Acta Herpetologica 3(1): 51-55, 2008
ISSN 1827-9643 (online)

An estimate of local population of *Nyctibatrachus aliciae* at two habitat gradients of forest in Western Ghats

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Submitted on 2007, 18th June; revised on 2007, 16th December; accepted 2008, 28th January.

Abstract. Alice's Wrinkled Frog (*Nyctibatrachus aliciae)* is an endemic anuran amphibian of the Western Ghats. The population estimation of this species in native forest and adjoining secondary forest has revealed distinct differences in size. The population size in native forest (n = 554) was large compared to secondary forest (n = 234). The two forest habitats are characterised by air temperature, humidity, light intensity and canopy cover differences. Manmade activity and habitat variables likely influenced the reduction of population size in secondary forest.

Keywords. *Nyctibatrachus aliciae*, population size, India, environmental factors, conservation.

Alice's Wrinkled Frog (*Nyctibatrachus aliciae* Inger, Shaffer, Koshy and Bakde, 1984) is an endemic frog of the Western Ghats, listed as vulnerable of IUCN Red list categories (Anonymous, 2001). This frog inhabits water logged forest floors and streamsides in evergreen and secondary forests at about 900 m a.s.l. within the geographical range of 8-9°N and 12-13°N (Daniels, 1992). The distribution range of this frog is more than 20,000 km^2 in restricted patches of Western Ghats. This frog is known to be threatened by human activites such as deforestation, forest fragmentation and depletion in quality of the habitat (Inger et al., 1984). The continued decline of this species has been observed in severely fragmented areas (Anonymous, 2001). Unfortunately, there are no reliably estimates of population sizes both in different habitat gradients and human affected areas within the forest (Manjunatha Reddy, 2004). Alice's wrinkled frogs are highly secretive, and confined to debris and organic mulch in forest stream. This frog has strong conformity; adult breed in the same habitat and have very poor dispersal capacity.

In the present study, the population of Alice's Wrinkled Frog was estimated in a native and a secondary forests of Kuvempu Bioreserve (Loc: 13°35'-13°40'N and 75°15'-75°20'E) located in Western Ghats. The population was estimated using Schnabel method of mark-

recapture as described by Sutherland (1997) using knee tagging technique as described by Elmberg (1989). Silk threads were used to tag the frogs, and in both sites, marked and unmarked frogs were collected for every fortnight. The study was made for a short duration of 8 months of post monsoon (October through January) and premonsoon (February to May), and not made in monsoon (June to September), when abundant water favour dispersal of frogs. Data were processed following Schnabel method (Krebs, 1999). The native forest site (area: 2 ha; altitude: 710 m a.s.l.) is extended on either the banks of a stream within the Bioreserve, while the secondary forest site (area: 5 ha; altitude: 650-670 m a.s.l.) is located 1 km downstream to the native site. Habitat modifications in this site mainly related to agriculture practices which removed most of native trees and changed the texture of the forest floor. During each survey, important habitat variables *viz,* air, water, soil temperature, humidity, light intensity, and canopy cover were recorded. Air and water temperatures of the habitat were measured using the mercury bulb thermometer (Make: Jennson, precision 0.1 °C). The soil temperature was recorded using a mercury soil thermometer (Make: Jennson; graduated to 0.1 °C). An illuminometer (Model 5200; Kyoritsu, Japan) was used to measure the light intensity and values were recorded in lux. Using the thermohygro-clock (Model J412 – CTH, Japan), the relative humidity (%) of the habitat was recorded. Using a photograph of canopy, the percent coverage of the region was calculated. Seventeen field surveys for each study site were conducted early in the morning and four man-hours were spent during each occasion. Habitat variables were subjected to ANOVA to find out the significance of differences between the two sites. Karl-Pearson correlation coefficient was used to check the relationship among the habitat variables. Regression analysis was carried out to find out the linearity between proportion of marked frogs in each catch and number of frogs previously marked. All statistics were made using SigmaStat (Version 3.5) for Windows. The characters of the two sites were differentiated based on air, water, soil temperature, humidity, light intensity, and canopy cover recorded during study period. Table 1 presents the data on the habitat variables of study sites.

