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Aspects of the population dynamics of the wild Asiatic water buffalo (*Bubalus bubalis*) in Ruhuna National Park, Sri Lanka

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Abstract

A population of *Bubalus bubalis* L. was studied for two years in Ruhuna National Park (RNP) in Sri Lanka by seasonal direct counting. The park contains a shallow river and a large number of water holes, most of which dry up during the dry season. The vegetation consists of scrub forest interspersed with grassland, which covers an area of about 30% of the park. The buffalo population in an area of 140 km^2 usually fluctuated between 500 and 600. However, after a prolonged drought period the population decreased to 300 in January 1993.

Although the observed male to female ratio up to the subadult stage is 1:1, that of the adults fluctuated between 1:4.7 and 1:1.9 favouring females, males being relatively more frequent during the breeding season. Since there appears to be no selective mortality of adult males, the observed deviation from 1:1 sex ratio could probably be due to adult males moving away from the study area into deeper forest.

The main breeding season of the buffalo in RNP lasts from March to May. Calves are born from end of December to about mid-May, from the end of the main rainy season to the beginning of dry season when the grasses show a luxuriant growth; the peak of calving is in mid-January. Only about half the adult females appears to calve in any one year. The buffalo population in RNP is maintaining itself, any tendency of increase being controlled by the enhanced mortality during prolonged drought periods, which occur once every few years.

The elephant (*Elephas maximus*), spotted deer (*Axis axis*) and sambar (*Cervus unicolor*) are the major competitors of the buffalo for the food resources in the park. The leopard *Panthera pardus* and the crocodiles *Crocodylus porosus* and *C. palustris*, and perhaps the jackal (*Canis aureus*) are the only significant predators of the buffalo and they too are important only during the calf and juvenile stages.

KEYWORDS: Buffalo, *Bubalus*, Artiodactyla, population dynamics, reproduction, Sri Lanka, tropical.

Introduction

The Asiatic water buffalo (*Bubalus bubalis* L.), which is found in the tropical countries of India, Nepal, Bhutan, Burma, Thailand and countries of the former French Indo-China, is the largest member of the family Bovidae found in Sri

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Lanka. *Bubalus bubalis* is categorized as an endangered species in most of its range (IUCN, 1990). Although it can only be considered as vulnerable (according to IUCN (1990) threatened categories) in Sri Lanka at present, it may soon become endangered in the wild if its habitat continues to dwindle.

The water buffalo was widely distributed throughout the low country dry zone forests in Sri Lanka about a hundred years ago (Phillips, 1984), but today it is seen in the wild state only in protected areas such as the national parks and in a few other remote, sparsely populated areas. They are confined to the lowland dry zone although some solitary males wander occasionally into the lower hills (Phillips, 1984).

Even within the protected areas, buffalo populations face threat of severe reductions because they are claimed to be rapidly increasing and have been blamed for a long time for (a) spoiling and making unusable to other animals the water sources of the protected areas, especially during the peak drought by wallowing and defecating, and (b) over-grazing the grassland habitat, thus jeopardizing the other herbivores using the same habitat (Packeer, 1970, Claasz, 1973; De Silva, 1973).

The buffalo population of the Ruhuna National Park (Block I) was selected for the present study because (a) the extensive network of roads in the area allows access to all parts of the area, and (b) most of the earlier claims of over-population of the buffalo were based on observations of this area.

Materials and methods

The study area. Ruhuna National Park (RNP), which, with its adjacent reserves (Fig. 1), covers an area of about 1,500 km^2, is situated in the lowland Dry Zone of the south-eastern part of the country. RNP is bordered by the sea on the south and east and consists mainly of scrub forest and grasslands. High forest along the banks of the Menik River and saline flats along the sea coast are the other major habitats. A few natural waterholes and several man-made small reservoirs are found scattered within the park. The two rivers, Menik and Kumbukkan and a number of streams, which are mostly seasonal, drain the area.

