Annual Population Estimates of a Tropical Bird Species: Lessons in Confounding Variables

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Introduction

Palila are the only finch-billed honeycreeper remaining on the main Hawaiian islands, and they currently occupy less than 5% of their historical distribution on Hawai'i Island (Scott et al. 1986). The immature seeds, flowers and flush of the mamane tree(*Sophora chrysophylla*), and *Cydia* caterpillars associated with the flowers and pods of this tree, provide the majority of the palila's diet (van Riper et al. 1978, van Riper 1980a, Scott et al. 1984). They also prefer mamane trees for nesting habitat (Pletschet and Kelly 1990). While nest success varies little between years, nesting effort and start and end of the season are highly variable. This is most likely related to availability of pods and flowers of mamane trees in a given year (Pratt et al. 1997).

Palila habitat was severely degraded by feral ungulates over a period of 150 years, and as a result, 95% of the population has been concentrated in 137 km^2 of sub-alpine, dry forest on the SW slope of Mauna Kea since the early 1980's (Scott et al. 1984, Jacobi et al. 1996, Hess et al. 1998, Gray et al. 1999). Since judicially mandated eradication of feral ungulates began in 1981 (Scowcroft and Giffin 1983), the mamane forest has begun to recover. Biologists at Kilauea Field Station have been conducting annual censuses of palila on Mauna Kea since 1980, and annual studies of breeding biology began in 1988. Thus, we now have a continuous data set on nesting effort and productivity to consider when we assess trends in the population over time.

