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Population Surveys of the Yellow-shouldered Parrot (*Amazona barbadensis rothschildi*) on Bonaire in March and October 2010–2012.

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Introduction

We conducted before-and-after reproduction surveys of the Yellow-shouldered Parrot population on Bonaire. Our main objective was to estimate density (parrots/ha), population size (parrots in survey region A = 17.000), and rate of change over time (births – deaths in a parrot population that is closed to immigration and emigration). We used a random-systematic sampling scheme to survey the parrot population in March 2010 and 2012 (before-reproduction surveys) and October 2010, 2011, and 2012 (after-reproduction surveys).

Study Area and Methods

We defined a survey region (A) covering 17,000 ha of habitats occupied or potentially occupied by parrots on Bonaire (Figure 1). We used a combination of count methods for

parameter estimation. In this report, we focus on multiple-covariate distance sampling. For additional information about survey design and count methods, see previous reports posted at the STINAPA website (http://www.stinapa.org/downloads.html).

Results and Discussion

We made 303 parrot detections in 182 points surveyed before-and-after reproduction. The half-normal key function with no adjustment term with detection time and cluster size covariates was the detection model of best fit to the parrot distance data (Table 1). There was a tendency to detect distant parrots during the second part of the 6-min count, but large clusters were more detectable than small clusters far from point centers (Figure 2). Other covariates, such as point location, sampling period, detection form, and vegetation cover were not important sources of detection function heterogeneity. Parrot detection probability was 25% within a truncation distance w = 240 m, resulting in an effective detection radius of 120 m (Table 2).

The point estimates of density and abundance increased from 0.165 to 0.192 parrots/ha and from 2,810 to 3,322 parrots in the survey region between March and October 2010; that is, the point estimate of rate of change was 0.167, representing an average increase of 18% in the population (Table 3). In comparison, the point estimates of density and abundance increased from 0.161 to 0.182 parrots/ha and from 2,731 to 3,085 parrots in the survey region between March and October 2012; that is, the point estimate of rate of change was 0.122, representing an average increase of 13% in the population (Table 4). Although not statistically significant, judging from the wide overlap of 95% confidence intervals, on average parrot reproduction seemed to be slightly lower in 2012 than in 2010 and 2011 (Tables 5). Overall, density was

0.180 parrots/ha (95% CI = 0.142, 0.226) and abundance was 3,054 parrots (95% CI = 2,413, 3,847) in the survey region (Table 6).

See our May 2012 report (http://www.stinapa.org/downloads.html), for additional information about rate of change between October 2011 and March 2012 (deaths only), and population conservation objectives based on before-reproduction survey data collected in March 2010. This report was prepared to share information with resource managers and the interested public in a timely manner; data analyses are ongoing, and results and products (e.g., density gradient maps based on hierarchical distance sampling) will be presented in future reports and publications.

Recommendations

1) The parrot population seems to be fluctuating around a stable equilibrium at this time. Therefore, unless a catastrophic natural event or management intervention occurs, we recommend conducting before-and-after reproduction surveys every other year to monitor population trend.

2) Based on a desired CV $D < 15\%$ and sample size $n = 60–80$ per sampling period, we recommend surveying 150 points (k) before-and-after reproduction ($v = 2$ per point; i.e., survey effort $K = k \times v = 300$).

3) Continue with data analyses, prepare reports and presentations as needed, and submit manuscripts for publication in high-quality, peer-reviewed journals in 2013.

4) Integrate research, monitoring, and modeling for the management of parrots and their habitats on Bonaire. For additional recommendations, see previous reports at the STINAPA website (http://www.stinapa.org/downloads.html).

Figure 1. Survey region (A = 17,000) and sample points (k = 182) based on a random-systematic survey sampling scheme for Bonaire in March and October 2010–2012.