Table 1. Habitat variables (mean ± SE) of native and secondary forest sites. Values in the parentheses indicate ranges.

Parameter	Native forest (n = 17)	Secondary forest (n = 17)	$F_{1, 32}$	P
Air Temperature (°C)	22.99 ± 0.47 (19-26)	25.31 ± 0.55 (22-30)	10.371	0.003
Water Temperature (°C)	22.20 ± 0.66 (18-30)	23.18 ± 0.56 (20-26)	1.299	0.264
Soil Temperature (°C)	22.64 ± 0.36 (21-25)	23.42 ± 0.45 (18-26)	1.832	0.187
Humidity (%)	76.88 ± 2.13 (63-90)	69.96 ± 2.80 (44-84)	3.865	0.041
Canopy cover (%)	83.53 ± 1.02 (79-92)	80.10 ± 0.37 (78-84)	10.09	0.004
Light intensity (Lux)	993.42 ± 135.63 (273-1,639)	1,990.88 ± 443.10 (511-7,260)	4.633	0.040

Compared to native forest site, average air temperature and light intensity, recorded during the study period, were higher in secondary forest site (Table 1). The air temperature of the secondary forest site ranged between 22 and 30 °C against 19° and 26 °C recorded in the native forest site. The light intensity ranged between 511 and 7,260 lux in secondary forest, while in primary forest it ranged between 273 and 1,639 lux and the differences were statistically significant (see Table 1 for statistics). Similarly, compared to native forest, the humidity and canopy cover were lower in secondary forest and the differences were significant (see Table 1 for statistics). Air temperature was positively correlated with light intensity (r = 0.51, P = 0.011) and negatively with canopy cover (r = -0.54, P = 0.008). The variation in the canopy thickness and light intensity indicate the changes associated with habitat structure, likely due to human acrivity.

Population estimate of *N. aliciae* in two different forest habitats is given in Table 2. During the study, a total of 157 frogs from native forest and 97 frogs from secondary forest were collected. Out of these, 18% and 25% of the frogs were recaptured respectively. The population estimate value of *N. aliciae* in the native forest (n = 553.73) was large as compared to secondary forest (n = 234.07). The frequency of marked individuals in the native forest increased linearly with increasing previously marked frogs (Fig. 1a; y = 0.077 + 0.001x; R^2 = 0.48) indicating that the size of the population was constant. By contrast, in secondary forest (Fig. 1b), the non-linearity (y = 0.106 + 0.003x, R^2 = 0.124) depicts the violation of assumption generally made for Schnabel method of mark-recapture. The non linearity of marc-recapture curve (Fig. 1b) indicates disappearance of some frogs from this site over the time of study. Since this frog is sensitive to habitat quality, the manmade activities that have changed habitat character could be a factor for high fluctuation in population size.

Ecologist have used many measures of landscape structure to predict the population dynamic consequences of habitat loss and fragmentation (Gustafson and Gardner, 1996: With et al., 1997) and microhabitat heterogeneity is known to influence the distribution of frog species (Kam and Chen, 2000). Anthropogenic activities in agriculture and silviculture have negative effect on amphibian populations and influence the abundance and richness (Demaynadier and Hunter, 1998; Ŝireika and Staŝaitis, 1999). In the present study, the past anthropogenic activities were evident in the secondary forest (Table 1). Further, the frog population was low in secondary forest site amounting to only 42.3% of those recorded in native forest site.

Table 2. Population size of Alice's wrinkled frogs (*Nyctibatrachus aliciae*) in Kuvempu Bioreserve, Central Western Ghats.

