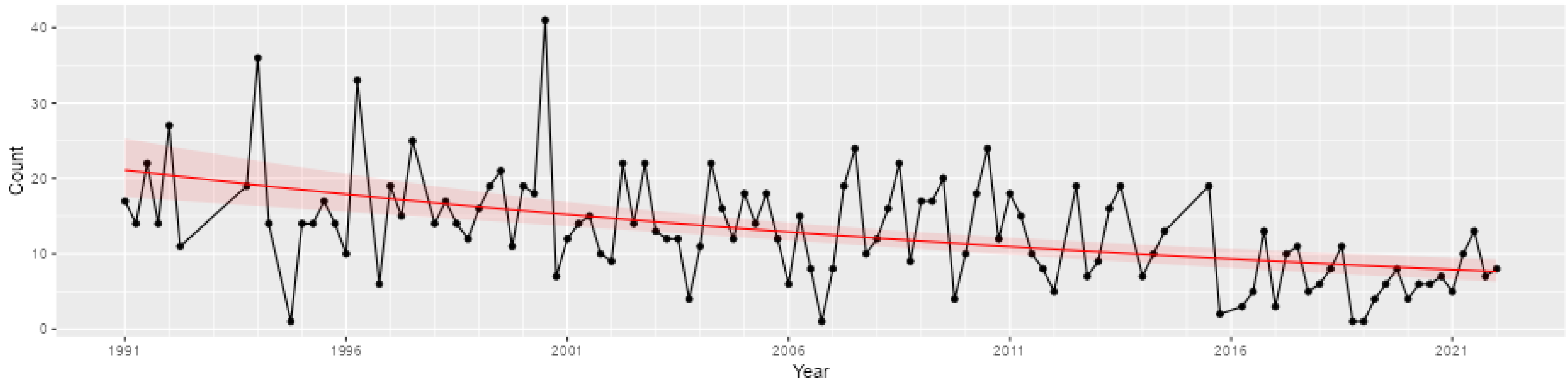

Figure 7. Changepoint model depicting the Nightingale Reed-warbler (*Acrocephalus hiwae*) population trend from Saipan BBS data (1991 – 2022). No significant changes in the direction of the population trend have occurred.

Figure 8. Changepoint model depicting the Rufous Fantail (*Rhipidura rufifrons*) population trend from Saipan BBS data (1991 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

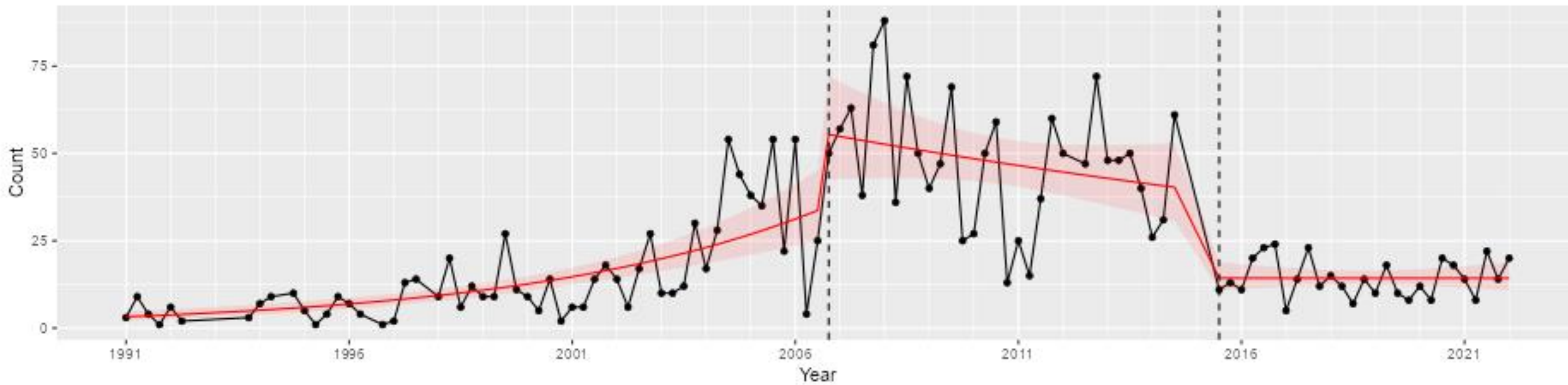

Figure 9. Changepoint model depicting the White-throated Ground Dove (*Gallicolumba xanthonura*) population trend from Saipan BBS data (1991 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

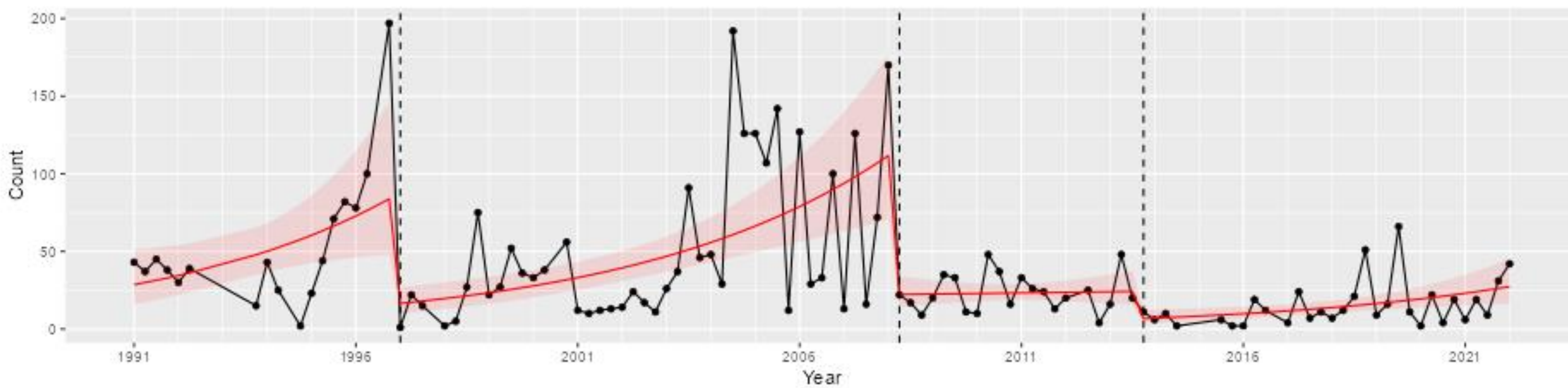

Figure 10. Changepoint model depicting the Eurasian Tree Sparrow (*Passer montanus*) population trend from Saipan BBS data (1991 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

