THE SARAWAK MUSEUM JOURNAL

https://museum.sarawak.gov.my

Crossref

The Sarawak Museum Journal
Vol. LIV No. 75
December 1999

ISSN: 0375-3050
E-ISSN: 3036-0188

Citation: C.H Diong et al. (1999). Nesting Pattern, Clutch Size Variation, and Estimates of Female Population Size in the Sarawak Green Sea Turtle *Chelonia Mydas*. The Sarawak Museum Journal, LIV (75): 309-318

NESTING PATTERN, CLUTCH SIZE VARIATION, AND ESTIMATES OF FEMALE POPULATION SIZE IN THE SARAWAK GREEN SEA TURTLE *CHELONIA MYDAS*

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INTRODUCTION

Nesting and clutch size data collection for the stock of green sea turtle *(Chelonia mydas)* which nests on the shores of three uninhabited islands, Talang Talang Besar, Talang Talang Kechil, and Satang Besar off the southwestern coast of Sarawak, Malaysia, has been initiated for many decades (Harrisson, 1969; Hendrickson, 1958; Chin, 1975; Leh, 1985, 1994; Mortimer, 1990). In recent years, the collection of data was carried out more intensively. In this paper, we analyze the nesting activity and clutch data collected over the three consecutive breeding seasons from May 1995 to October 1997 with the following two objectives; (i) to describe turtle nesting pattern, mean clutch size and clutch size variations over three consecutive breeding seasons, and (ii) to estimate the size of the stock of mature female turtles as a function of remigration interval and internesting frequency. The implications of nesting records for managing the existing stock of sea turtle are discussed.

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MATERIALS AND METHODS

The stock of green sea turtle under consideration lays eggs all year round. However, the main breeding activities fall into a six-month period from May to October each year. Thus, data on the number of nestings per night and the number of eggs per nest were collected during this period as nests were excavated to collect whole clutches of eggs within 2-6 hours after laying for replanting in a beach hatchery. Nightly nesting records collected during the May to October breeding season from 1995 to 1997 were examined and analysed using line graphs and boxplots. Boxplots, also known as box-and-whisker plots, were used to show distributional characteristics of clutch size data.

Size of mature female (egg-laying) turtles in the stock was estimated by using the data on turtle nestings. Total number of turtle nestings was assumed to be related to the number of mature female turtles, depending on their remigration interval and internesting frequency.

Let $N_f(i, r)$ represent the number of egg laying females in the stock, with r and i denoting, respectively, the remigration interval and internesting frequency of the green turtle population. Let $n_j, j = 1, 2, 3$, denotes the total number of turtle nests in the j^{th} breeding season. Hence n_1, n_2, and n_3 correspond respectively to the total number of turtle nests in 1995, 1996, and 1997. As the total number of turtle nests for the 1993 and 1994 breeding seasons are also available now, use can be made of them in our estimation of N_f. Thus n_{-1} and n_0 correspond to the total number of turtle nests in 1993 and 1994 respectively. With these notations, the number of egg laying females in the stock is given by

$$N_f(i,r)\begin{cases} \frac{1}{5i}\sum_{j=-1}^{3} n_j & \text{if } r=1 \\ \frac{1}{6i}\left[2\sum_{j=-1}^{3} n_j + \sum_{j=0}^{1} n_{2j}\right] & \text{if } r=2 \\ \frac{1}{2i}\left[\sum_{j=-1}^{3} n_j + n_1\right] & \text{if } r=3 \\ \frac{1}{2i}\left[\sum_{j=-1}^{3} n_j + \sum_{j=0}^{2} n_j\right] & \text{if } r=4 \end{cases}, \quad i = 2,3,4,5.$$

Sea turtles do not reproduce every year (Carr *et. al.*, 1978; Hirth, 1980; Lutz and Musick, 1997). Populations of *Chelonia mydas* in Surinam (Schultz, 1975), Sabah (de Silva, 1981, 1982), and Sarawak (Hendrickson, 1958) exhibit a 2-, 3-, 4- year breeding periodicity with the triennial cycle dominating. Lutz and Musick (1997) found from his analyses of the data from nine populations of the green turtle that the remigration interval of turtles varied from 1 to 7 years with a mean interval of 2.86 $\pm$ 0.23 years. Internesting frequency in the Sarawak greens ranges from 2-5 times per breeding season, with most females laying three clutches in a season. Based on these life history data, we estimated the Sarawak stock of mature female (egg-laying) turtles in for $2 \leq r \leq 3$ and $3 \leq i \leq 5$. Note that if r is taken as 2, then the 1993, 1995 and 1997 turtle landings correspond to the same group of turtles which makes up $\frac{1}{2}$ of the total stock of mature female turtles in Sarawak. Similarly, if $r = 3$, then the total stock of female turtles may be regarded as one consisting of three equal parts, $\frac{1}{3}$ of which contributes to the 1993 and 1996 landing data, with