Block I of RNP (140 km^2 in area) (Fig. 2), where the present study was carried out, is roughly triangular in outline with the Menik River forming the northern boundary and separating it from Blocks II and III.

RNP experiences a major rainy period in October to November by chiefly convective rains of the inter-monsoonal period and during November to December by chiefly advective rains of the North-East monsoonal period (Fig. 3). The climate of Sri Lanka is characterized by two monsoonal and two inter-monsoonal periods: from late May to September the south-west monsoonal winds blow, while from late November to mid-February, the north-east monsoon is active. The major rainy season is followed by a short period of atmospheric drought in February. The inter-monsoonal rains commence in March and continue until about the mid-May. However, this pattern of rainfall can vary considerably from year to year. The major drought period is during the south-west monsoon. During the peak of the drought in August-September, most of the waterholes dry up completely. The monthly mean temperature in the area varies between 26°C and 29°C (Müeller-Dombois, 1968).

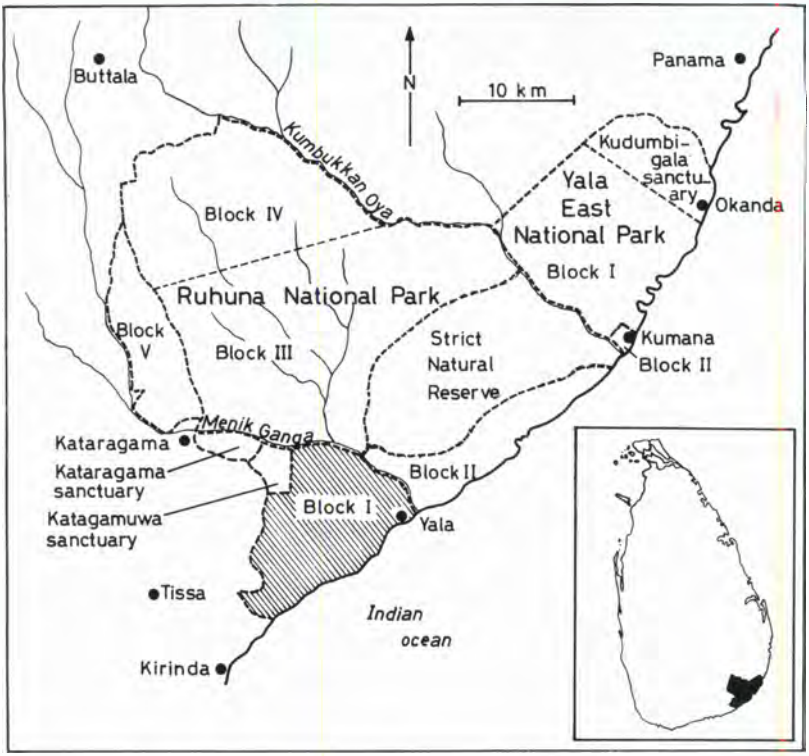

Figure 1. Map of Ruhuna National Park and associated protected area.

The main vegetation cover of RNP is woody, mostly scrub, i.e. canopy below 5 m height, but forest occurs in the form of larger and smaller "islands" within the scrub (Müeller-Dombois, 1972). The vegetation of the Park has been classified by Müeller-Dombois (1968) into three categories: (a) forest, characterized by a crown biomass of at least 20% above 5 m height, (b) scrub with less than 20% of crown biomass above 5 m, and (c) grassland or plains. The major species of plants in these categories are given in Balasubramaniam *et al.*, (1980). The coastal region in Block I (Fig. 2) is characterized by numerous waterholes (and a few reservoirs) surrounded by grassy plains. The inner region of Block I is mostly scrub with scattered small patches of grass.

Methods. The study was carried out in Block I during the months of June and October in 1991, January, March and June in 1992 and January and March in 1993. During each month the large mammals at various parts of the park (Block I) were observed for at least one week between 0600 hrs and 1800 hrs each day. Since much of Block I could be traversed using its extensive network of roads (Fig. 2), the survey covered a diversity of habitats found in the forest, scrub, grassland and waterholes.