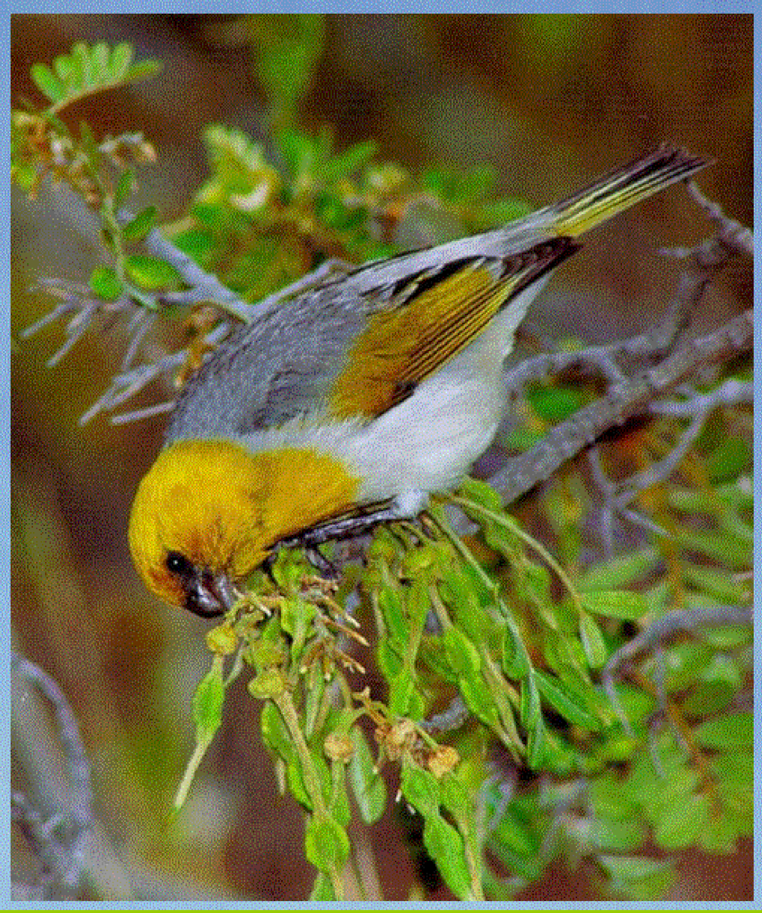

Fig. 1 Male palila feeding on immature mamane pods

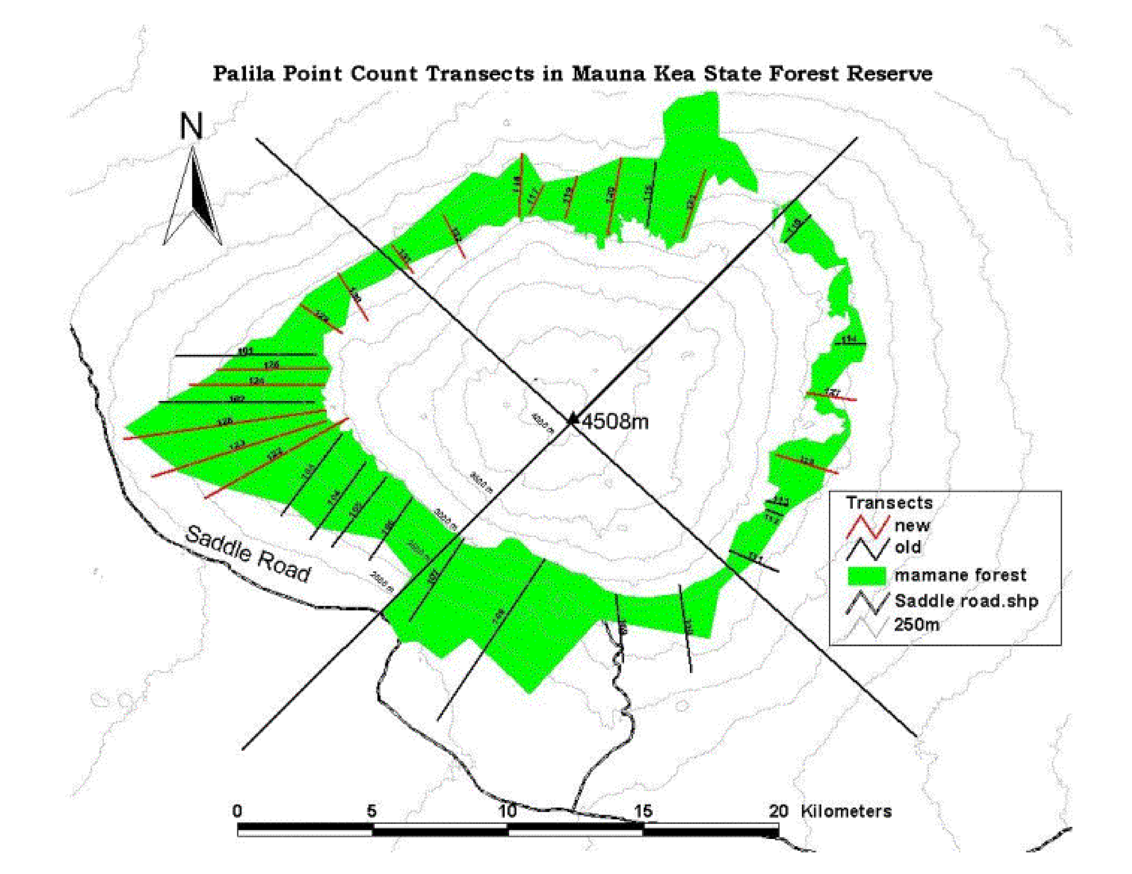

Fig 2. Map of point count transects used to census Palila populations annually since 1980. The 17 Original transects are shown in black, and the new transects are shown in red. 95% of the Palila population exists between transects 101 and 106.

Methods

We used the variable circular-plot method (Reynolds et al. 1980), with 6 minute counts, to census palila at the same stations, along 17 established transects, each year. Between 1997 and 1998 we added 14 new transects to survey in addition to the original transects. Observers were trained and counts were conducted with the same protocols as reported in Scott et al. 1984, Fancy et al. 1996, Banko et al. 1998, and Gray et al. 1999.

For analysis we assigned each station to one of four geographic strata (North, South, East, West) Fig.2. We used the methods outlined by Fancy 1997, a modification of Ramsey et al. 1987, to determine the effective area surveyed at each station and calculate a density estimate using covariates that affect detectability (time of day, clouds, rain, wind). We created two separate files of detections, pooled over years, to use in determining the effective area surveyed. The 1980-1997 data were only from the original 17 transects surveyed each year and were analyzed as "grouped" data in program DISTANCE due to some heaping on the 0 and 5 meter intervals at some distances (Laake et al. 1994). The 1998-2001 data were from the old and new transects and were analyzed as "exact." We truncated the merged files in program DISTANCE, choosing a point where g(0)= .10 or best fit to the data. We generated the graph of population estimates using only data from the original transects. We generated population estimates for 1998-2001 using all transects, separately.

Results

The 1980-1997 merged data set, truncated at 98m, contained 1985 detections. It produced an effective detection radius(EDR) of 64.482 and a coefficient of variation (CV) of 1.47%, and we obtained a best fit to the data with a half-normal key model. Wind(p=0.79), rain(p>.90) and clouds(p>88) did not significantly affect detection area and thus were not included in the model. Transect 102 had the largest number of palila detections.

The 1998-2001(using only the original transects) merged data set, truncated at 72.9 m, contained 624 palila detections. It produced an EDR of 53.493 and CV of 2.22% with a hazard rate key model fitting the data best. Rain (p=.23) did not significantly affect detection area and was not included in the model.