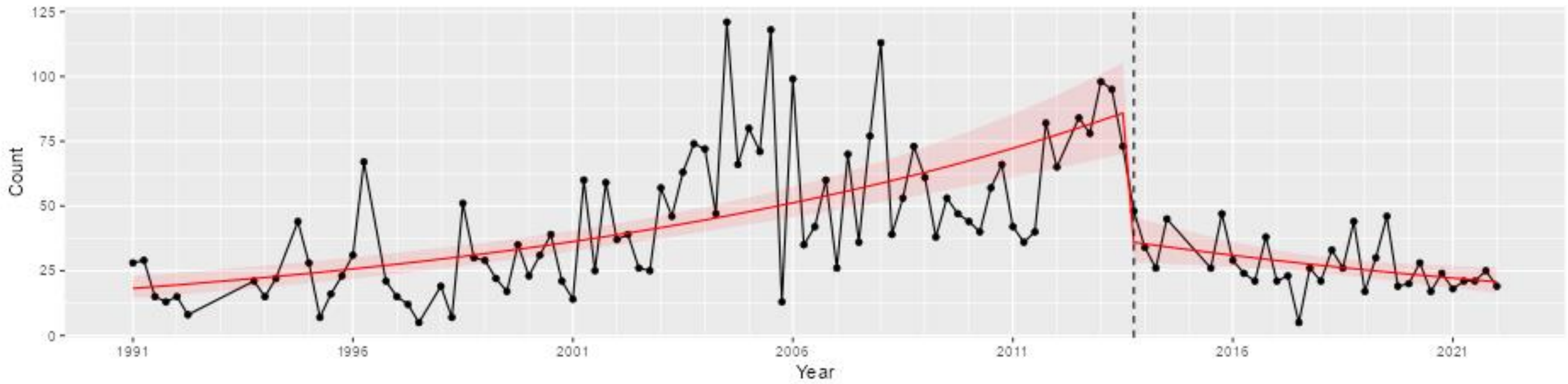

Figure 11. Changepoint model depicting the Philippine Collared-Dove (*Streptopelia bitorquata*) population trend from Saipan BBS data (1991 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

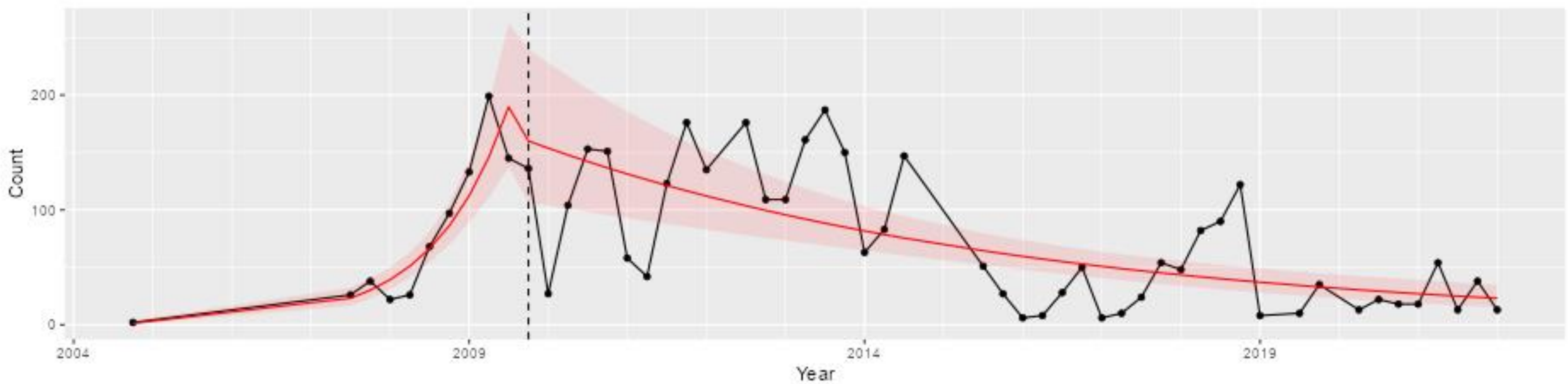

Figure 12. Changepoint model depicting the Orange-cheeked Waxbill (*Estrilda melpoda*) population trend from Saipan BBS data (2004 – 2022). No significant changes in the direction of the population trend have occurred.

APPENDIX B: Forest Bird Population Trends on Tinian Based Upon BBS Data

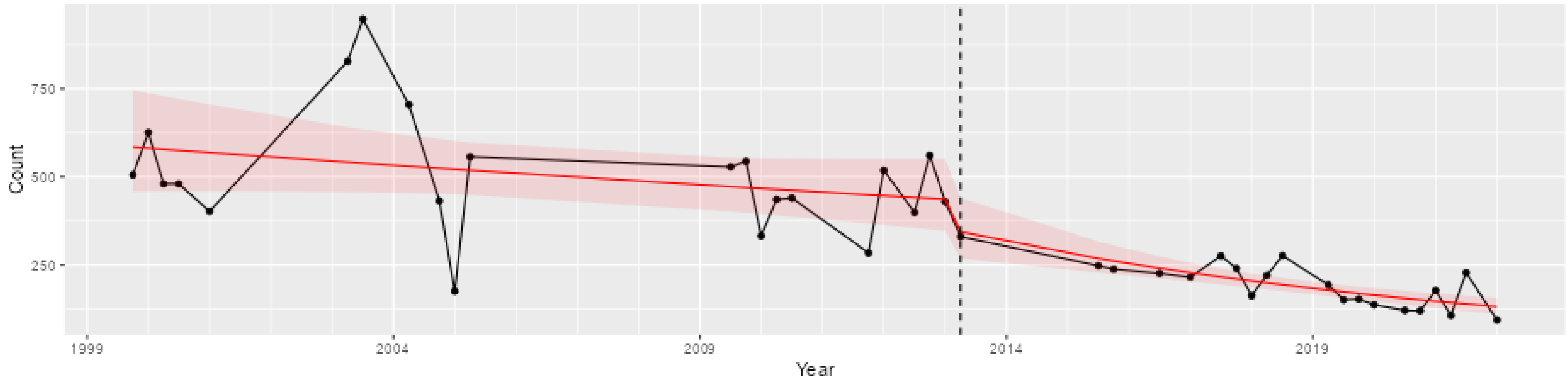

Figure 1. Changepoint model depicting the Bridled White-eye (*Zosterops conspicillatus saypani*) population trend from Tinian BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

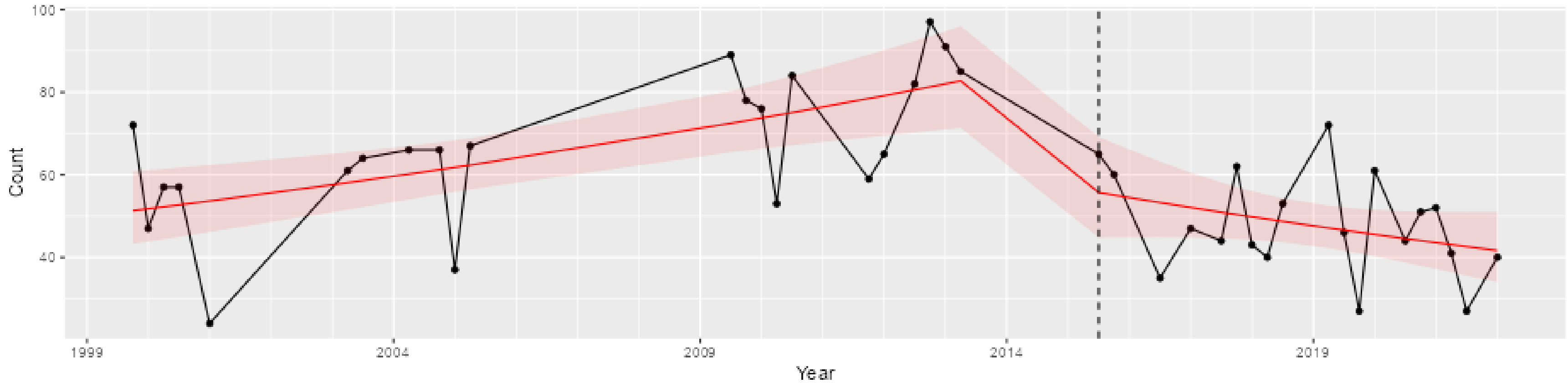

Figure 2. Changepoint model depicting the Mariana Kingfisher (*Todiramphus albicilla*) population trend from Tinian BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