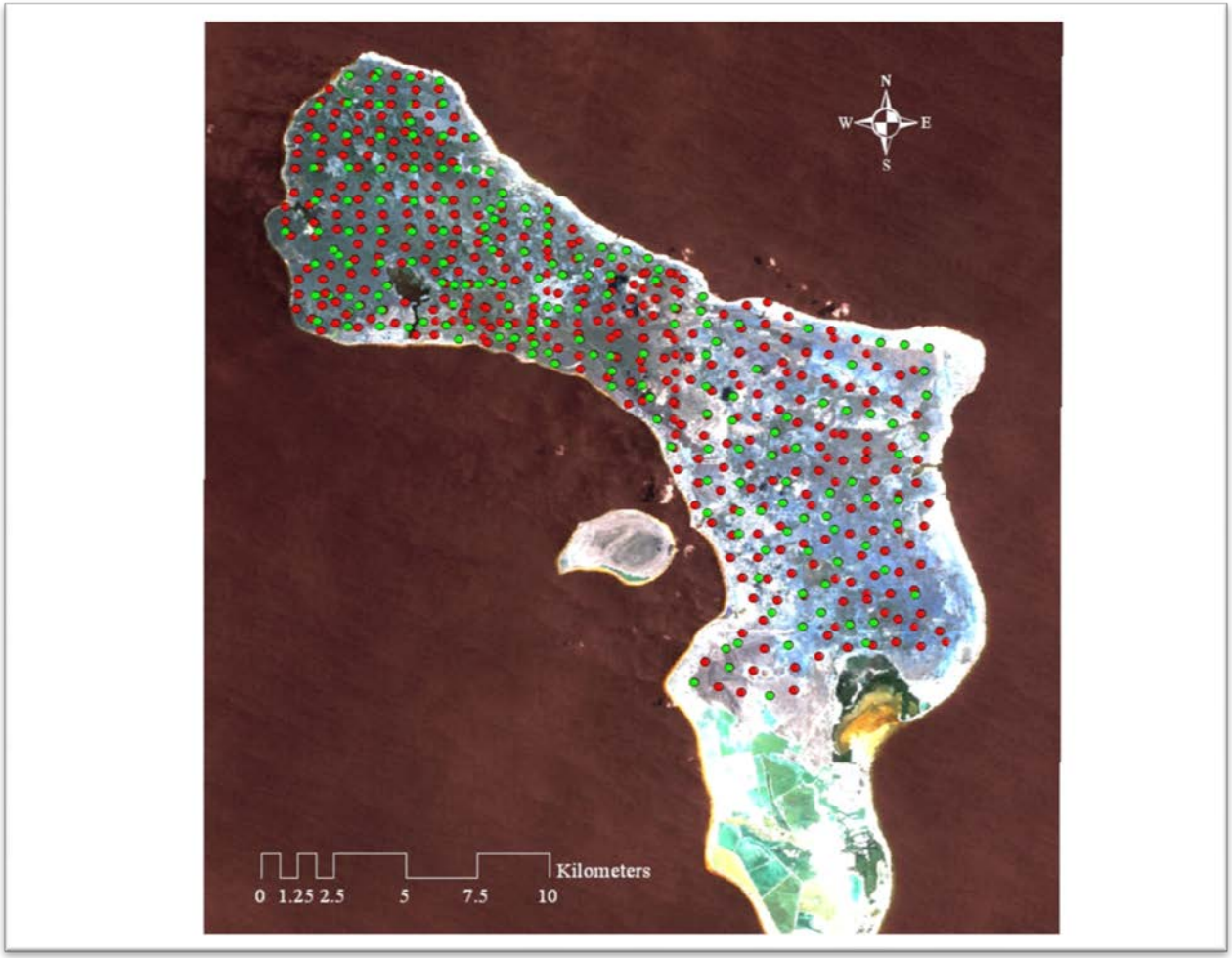

Figure 2. YSPA detection function based on survey data collected on Bonaire in March and October 2010–2010 (n = 303, k = 182)

