A Simple Population Forecast Model for Purple Martins in British Columbia

Bruce Cousens[1], J. Charlene Lee[1], Laura M. Darling[2], J. Cam Finlay[3] and Thomas W. Gillespie[4]

[1]Georgia Basin Ecological Assessment and Restoration Society, #4 – 1150 N. Terminal Ave., Unit 117, Nanaimo, BC, Canada V9S 5L6
[2]Parks and Protected Areas Branch, BC Ministry of Environment, P.O. Box 9398 STN PROV GOV, Victoria, BC V8W 9M9 Canada
[3]Independent volunteer, 270 Trevlac Place, RR#3 Victoria, BC, V8X 2C4 Canada
[4]Independent volunteer, 954-A Queens Ave., Victoria, BC V8T 1M6 Canada

[1]Corresponding Author contacts: Ph: 250-758-2922 Fax: 250-758-2922 E-mail: pmartins@island.net
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Extended Abstract

Western Purple Martins (*Progne subis arboricola* Behle 1968) have been the subject of an extensive and highly successful mainly volunteer-based nest box recovery program in the Georgia Depression Ecoprovince of southwest British Columbia since 1985, following major population declines after the mid-1900s, with a resulting increase from only 5 known pairs nesting in BC in 1985 to over 600 pairs in 2006, all using nest boxes (Lee et al, 2007). Since 1997 a scientific monitoring program has been implemented involving documented annual nest box inspections at almost all nesting colonies within the province to monitor and track progress of the recovery and obtain reliable data on abundance, productivity, nesting success and fledgling production for this geographically confined population, providing a unique long-term research opportunity with an entire regional songbird population.

Analysis of the resulting data accumulated over a decade has allowed development of a simple population forecast model based on annual nesting pair abundance (N), fledgling production (F) and cumulative mean overall survival independent of age (S) from one nesting season to the next that fairly accurately so far (often within 10%) predicts the return of breeding birds in the following year:

$$N_{(i+1)} = [2(N_{(i)}) + F_{(i)}]/2 \times S_{(\text{cum.mean } 2,i)}$$

Input criteria (number of nesting pairs and number of nestlings fledged) are obtained from nest box inspections prior to fledging. Average annual overall survival (all age classes combined, since we have no practical way to determine age class-specific annual survival rates and the mean of published values is similar to the overall mean in this study) can be estimated from the previous years' data, knowing the number of parent birds (breeding pairs) and fledged young leaving at the end of the nesting season and the number of breeding pairs that return the following year.

The accuracy of the following year forecast results from the ability to directly measure abundance and production for the previous season across the whole regional population, thus isolating the other key variable, annual survival, which appears relatively stable (~40-60%) between years with a mean value of ~50% (se = 0.04, n = 9). As well, since banding studies have shown that martins exhibit strong nest site fidelity and almost all juvenile recruitment dispersal and adult relocation occur within the geographically confined Georgia Basin population, emigration losses from the study area are minimal (only to Puget Sound to the south, offset by immigration from this adjacent contiguous population) and study area bias concerns are largely eliminated.

Initial abundance and average annual survival can be combined with cumulative mean fledging success over the 10-yr study period (2.88 young/nest, se = 0.19, n = 10) to iteratively predict returns in subsequent years, providing a multiple year forecast of the longer term population trend:

$$N_{(i+n)} = [2(N_{(i+n-1)}) + F_{(\text{cum.mean } 1,i+n)}]/2 \times S_{(\text{cum.mean } 2,i+n)}$$

However, since fledgling production (and to a lesser degree annual survival) is strongly determined by unpredictable stochastic weather effects on flying insect abundance and foraging success (i.e. food availability), accuracy will vary to the extent that weather-related impacts vary from means reflected in the model parameters for the prior years of

the study, so that predictions are likely to become increasingly unreliable over time due to cumulative errors in the progressive estimation process. As such, while the ability to make accurate following year abundance forecasts is a useful adaptive management tool for planning for the coming nesting season, multiple year forecasts will be of limited reliability or practical value without the ability to accurately predict long-term weather conditions and effects on the flying insect food supply, though they do represent the best estimate available of the population trend in the near future at least.

It follows from these results that with a mean overall annual survival of 50%, a minimum fledging success of 2 young per active nest is required on average to sustain a stable population. Conversely, with a fledging success of 2.88 young per nest (the long-term mean in BC), the population can withstand annual survival rates as low as 40% without significant declines. Given the essential availability of a surplus of suitable nest cavities as a result of the BC nest box stewardship and recovery program, the observed interaction of these two variables fully explains the recent Purple Martin recovery success in BC.

The question arises of whether this simple model or at least some of the model parameters are applicable to other martin populations (or possibly other passerine populations) where the parameters may not be directly measurable or measurable in practical terms without significant study area bias concerns. Published similar long term production and survival data sets for martin populations are rare, but when the model was applied to the results of a comparable 14-yr monitoring study of eastern martins in PA, OH and NY by Hill (1998), the following year forecast accuracy was comparable to that in the BC study in some years, somewhat less in others (+/- 5-20%).

The reduced accuracy was attributed to a combination of increased variability with more extreme adverse weather impacts (e.g. early season adult mortality, extreme temperature and severe storm effects), immigration/emigration recruitment dispersal biases in an open local population (study area bias) and changes in study parameters. However, the model did reliably predict the direction (increase or decrease) of the following year trend in most years, as well as the direction of the long term population growth trend. We concluded that with reliable monitoring data the model may have utility with other martin populations, perhaps with some refinement for local conditions effecting in-season survival and fledging success. It remains to be seen whether it has practical applicability with other passerine species populations, given the quality and extent of monitoring data required.

Literature Cited

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