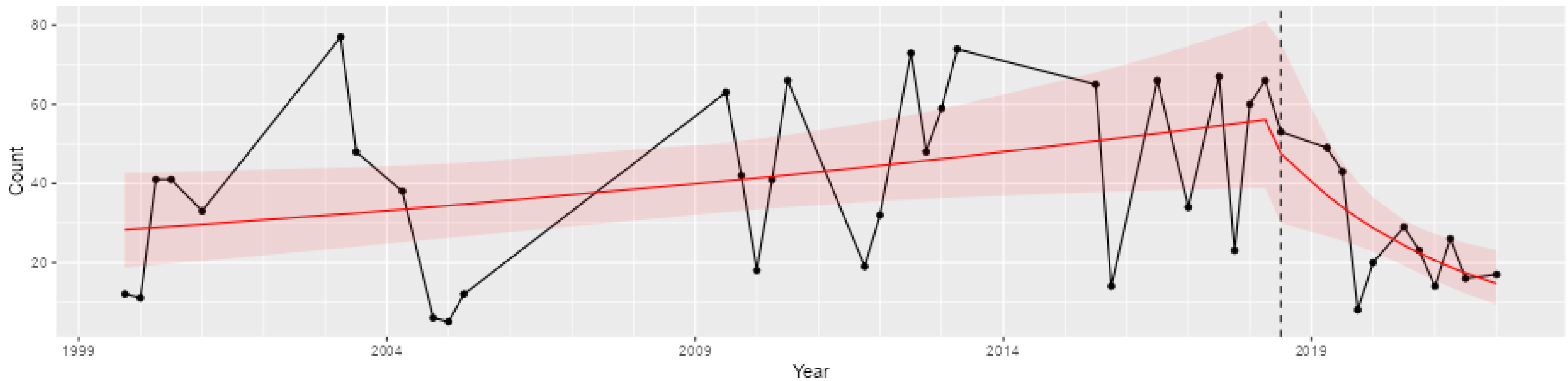

Figure 3. Changepoint model depicting the Mariana Fruit Dove (*Ptilinopus roseicapilla*) population trend from Tinian BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

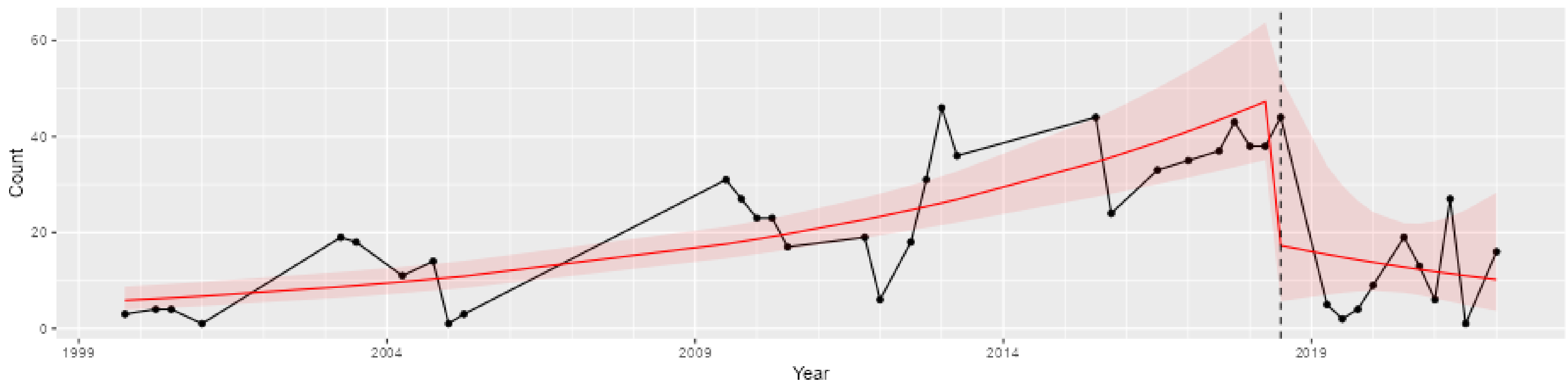

Figure 4. Changepoint model depicting the Micronesian Myzomela (*Myzomela rubratra saffordi*) population trend from Tinian BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

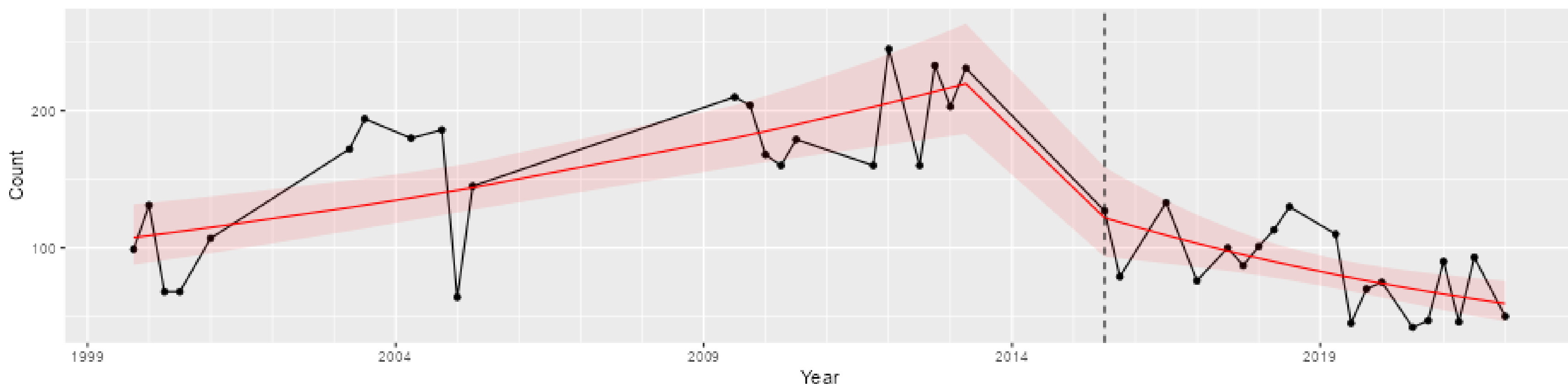

Figure 5. Changepoint model depicting the Micronesian Starling (*Aplonis opaca*) population trend from Tinian BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