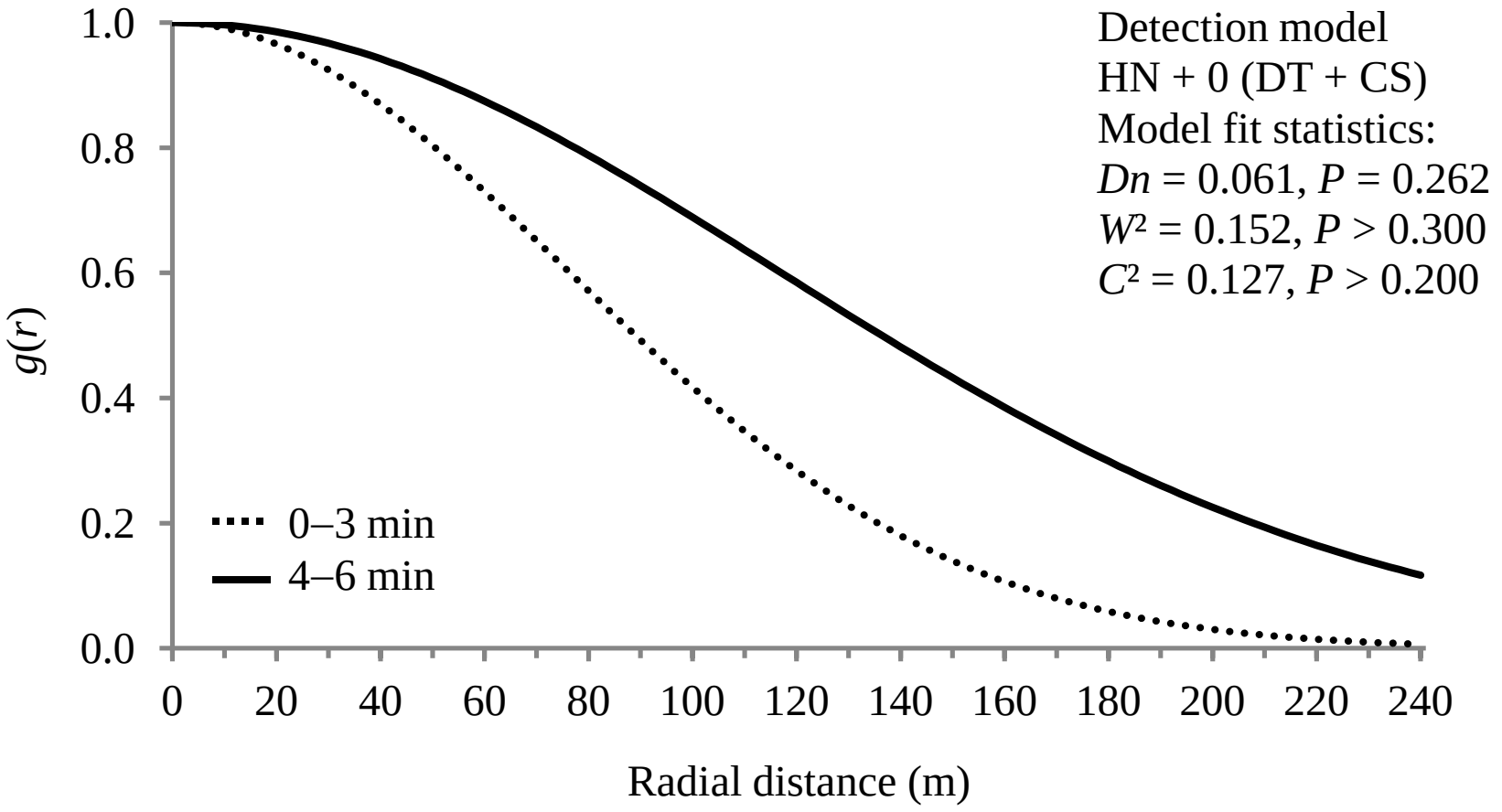

Table 1. Multiple-covariate distance sampling detection models based on YSPA survey data collected on Bonaire in March and October 2010–2010 (n = 303, k = 182).

Detection model	Parameters	AIC	ΔAIC
HN + 0 (DT + CS)	3	0	2,896.30
HN +0 (DT)	2	7.43	2,903.72
HN + 0 (CS)	2	18.04	2,914.34
UN + 2 COS	2	20.41	2,916.71
HN + 0 (DF)	2	22.31	2,918.60
HN + 0	1	22.41	2,918.71
HNO + 0 (VC)	2	22.43	2,918.73
HN + 0 (PL)	2	23.05	2,919.34
HN + 0 (SP)	5	23.52	2,919.81

Table 2. Detection probability and effective detection radius based on YSPA survey data collected on Bonaire in March and October 2010–2010 (n = 303, k = 182).

Parameter estimate	Mean	2.5%	97.5%
$\hat{P}_a$	0.248	0.175	0.240
$\hat{p} = w \times \sqrt{\hat{P}_a}$	120	113	126

Table 3. Estimate of density, abundance, and rate of change before-and-after YSPA reproduction on Bonaire in 2010.

Density	Mean	2.5%	97.5%
Mar 2010	0.165	0.131	0.209
Oct 2010	0.192	0.152	0.243
$\Delta\hat{D}$	0.027	0.021	0.034
Abundance	Mean	2.5%	97.5%
Mar 2010	2,810	2,229	3,544
Oct 2010	3,322	2,572	4,291
$\Delta\hat{N}$	512	343	747
$\hat{r}_t = \ln(\hat{N}_{t+1} / \hat{N}_t)$	0.167	0.143	0.191
$(\exp(\hat{r}_t) - 1) \times 100$	18.22%	15.39%	21.08%

Table 4. Estimates of density, abundance, and rate of change before-and-after YSPA reproduction on Bonaire in 2012.

Density	Mean	2.5%	97.5%
Mar 2012	0.161	0.127	0.203
Oct 2012	0.182	0.138	0.235
$\Delta\hat{D}$	0.021	0.011	0.022
Population size	Mean	2.5%	97.5%
Mar 2012	2,731	2,163	3,448
Oct 2012	3,085	2,342	3,995
$\Delta\hat{N}$	354	179	547
$\hat{r}_t = \ln(\hat{N}_{t+1} / \hat{N}_t)$	0.122	0.080	0.147
$(\exp(\hat{r}_t) - 1) \times 100$	12.98%	8.33%	15.86%

Table 5. Estimates of density and abundance after YSPA reproduction on Bonaire in October 2010–2011.

Density	Mean	2.5%	97.5%
Oct 2010	0.192	0.152	0.243
Oct 2011	0.193	0.152	0.245
Oct 2012	0.182	0.138	0.225
Abundance	Mean	2.5%	97.5%
Oct 2010	3,322	2,572	4,291
Oct 2011	3,276	2,578	4,162
Oct 2012	3,085	2,342	3,827

Table 6. Overall estimates of density and abundance based on YSPA survey data collected on Bonaire in March and October 2010–2012 (n = 303, k = 182).

Parameter estimate	Mean	2.5%	97.5%
$\hat{D}$	0.180	0.142	0.226
$\hat{N}$	3,054	2,413	3,847