At every sighting of buffaloes their number was recorded, and whenever possible, the composition of the groups and the behaviour of their members noted. For the purpose of censusing, four categories, namely, adult, subadult,

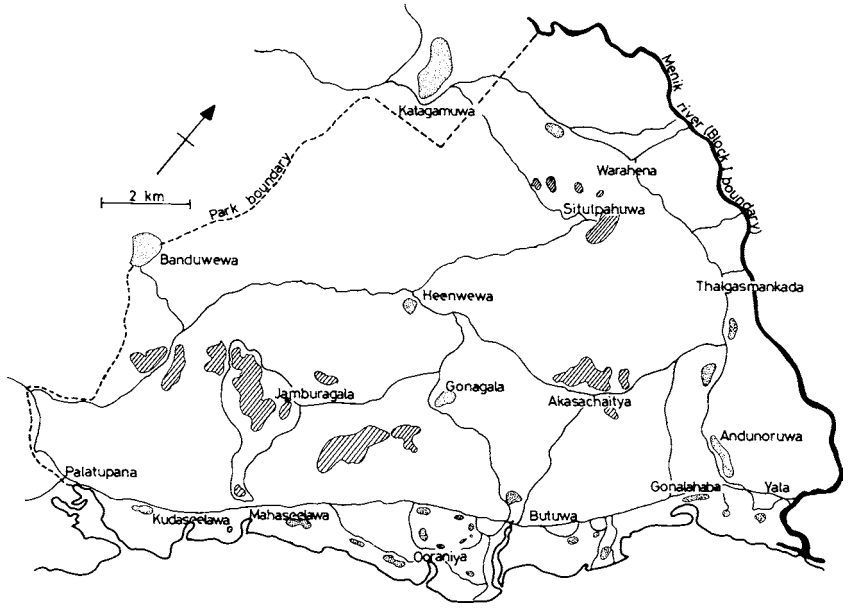

Figure 2. Map of Ruhuna National Park - Block I, showing waterholes (stippled), rocky outcrops (hatched) and road network. Coastal and inner regions as distinguished in the present study are indicated.

juvenile and calf of either sex, were recognized following Eisenberg & Lockhart (1972). In the instances in which the sex was uncertain or the herds could not be properly classified, the individuals were taken as 'unsexed' or 'unclassified', respectively.

Buffalo calves are tan in colour and distinguished from juveniles by the absence of horns. The juvenile stage is from the appearance of the horn stub to the time when the horns start to show a slight curvature. Subadults show a slight curvature of horns, the reddish-brown juvenile pelage having been changed to a greyish-black colour. The adult shows prominent curvature of horns and a black colour. In instances where external genitalia are not visible (e.g. during wallowing), the adult male can usually be distinguished from the adult female by its broader face, prominent bases of the horns, broader horn bases and closer curvature of the horns. But, it was found that in a few cases (<5%) horn characteristics may lead to an error whereby a sub-dominant male is mistaken for a female.

For estimating the population density of *B. bubalis*, the area was divided into several sectors (Fig. 5) and each sector was studied at different times for several days. The highest number of individuals observed in a sector in any one censusing session was taken as the minimum population density in that sector. This estimation depends on the assumption that the animals did not move from one sector to another within the period of monthly censusing. This assumption seems justified since the individuals, especially the herds, were found to remain within the same area unless the waterholes in the area dried up (Eisenberg & Lockhart, 1972; present study). An estimation of the population size by observing