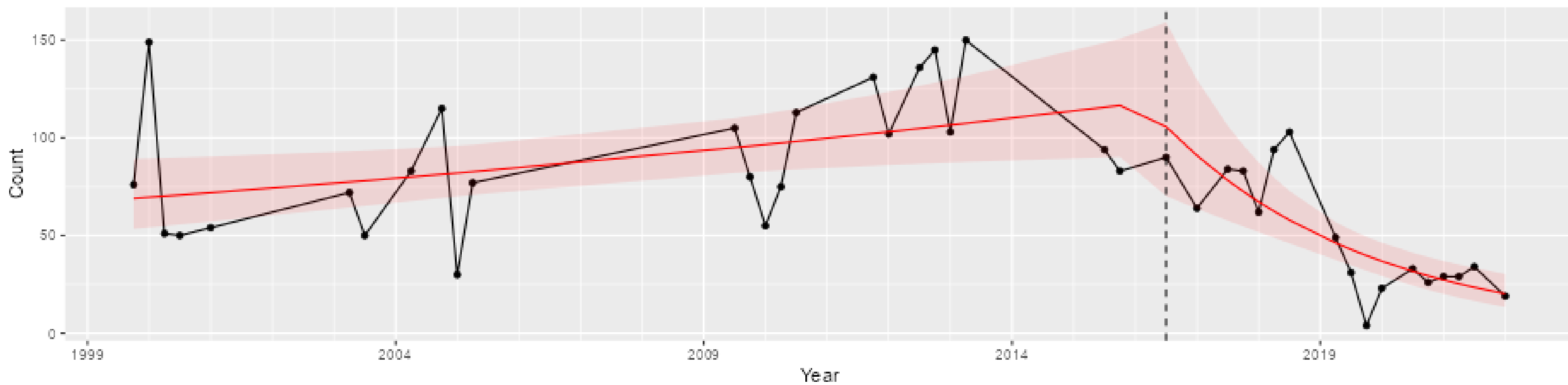

Figure 6. Changepoint model depicting the Rufous Fantail (*Rhipidura rufifrons*) population trend from Tinian BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

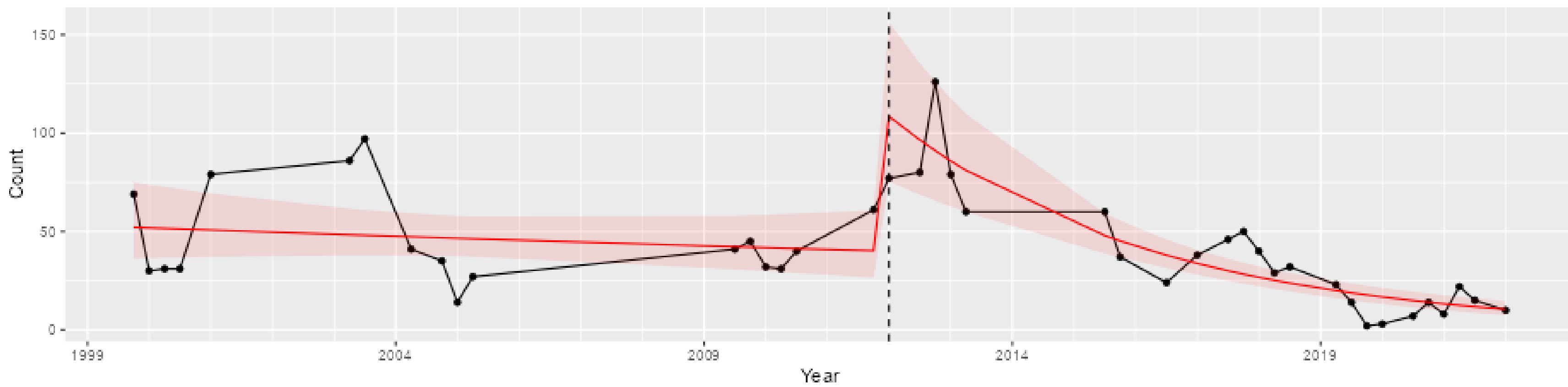

Figure 7. Changepoint model depicting the Tinian Monarch (*Monarcha takatsukasae*) population trend from Tinian BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

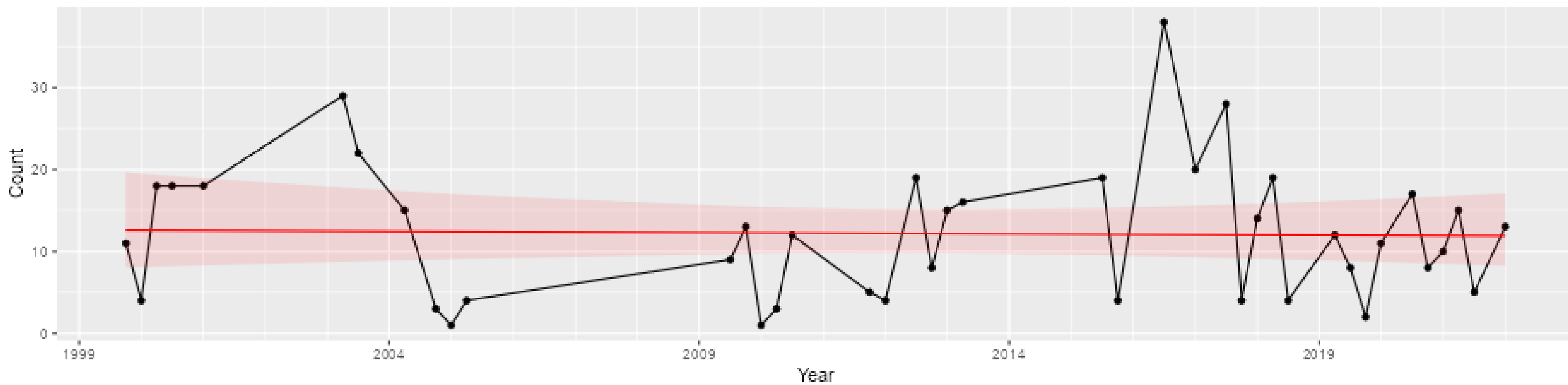

Figure 8. Changepoint model depicting the White-throated Ground Dove (*Gallicolumba xanthonura*) population trend from Tinian BBS data (1999 – 2022). No significant changes in the direction of the population trend have occurred.