The mean population estimate for 1987-2001was 2477±209 palila with a high of 3815±365 in 1990 and a low of 952±259 in 1992. If the new transects are included from 1998-2001, the EDR is 55.065 and CV is 1.18% with a best fit to the data in a hazard rate key model. The mean estimate is 2780±282 palila with a high of 4917±422 in 1999. Transects 102, 126 and 122 had the largest number of palila detections

The estimates show a large increases in the population from 1989-1990,1992-1993, and 1995-1996. There were periods of apparent decline from 1990-1992, 1993-1995, and 1998-2000.

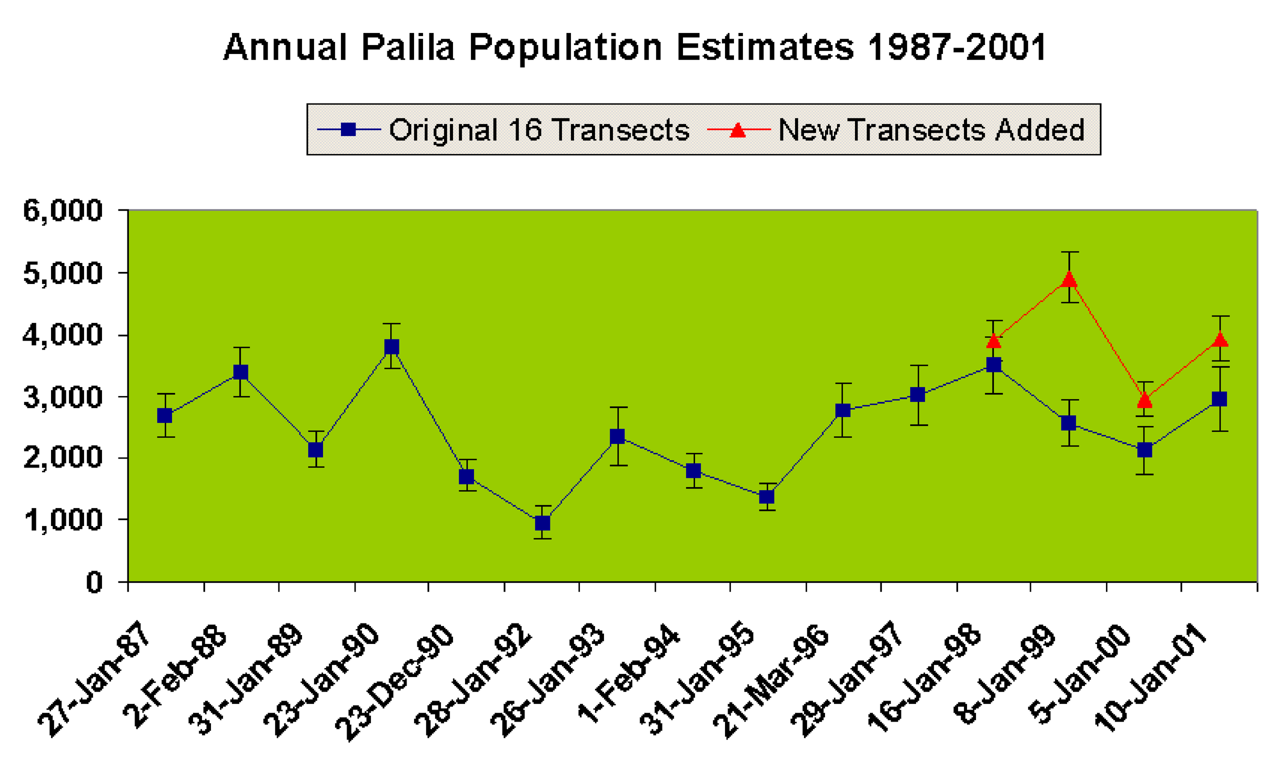

Fig 3.Graph of Population Estimates showing the date censuses began each year. The blue line shows the estimated population based on detections from the original 16 transects. Estimates generated with detections from all transects are shown in red.

Discussion

The EDRs for the 1987-1997 and 1998-2001 data sets were different by 10 m. While the habitat is recovering, it has not progressed to the point that we see a change in the forest structure that would affect our ability to detect palila. We believe the difference is more likely due to the fact that these files had several different observers who differed in their distance estimation and hearing.

The perceived population decline from 1990-1992 coincides with a 1991-2 El Nino drought. While it is conceivable that the drought directly impacted the population, it is not conceivable that the population could more than double by January 1993 when there were only 5 nests found during the 1992 breeding season (fig 4). In a similar event, the population estimate doubled between January 1995 and March of 1996, but there were less than 25 nests found in 1995. We believe that these increases are not increases in the number of Palila, but are more reflective of an increase in the detectability of palila. In both 1993 and 1996 palila began laying eggs in February, and both seasons lasted over 5 months. The January 1993 count occurred only a few weeks before the first eggs were laid, thus it is possible that a high number of palila were quite vocal as they selected nest habitat and constructed nests. The 1996 count was conducted in March, and was not a complete survey of the transects, however, the nesting season lasted 7 months, thus March was still an active month for nest site selection and courtship.

