POPULATION CHARACTERISTICS AND IMPACTS ON WOODY VEGETATION OF ELEPHANTS ON NAZINGA GAME RANCH, BURKINA FASO

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ABSTRACT

A total count of elephants of Nazinga Game Ranch identified 268 animals while a transect sample survey estimated 234 ± 379 animals. Because of the large confidence interval produced by a highly clumped distribution of elephants, a total count seems to be the most acceptable method of monitoring the population. The Nazinga elephant population is young with 79% under 15 years of age and a sex ratio that favours females 67% to 33%. Vegetation impact is characterized by broken branches and stems, mainly in the small diameter classes of trees and shrubs. Most often damaged species were *Vitellaria paradoxa, Acacia gourmaensis* and *A. dudgeonii*. Elephants on Nazinga are better protected than in national parks and more ingress from outside the ranch can be expected. Because of its age and sex structure, this population is expected to increase rapidly, which would lead to significant impacts on vegetation and depredations on surrounding villages. These changes will present challenges to the ranch management.

INTRODUCTION

Burkina Faso is a landlocked country in West Africa with an area of 274,000km2 and a population of 8,000,000 (Direction de la Presse Presidentielle, 1988). The economy of the country is based on animal husbandry and agricultural crops (sorghum, millet, maize, groundnuts, cotton, sesame, rice and sugarcane). Tourism is relatively undeveloped and wildlife-associated visits have been primarily for big game hunting *(The Statesman's Year Book 1985-86)*. Opportunities for developing wildlife-related tourism in Burkina Faso are linked to the country's elephant populations, prompting interest in better understanding these animals.

Estimates from the African Elephant and Rhino Specialist Group (1987) indicated that Burkina Faso contained approximately 3,900 elephants, ranking it first among the 14 West African countries. Moreover, the northern part of the country contains a portion of the seasonal range for the Sahel elephant populations which migrate annually to Burkina Faso from Mali and Niger *(Nature et Faune,* 1989). Resident elephants are distributed in five game reserves and three national parks (Direction de la Protection, 1988). These national parks are Arly and the "W" in the southeastern part of the country, and Kabore Tambi National Park (KTNP) in the south-central region, approximately 25km north of Nazinga Game Ranch (Figure 1).

Because of the rapid increase in numbers of elephants on Nazinga Game Ranch, presumably through migration from KTNP, our study was initiated to investigate their impact on woody vegetation and surrounding village crops. Specific study objectives were to refine methods for estimating numbers of elephants on Nazinga, to characterize elephant population sex and age structure, to document impacts on woody vegetation on the ranch and to identify social impact on local communities surrounding the ranch. We have reported previously on social impact and attitudes of local villagers toward elephants (Damiba & Ables, 1992).

STUDY AREA

Nazinga Game Ranch is located in south-central Burkina Faso, 202km south of the capital city of Ouagadougou and half way between the cities of Po and Leo (Figure 1). The core area of the ranch (Figure 2) covers 806km^2 with a buffer zone on the south that increases the total area to 940km^2. Facilities include offices, lodgings for employees, accommodation for tourists (restaurant and bungalows), an abattoir, a research centre and a network of trails and primitive roads. The ranch was created in 1979 to protect wildlife species threatened by poaching and agricultural encroachment, to create jobs for local peoples and to provide a sustained yield of harvestable wild game. Since November 1989, the ranch has been

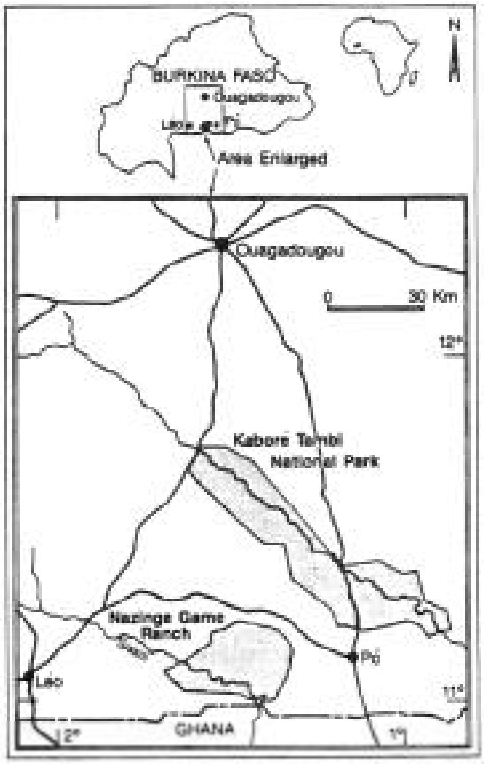

Figure 1. Location of the Nazinga Game Ranch in Burkina Faso (adapted from IUCN-SCD 1988).

self-sustaining, with income generated from cropping harvestable quotas of game species, safari hunting by expatriates and more recently, by an increase in tourists.