Variables	Native forest	Secondary forest
Number of surveys	17	17
Population Estimate (size)	553.73	234.07
Variance	0.1195	0.699
SE	0.000266	0.000007
Confidence limit	0.01018-0.0113166	0.010725-0.010758

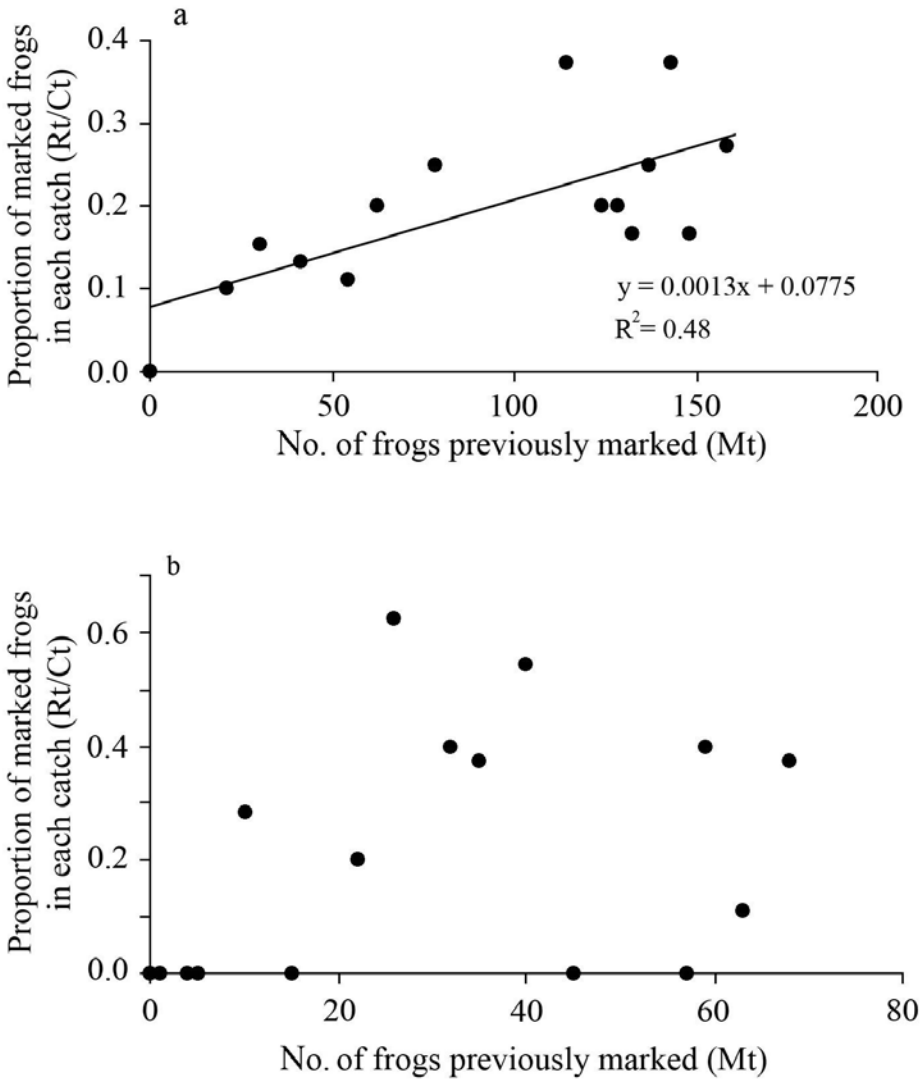

Fig. 1. Proportion of marked frogs in native (a) and secondary forest (b) sites.

Alice's Wrinkled Frog, as an endemic amphibian of Western Ghats, requires specific habitat. Manmade activities and conversion of the habitat have rendered direct and indirect effect on habitat quality affecting the population size of this frog. The earlier work (Manjunatha Reddy, 2004) and present study have revealed the importance of thick canopy cover, low air temperature and light intensity as favourable factor for the occurrence of the species. Therefore, it is important to emphasize on these habitat variable for the conservation of species.

ACKNOWLEDGEMENTS

Authors are thankful to two anonymous referees and Dr. Marco A.L. Zuffi, University of Pisa for the comments and suggestions on the manuscript.

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