So, where were all of these palila in 1992 and 1994 and 1995? We suspect that they were in the habitat, but that they were difficult to detect because they were dispersed and searching for pods when it was dry and food was scarce. When food resources are plentiful, palila can feed in loose flocks and are possibly easier to detect. Since over 90% of palila detections on VCP counts are audible detections, our surveys may be inadequate for detecting palila when they are dispersed and less social.

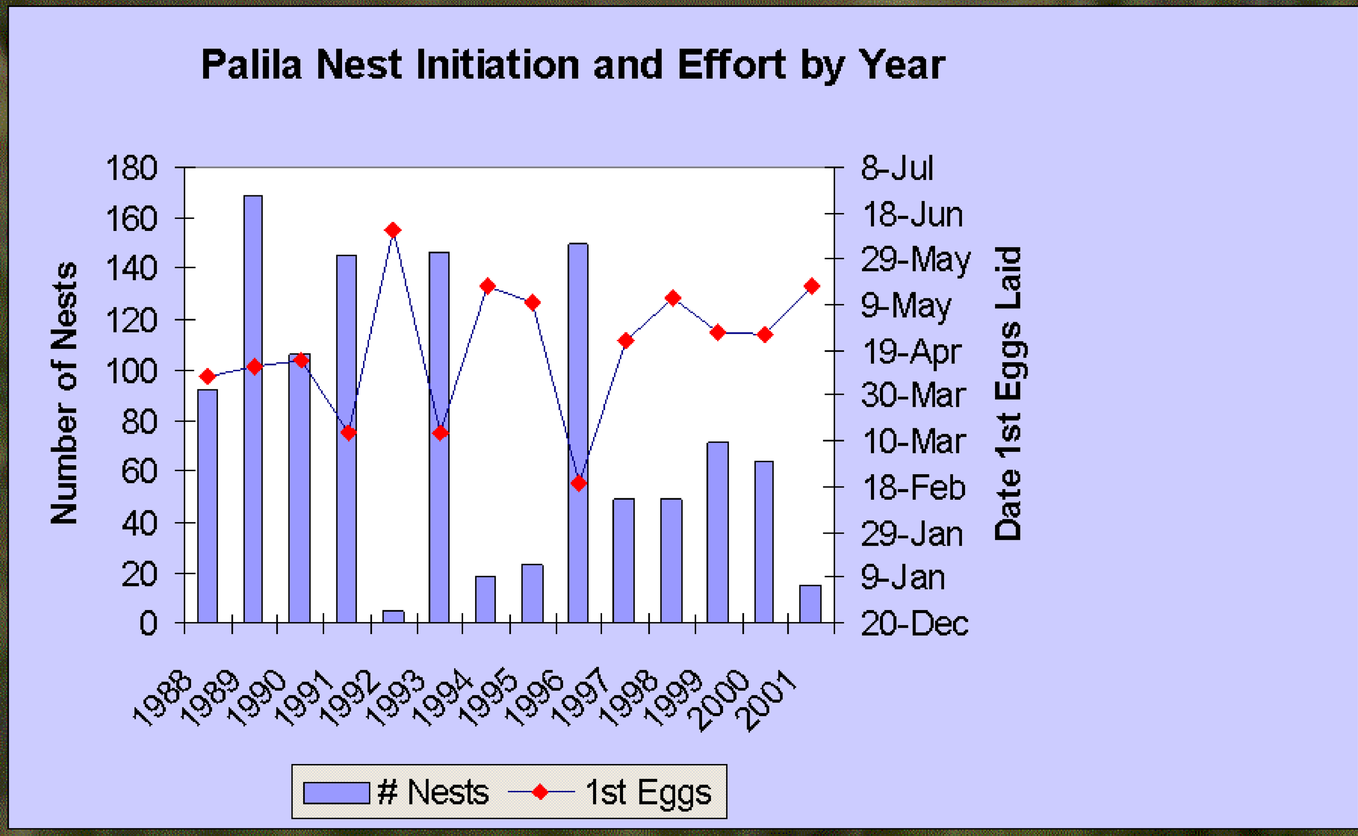

Fig. 4. Graph of the number of palila nests found and the date the 1st eggs were laid each season

Conclusions

Population estimates of palila on Mauna Kea show variability on an annual basis that is sometimes not supported biologically. While we believe that some of the variability is linked to a variable breeding season, there may also be other factors affecting detectability that we have yet to discover. We hope to undertake a study of palila vocalization rates to better understand how detectability of palila changes throughout the year, among age classes and sexes. We encourage researchers conducting point-counts in the tropics to carefully choose the timing of their annual surveys.

Acknowledgements

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