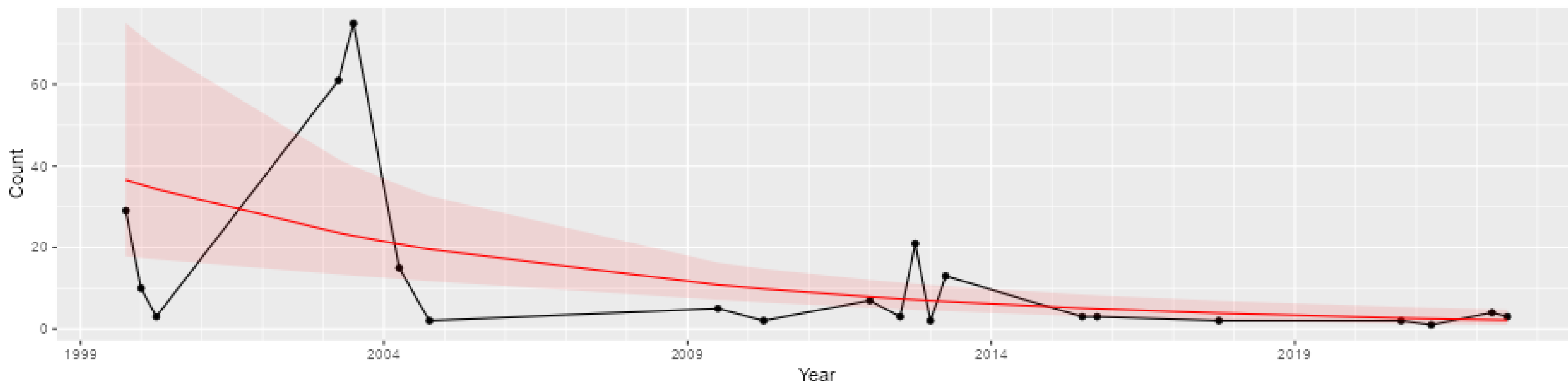

Figure 9. Changepoint model depicting the Eurasian Tree Sparrow (*Passer montanus*) population trend from Tinian BBS data (1999 – 2022). No significant changes in the direction of the population trend have occurred.

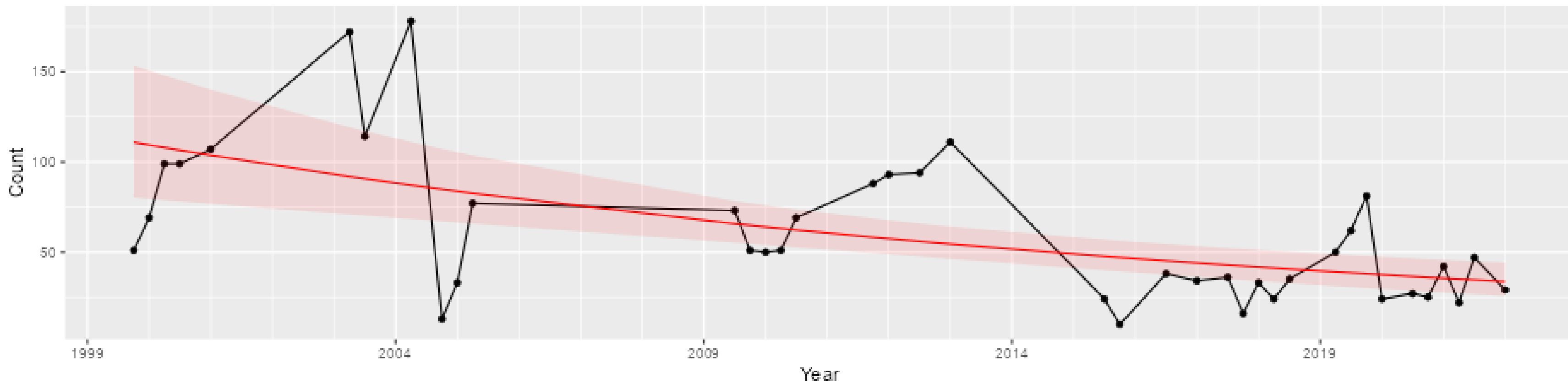

Figure 10. Changepoint model depicting the Philippine Collared-Dove (*Streptopelia bitorquata*) population trend from Tinian BBS data (1999 – 2022). No significant changes in the direction of the population trend have occurred.

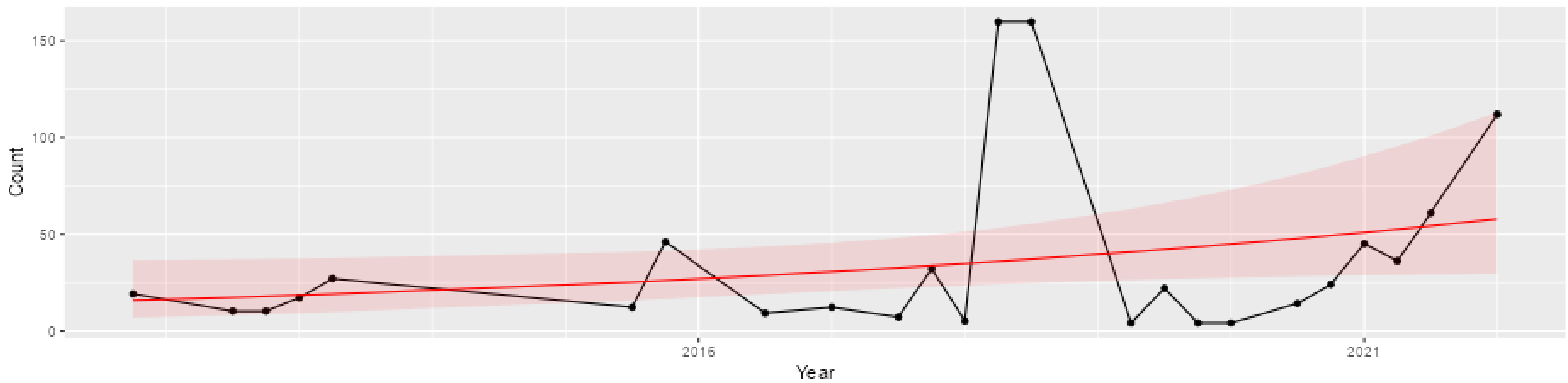

Figure 11. Changepoint model depicting the Orange-cheeked Waxbill (*Estrilda melpoda*) population trend from Tinian BBS data (1999 – 2022). No significant changes in the direction of the population trend have occurred.

APPENDIX C: Forest Bird Population Trends on Rota Based Upon BBS Data

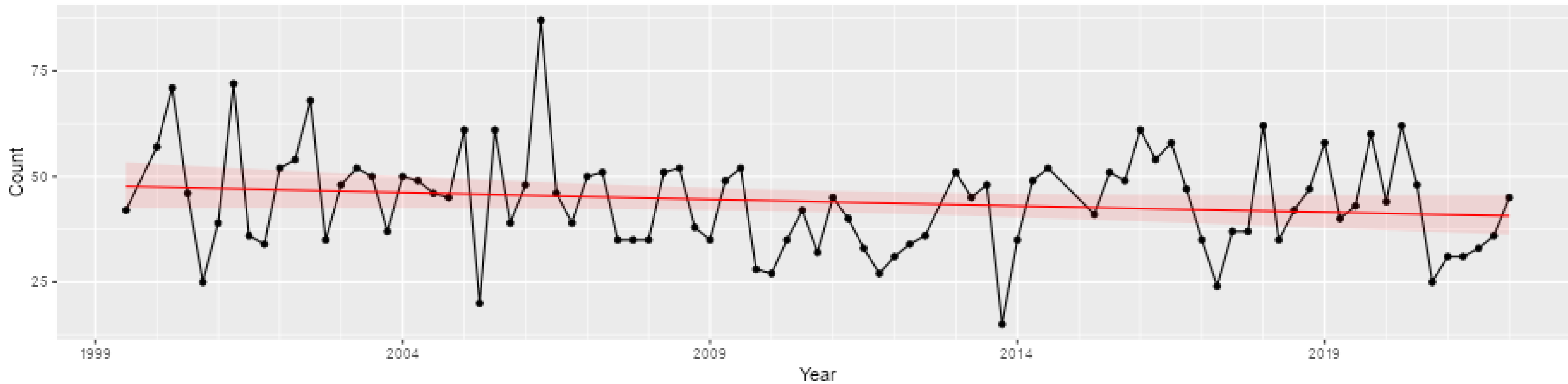

Figure 1. Changepoint model depicting the Mariana Kingfisher (*Todiramphus albicilla orii*) population trend from Rota BBS data (1999 – 2022). No significant changes in the direction of the population trend have occurred.