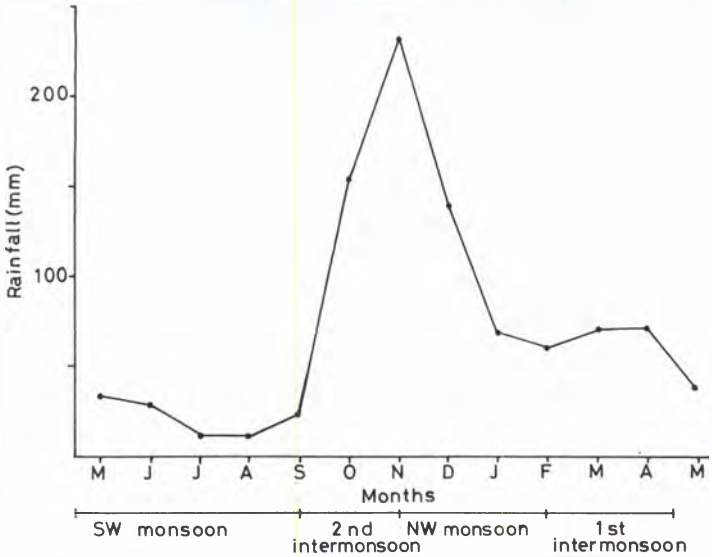

Figure 3. Monthly mean rainfall in Ruhuna National Park - Block I for the period 1972 to 1992 (data from Ruhuna National Park).

the animals visiting the waterholes from 0600-1800 hrs during the peak drought period in October 1991 showed that the estimates by the two methods are within 4% of each other.

Results

In 1991 and 1992 the wild buffalo population in RNP (Block I) consisted of about 500 individuals which temporarily increased to about 600 during the breeding season (Fig. 4). However the population was reduced to about 300 by January 1993. This resulted from the very high mortalities that occurred during the unusually prolonged drought during the period of July to September 1992. The population structure during the study months is given in Fig. 4. The average density of buffaloes in the study area before the high mortalities occurred was 3.8 km^{-2} but was reduced to 2.1 km^{-2} in January 1993 (that of adults only was 3.1 km^{-2} and 1.9 km^{-2}, respectively). However, the distribution of the buffalo in the study area was uneven. The coastal zone (Fig. 2), which consists mainly of grasslands with many waterholes, had a very high average density of 14.55 km^{-2} (Fig. 5), whereas the rest of the study area, which consists mainly of scrub forest, had a low average density of 1.34 km^{-2}. As indicated in Fig. 5, even within coastal and inner areas different regions showed different densities. The highest density of 17.08 km^{-2} and the lowest density of 9.12 km^{-2} in the coastal zone were observed in March 1992 and January 1993, respectively. The buffalo density in some regions changed markedly from wet season to dry season. For instance in the Heenwewa area (sector 12 in Fig. 6), the density in October 1991 (end of dry season) is much higher than that in March 1992 (end of wet season), and in the Buthuwa area (sector 4 in Fig. 6) the density in March 1992 is about double that in October 1991. This is because, during the dry season, buffaloes from the

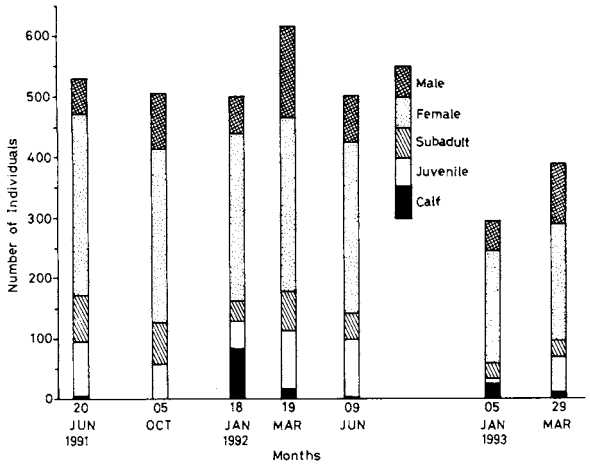

Figure 4. Buffalo population structure in the study area during the survey months.

adjacent areas moved into Heenwewa area as it contained a permanent reservoir and the buffaloes in the Buthuwa area moved away from it as the grasslands in the area became dry.

