N-mixture models provide informative crocodile (*Crocodylus moreletii*) abundance estimates in the region of Calakmul (Campeche, Mexico)

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Abstract: Estimates of animal abundance provide essential information for population ecological studies. However, the recording of individuals in the field can be challenging, and accurate estimates require analytical techniques which account for imperfect detection. Here, we quantify local abundances and overall population size of Morelet's crocodiles (*Crocodylus moreletii*) in the region of Calakmul (Campeche, Mexico), comparing traditional approaches for crocodylians (Minimum Population Size—MPS; King's Visible Fraction Method—VFM) with binomial N-mixture models based on Poisson, zero-inflated Poisson (ZIP) and negative binomial (NB) distributions. A total of 191 nocturnal spotlight surveys were conducted across 40 representative locations (hydrologically highly dynamic aquatic sites locally known as aguadas) over a period of 3 years (2017–2019). Local abundance estimates revealed a median of 1 both through MPS (min–max: 0–89; first and third quartiles, Q1–Q3: 0–7) and VFM (0–112; Q1–Q3: 0–9) non-hatchling C. moreletii for each aguada, respectively. The ZIP based N-mixture approach shown overall superior confidence over Poisson and NB, and revealed a median of 6 ± 3 individuals (min = 0; max = 120 ± 18; Q1 = 0; Q3 = 18 ± 4) jointly with higher detectabilities in drying aguadas with low and intermediate vegetation cover. Extrapolating these inferences across all waterbodies in the study area yielded an estimated ~10,000 (7,000–11,000) C. moreletii present, highlighting Calakmul as an important region for this species. Because covariates enable insights into population responses to local environmental conditions, N-mixture models applied to spotlight count data result in particularly insightful estimates of crocodylian detection and abundance.

Keywords: Abundance, Mexico, N-mixture models, Population size.

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