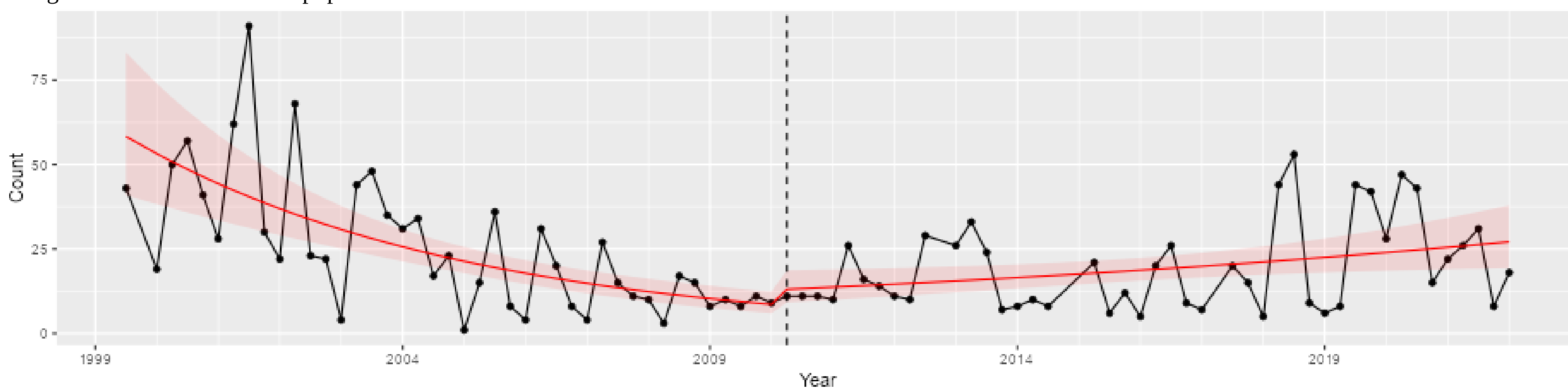

Figure 2. Changepoint model depicting the Mariana Fruit Dove (*Ptilinopus roseicapilla*) population trend from Rota BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

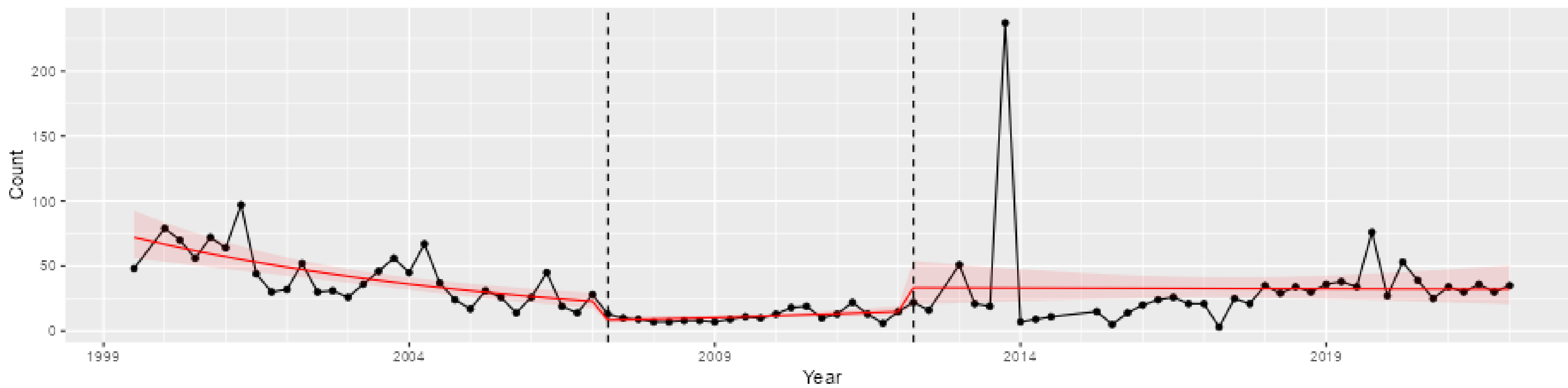

Figure 3. Changepoint model depicting the Micronesian Myzomela (*Myzomela rubratra saffordi*) population trend from Rota BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

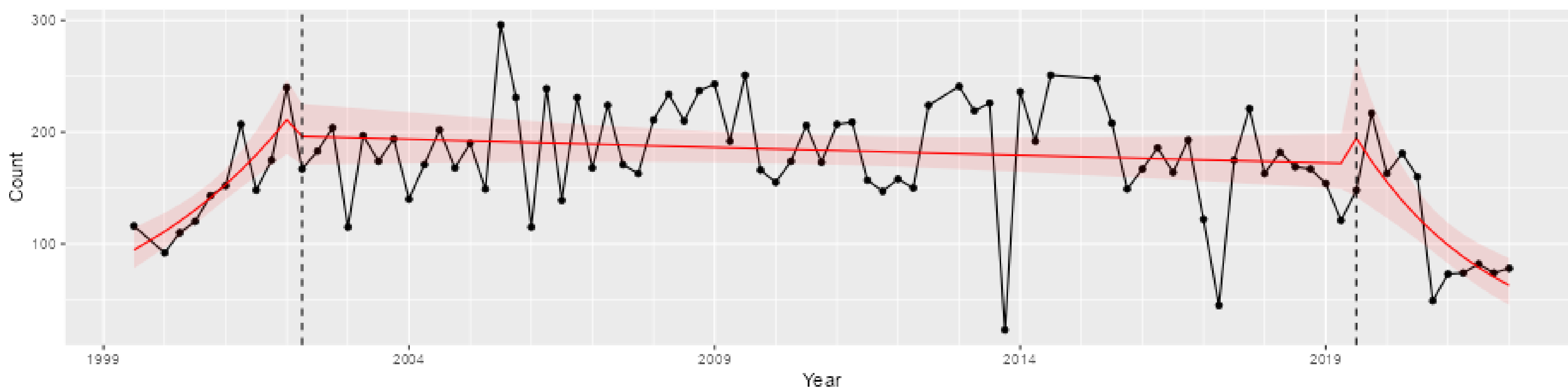

Figure 4. Changepoint model depicting the Micronesian Starling (*Aplonis opaca*) population trend from Rota BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