The adult male to female sex ratio varied from 1:1.94 in March 1992 (breeding season) to 1:4.68 in January 1992 (calving season). The ratio in March 1993 and January 1993 was 1:1.97 and 1:3.80, respectively. The sex ratios of juveniles and subadults were 1:0.98 and 1:1.1, respectively, and did not vary significantly from the expected 1:1 ratio. Therefore, the sex ratio of the calves could also be assumed to be 1:1. This indicates that there is no selective mortality between males and females at least up to the subadult stage.

Because of the skewed sex ratio of adults and the short duration of the calf, juvenile and subadult stages, the fluctuations in the population could most reliably be given with reference to the adult females. The number of adult females fluctuated between 276 and 300 with a mean of 288.8 during the period of June 1991 to June 1992 but, during the prolonged drought period in June to October 1992, the number of females was reduced to 186, which indicates a 37% mortality of the adult female population during the drought period. The buffalo density decreased markedly during the period in most sectors as seen from the densities in March 1992 and March 1993 (Fig. 6).

A single calving season was observed from December to May with a peak in late January (Fig. 7). The number of calves recruited to the population in 1991 is estimated from the number of calves and juveniles as 115, but the number recruited during 1992 appears to be only 70. This indicates that about 39% of the pregnant females died during the prolonged drought period. This agrees well with the earlier estimation of adult female mortality during the period.

On several occasions during the present study, two calves accompanying a single cow were observed. In a few occasions, it was also observed that the number of calves exceeded the number of cows in the particular herd. Although the possibility of these excess calves being those of females that may have left the

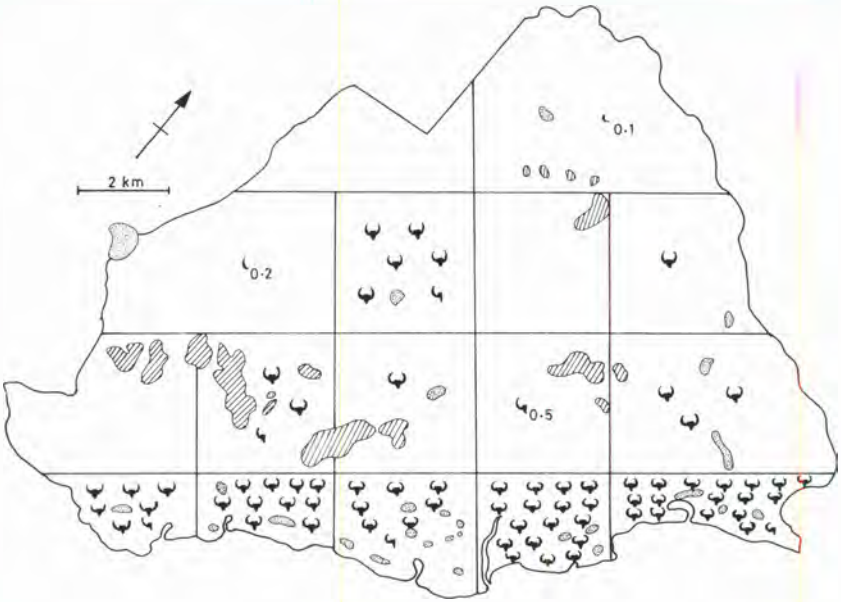

Figure 5. Mean population density of the buffalo in different parts of the study area for the period of June 1991 to June 1992. (Each symbol represents a density of 1 km^{-2}.)

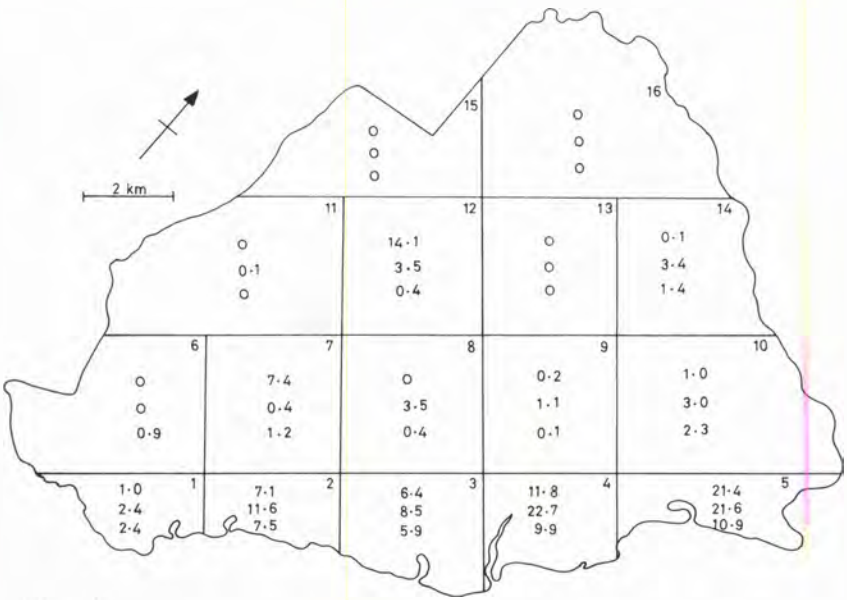

Figure 6. Buffalo population densities in different parts of the study area during the months of October 1991 (top figure), March 1992 (middle) and March 1993 (bottom).

herd or that may have died could not be ruled out, this also raises the interesting possibility of buffalo cows giving birth to twins.

The major predators of the water buffalo in RNP appear to be the leopard (*Panthera pardus*) and the two species of crocodiles, namely, the swamp crocodile (*Crocodylus palustris*) and the estuarine crocodile (*C. porosus*), of which the former is more common than the latter in RNP. All significant water holes in RNP are infested with crocodiles and these predators are frequently found in deeper pools of the Menik river as well during the dry season when the river flow is low. The jackal (*Canis aureus*) may also be a significant predator. Losses due to predation appear to be significant only at the calf and juvenile stages as there is no evidence of predators attacking subadult or adult buffaloes.

Mortalities were observed in several occasions. Two juveniles with very small horns were found dead owing to festered wounds. These wounds were in the thigh region and appeared to have caused by the horns of an adult. On two other occasions juveniles were observed just out of water in waterholes with bleeding wounds in the lower part of legs, which may probably have caused by crocodile attacks. On one occasion, a very old female was found sitting under the shade of a tree, remaining there without feeding for three days after which she died. On several occasions carcases partly eaten by jackals and wild pigs were observed in different parts of the park. During the unusually prolonged drought of 1992, several buffalo carcases were observed in the dried up bed of the Menik River.

Discussion

The average density of 3.8 km^{-2} found in RNP is much higher than that of 0.28 km^{-2} observed in the Wilpattu National Park, Sri Lanka (WNP) in 1972 (Eisenberg & Lockhart, 1972). Although the forest type is different in the two parks, WNP having a larger area of high forest, the grassland area is similar in both parks (27% of the total area in WNP and 30% in RNP-Block I). However, although WNP contains a few large permanent waterholes, RNP contains many temporary shallow, small waterholes in addition to the few large permanent waterholes present. These small waterholes are the preferred habitat of the buffaloes for wallowing. Thus, RNP-Block I, especially the coastal zone, offers a very suitable habitat for the water buffalo, and a density as high as that found in this area could not be expected anywhere else in the island.