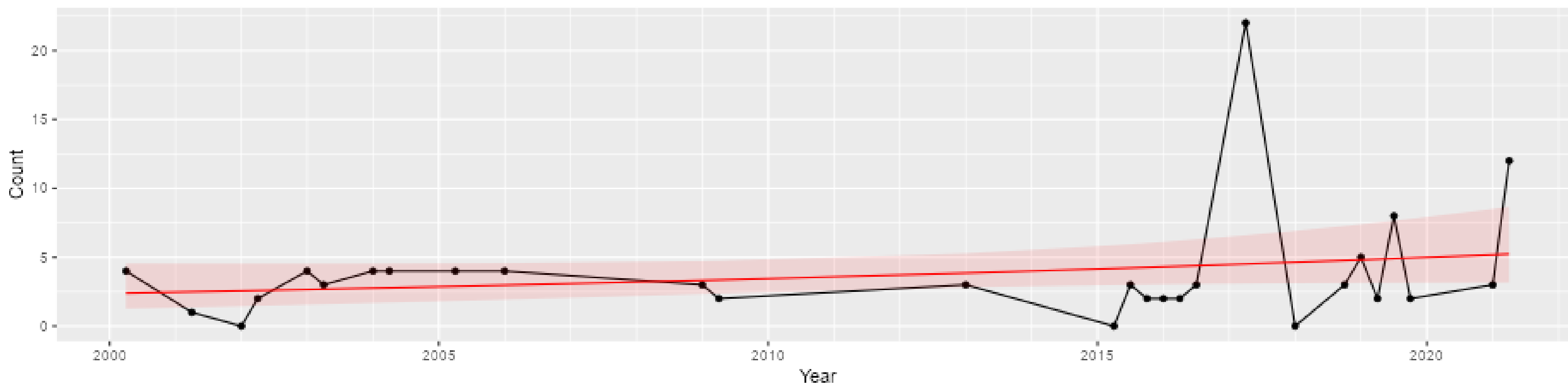

Figure 5. Changepoint model depicting the Rota White-eye (*Zosterops rotensis*) population trend from Rota BBS data (1999 – 2022). No significant changes in the direction of the population trend have occurred.

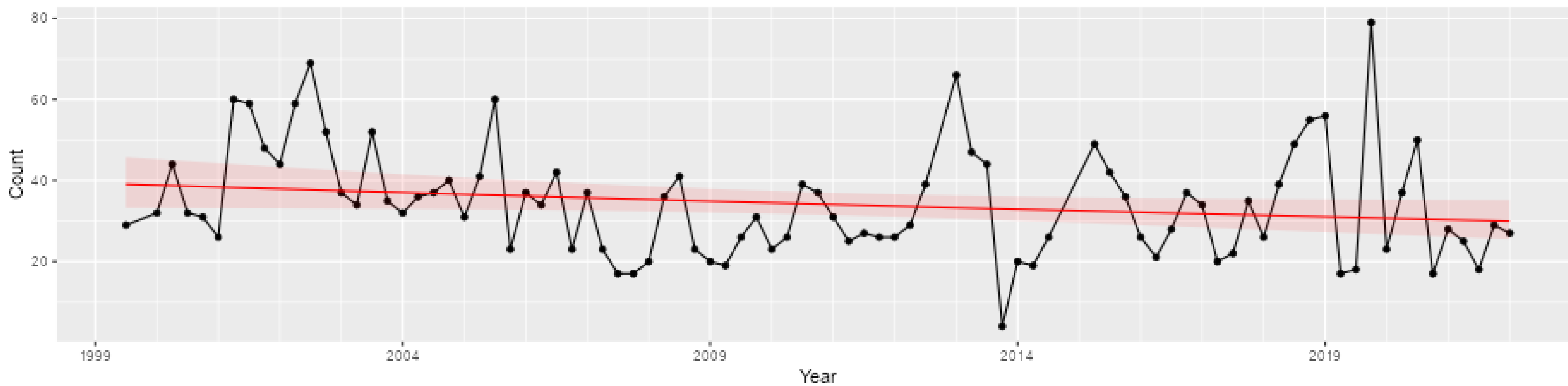

Figure 6. Changepoint model depicting the Rufous Fantail (*Rhipidura rufifrons*) population trend from Rota BBS data (1999 – 2022). No significant changes in the direction of the population trend have occurred.

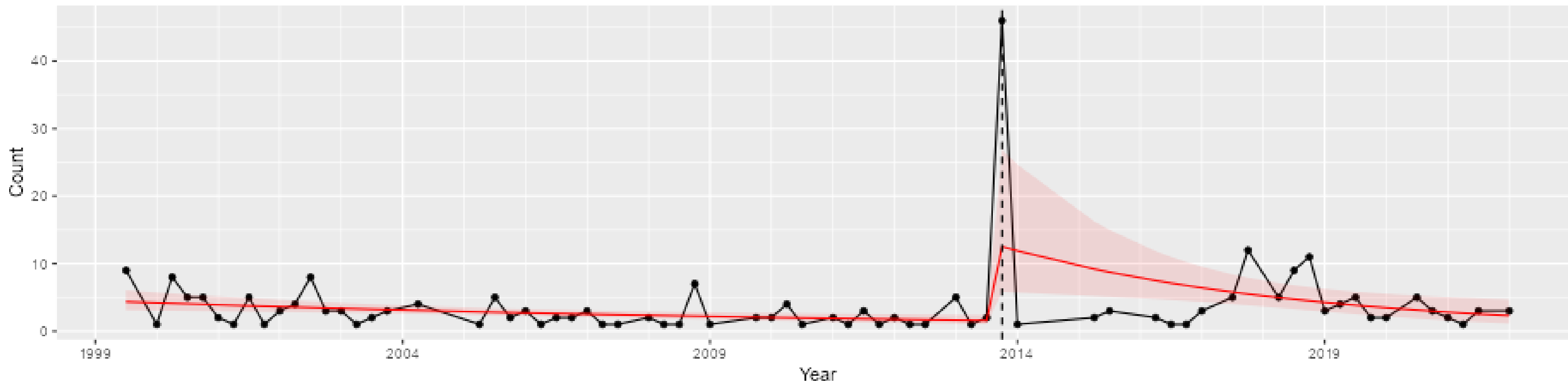

Figure 7. Changepoint model depicting the White-throated Ground Dove (*Gallicolumba xanthonura*) population trend, Rota BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