De Silva (1973) quoted a figure of 15,000 buffaloes in Blocks I, II and III in December 1971 giving a density of 23.2 km^{-2}, which is about 1.5 times higher than the density estimated for the coastal area in the present study. He also predicted that the population would increase to about 20,000 by 1972, 26,000 by 1973 and about 35,000 by 1974. None of these predictions appear to have materialized. Claasz (1973) quoted a figure of 26,000 buffaloes for the RNP, although it is not clear whether the estimate is for the entire RNP complex or a part of it. Assuming that his estimate is for the entire complex, it still gives a density of about 17 km^{-2}. These are obvious over-estimates, as has been already pointed out by Santiapillai & Chambers (1982) and Ashby and Santiapillai (1983). Since small waterholes and grasslands are not so common in the other blocks as in Block I coastal area, it is reasonable to assume that the density of buffaloes in areas other than Block

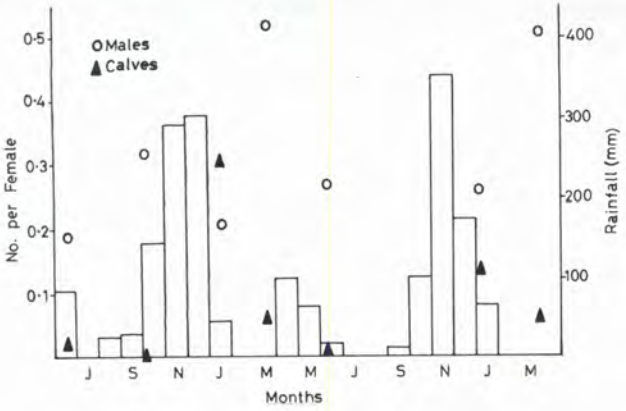

Figure 7. Number of adult males and calves in relation to the mean monthly rainfall during the study period. (Note: the highest number of calves was seen in late January. The highest number of males was seen in March).

I is closer to that of the scrub area of Block I, i.e. 1.3 km^{-2}. If this is correct, then the entire park complex (about 1500 km^2) will have only about 2000 buffaloes, less than 14% of the earlier estimates.

Although the male to female sex ratios of adults is biased in favour of the females, the mortality rates of both adult males and adult females of RNP appear to be similar as indicated by the life expectancy studies by Ashby & Santiapillai (1986), although Eisenberg & Lockhart (1972) were of the opinion that the mortality rate of adult males is higher than that of the adult females. There is also no reason to assume differential growth rates in adult males and females. The probable explanation for the adult females outnumbering adult males by about 3:1 therefore is that the males, as they mature, leave the herds and from Block I and move into other regions of the park owing to pressure from more dominant adult males. Some of these males seem to return during the breeding season as the number of males becomes temporarily higher during this period (Fig. 7).

Eisenberg & Lockhart (1972) gave the age of various categories of buffalo as: calf-up to 6 months, juvenile-6 months to 15 months, subadult-15 months to 20 months, adult-over 20 months. However, during the present study, it was observed that the horns appear in calves within three months, and possibly even as early as two months. Also, the juvenile and subadult stages appear to last for about twelve and six months respectively. In the present study, the age ranges of various categories were taken as follows: calf -up to 3 months, juvenile - 4 months to 15 months, subadult - 16 months to 21 months, adult - over 21 months.

The calving period extends from about mid-December to May, although the peak is in the latter part of January. Calving coincides with the end of rains and the ensuing period (Fig. 7). This is advantageous since, during this period, the waterholes are full and the grasslands are carpeted with new, tender grass. Only 26 calves were observed during the first week of January 1993, although many females were still seen in an advanced stage of pregnancy. However, 84 calves

were observed in the latter part of January, 1992. The secondary peak in April-May observed by Santiapillai & Chambers (1982) in RNP and that in April observed by Eisenberg and Lockhart (1972) in WNP was not observed during the present study. Assuming a ten -month pregnancy period (Eisenberg & Lockhart, 1972), the major breeding season appears to be from February to May, and this was confirmed by observations in the present study.

The calves suckle for three months or more, into the juvenile stage, and it is unlikely that females mate in the same year of calving. This means that, on average, only 50% of the cows will mate and calve in any single year. This is supported by the observation that although the adult females in the population ranged from 276 to 300 (mean=273) in 1991/1992, only about 115 calves were added to the population during the calving season in 1992. Thus, even allowing for the mortality of calves, less than 50% of the female population appear to calve in any given year. Since the females reach maturity (age at first mating) at about two years of age and then have a mean life expectancy of only about nine years in RNP (Ashby & Santiapillai, 1986), a female, on the average, will calve not more than five times. Assuming a mean number of 273 adult females and that the population is in equilibrium, and also assuming a life expectancy of about nine years, one would expect about 30 adult females to die each year. Therefore, if only about 120 calves are born per year (of which only 60 would be females, since the sex ratio is approximately 1:1), and if the survival rate of calves up to the adult stage is 64% as has been suggested by Ashby & Santiapillai (1986), it appears that only about 38 female calves would reach maturity each year. This gives a surplus of 8 individuals over and above the number required for replacement of 30 adult females expected to die each year. Thus, theoretically the buffalo population must increase. However, the buffalo population in RNP does not seem to be on the increase. This appears to be because of the high mortality that occurs during prolonged drought periods. Since the population was reduced to about 200 adult females in 1993, it will take seven to eight years to recover the 1992 level of 300 adult females, given the estimated rates of birth and mortality. Therefore, a reduction of the size experienced in 1992, if it occurs in once in eight years, will keep the population in balance.

Examination of the rainfall data for the last twenty years indicates that prolonged droughts are generally characterised by less than 12 days of rain and less than 200 mm of rainfall during the dry season, which lasts from the beginning of June to the end of September. Within the last 20 year period, such prolonged droughts occurred in 1978, 1980, 1983, 1988 and 1992, those in 1980 and 1992 being more severe.

The other herbivores with which the buffalo may be in competition for food are the elephant (*Elephas maximus*), sambar (*Cervus unicolor*) and spotted deer (*Axis axis*). The crude density of these large herbivore species in RNP-Block I is given in Table 1. Since the elephant is mainly a forest animal feeding on leaves and branches of trees (although it does feed on grass), the competition appears to be between the buffalo and the cervids, especially the spotted deer. The first to suffer through reduction of grass cover (e.g. during the dry season) is the buffalo, which is not as efficient a browser as the deer and sambar. Thus, periodic prolonged droughts experienced in RNP will tend to curb any tendency of the buffalo population to increase.

Table 1. Density and biomass of large herbivores and their percentage contribution to herbivore biomass in Ruhuna National Park-Block I (data from de Silva, 1992).

Species	Density		Biomass	% Contribution
	number	number km^{-2}	kg/km^{-2}	
Elephant	55	0.39	711.1	26.8
Buffalo	506	3.61	983.1	37.1
Spotted deer	1800	12.86	582.4	22.0
Sambar	360	2.57	347.1	13.1
Wild pig	138	0.99	26.6	1.0

The predators of buffalo are usually effective only during the calf and juvenile stages. Even during these vulnerable stages, the mother buffalo protects them from land predators. Santiapillai *et al.* (1982) estimated that there are 25 leopards in Block I of RNP (a density of 0.18 km^{-2}), although de Silva & Jayaratne (1993) estimate that there are only 16 adult leopards in Block I (a density of 0.11 km^{-2}). In any event, the major prey species of the leopard appear to be the spotted deer, sambar and grey langur, *Semnopithecus priam* (= *Presbytis entellus*). The crocodiles become important predators of the calves when wallowing. There appear to be more than 300 crocodiles in the waterholes in RNP (pers. obs.).

The buffalo population in RNP appears to be vulnerable to disease carried by domestic cattle and domestic buffalo. Phillips (1984) reported that the wild buffalo populations of Sri Lanka was almost wiped out at the beginning of this century by a severe outbreak of rinderpest. The wild pig population in RNP was almost extirpated by an outbreak of "swine flu" in 1989 (B.V.R. Jayaratne, pers. comm.). The spotted deer populations in Uttar Pradesh, India were greatly reduced by rinderpest (Schaller, 1967). Therefore, it is important to protect as many as possible of the separate and isolated populations of viable size located far enough apart so as to be unlikely to be equally subjected to a single catastrophic event (McCullough, 1978).

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