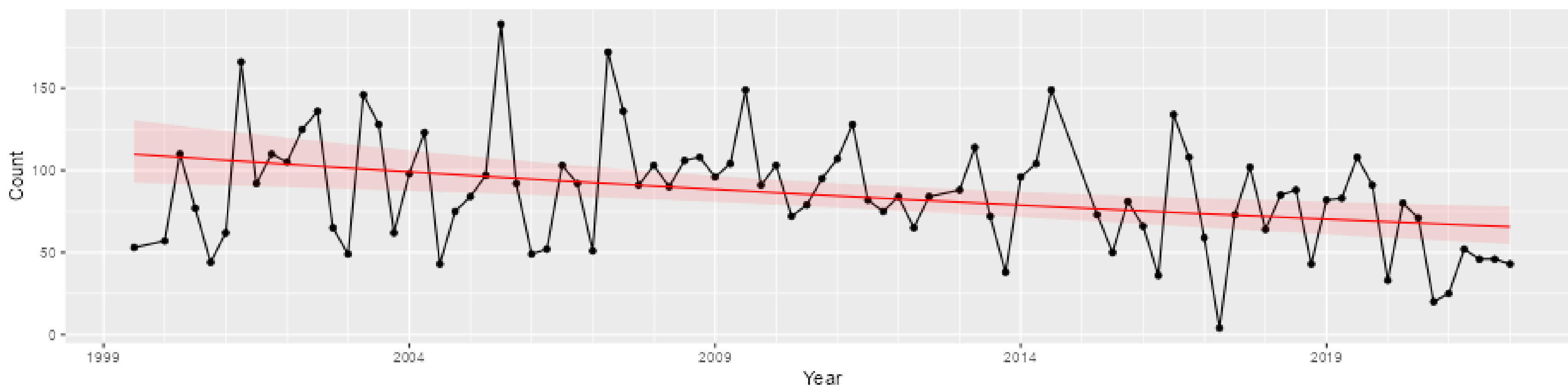

Figure 8. Changepoint model depicting the Black Drongo (*Dicrurus macrocercus*) population trend from Rota BBS data (1999 – 2022). No significant changes in the direction of the population trend have occurred.

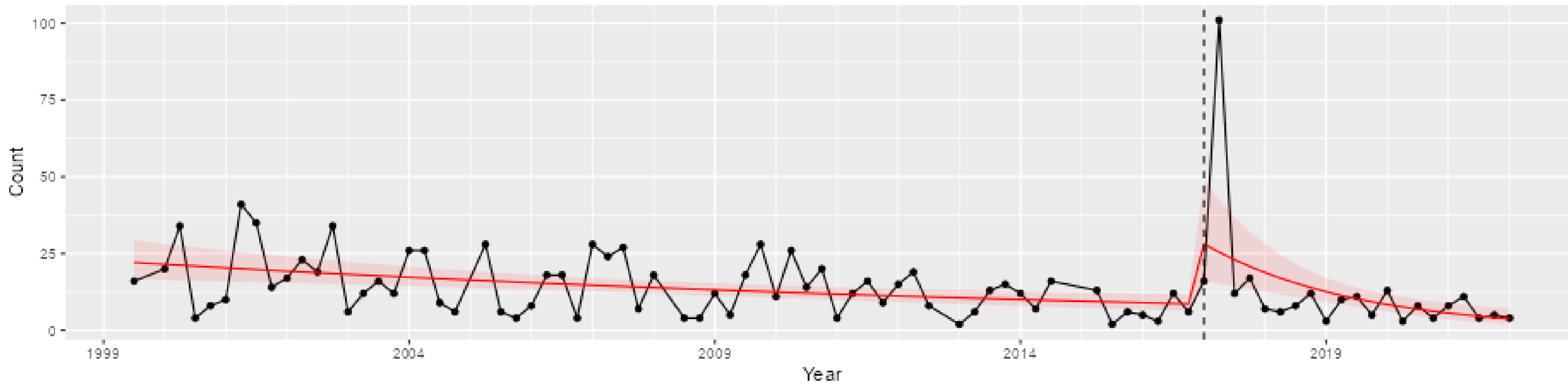

Figure 9. Changepoint model depicting the Eurasian Tree Sparrow (*Passer montanus*) population trend from Rota BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

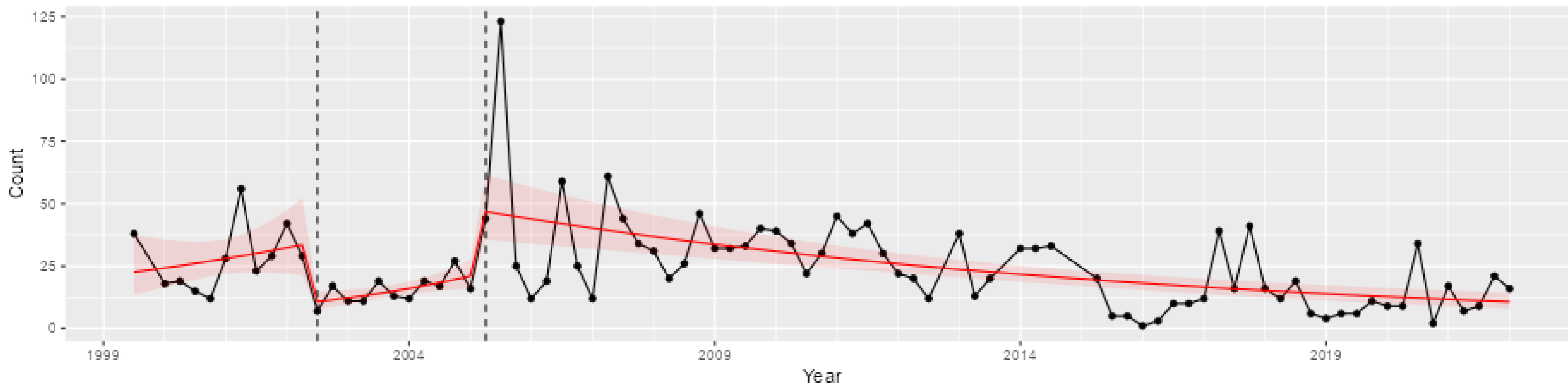

Figure 10. Changepoint model depicting the Philippine Collared-Dove (*Streptopelia bitorquata*) population trend from Rota BBS data (1999 – 2022). The dotted lines represent where significant changes in the direction of the population trend occur.

Appendix D: I Chenchon Colony Survey Point Locations

Table 1. I Chenchon colony seabird survey station descriptions and locations.

Station	UTM		Year Established	Left Bearing	Left Bearing Description	Right Bearing	Right Bearing Description
	Easting	*Northing*					
1	312938	1565335	1983	177°	Cut in rocks; looks like gun sight "V"		Left side of cliff at far right
2	312978	1565350	1983	143°	From just east of large rock to the north up to crack in cliff	190°	Cut in rocks that looks like gun sight (V) station 1 left bearing
3	313081	1565385	1983	126°	Tidal pool shelf at left side	183°	Left side of large rock to crack in cliff (station 2's left bearing)
4	313325	1565420	1983	93°	East side of large rock	194°	Left side of tidal pool shelf (station 3's left bearing
5	313568	1565603	1983	87°	West side of forested cliff line (station 6 right bearing)	203°	East side of big rock up north into crack, near gray rock face
6	313776	1565906	1983	133°	Rock in ocean	197°	East side of forested cliff line
6A	313864	1565954	1987	135°	Rocks in ocean-right boundary for station 7	162°	Rock in ocean, left boundary for station 6-up to white face on cliff
7	313897	1565979	1983	129°	Rock along coast up to white cliff face which is mostly forested	145°	Rocks in ocean left boundary for station 6A
7A	314134	1566134	1993	143°	Tidal pool shelf jetty jutting from coast	188°	Rock along coast up to small white face sticking out of cliff line mostly forested other side is boundary for station 7
8	314294	1566172	2000	80°	Large white cliff face against cliff to crack at coast	173°	Tidal pool shelf jetty jutting from coast station 7A left boundary
9	314699	1567040	2021		Large rock monolith with some vegetation, rock top slants inland		