The ranch landscape consists of flat plains (76%), low plateaux and undulating terrain (13%), riverine and low lands (10%) and forests (1%) (Decker, 1988). The altitude is approximately 300m above sea level (Damez-Fountaine, 1987). Climate is of the sudanian type with six months of drought and six months of rains and an average annual precipitation of 1,000 to 1,100mm (IUCN-CDC, 1988). During the dry season a major wind, the Harmattan, blows from the northeast and brings dry continental air from the Sahara desert. The ranch is drained by the Sissili river and its two seasonal tributaries, the Dawavele and Nazinga rivers (Figure 2). At 11 locations on these rivers, small dams have been constructed to provide permanent water for wildlife during the dry season.

Decker (1988) characterized Nazinga vegetation as woody plains dominated by *Vitellaria paradoxa*, *Terminalia avicennioides* and Com*bretum glutinosum* with islands *of Isoberlinia doka* woodlands. Common lowland and riverine trees are *Daniellia oliverii*, *Anogeisus leiocarpus*, *Mytragina inermis*, *Cola lauriflora* and *Combretum nigricans.* Small forests

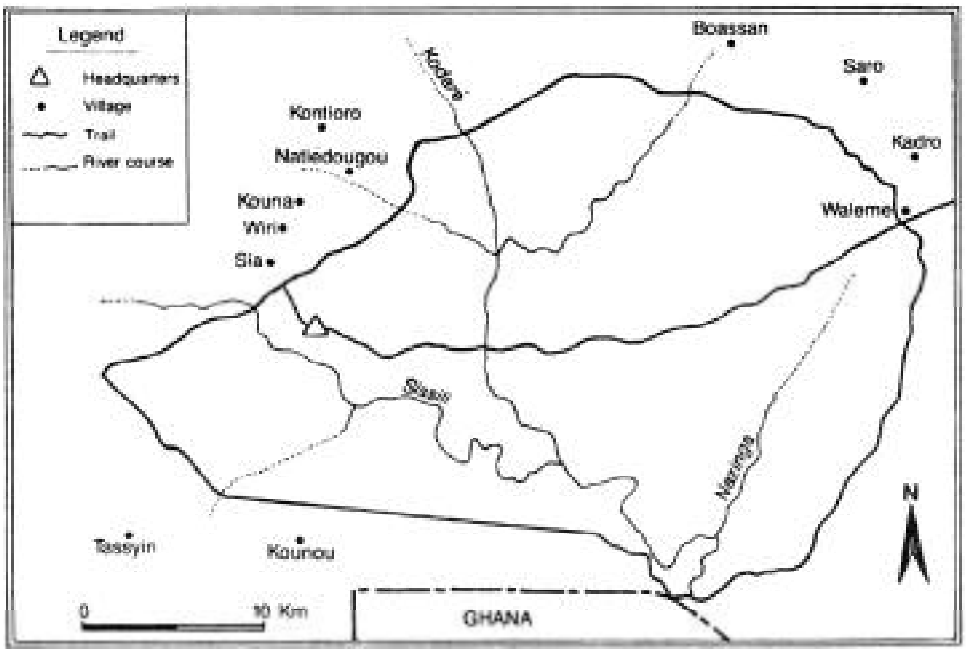

Figure 2. Outline map of Nazinga Game Ranch, Burkina Faso.

and gallery forests contain *Anogeisus leiocarpus, Khaya senegalensis, Diospyros mespiliformis* and *Piliostigma thoningii.* Major perennial grasses on the more open plains are *Hyparrhenia involucrata, Andropogon acinodis* and *Schizachirium sanguineum;* on the lowlands, grasses include *Andropogon gayanus, Vetiveria nigritana* and *Sporobolus pyramidalis;* and the gallery forests contain *Andropogon gayanus* and *Pennisetum subangustum.* Like elsewhere in West Africa, climate, fire and cultural practices have influenced the physiognomy, composition and distribution of the savanna vegetation (Cole, 1986). Fire is used as a major management tool in the various habitat types with a portion of the ranch being burned each year. In addition, accidental human-caused fires occur every three years on average.

Other common herbivores on Nazinga, in order of decreasing abundance, are as follows: warthog *(Phacochoerus aethiopicus),* roan antelope *(Hippotragus equinus),* oribi *(Ourebia ourebi),* Grimm's duiker *(Sylvicapra grimmia),* bushbuck *(Tragelaphus scriptus),* hartebeest *(Alcelaphus buselphus),* African buffalo *(Syncerus caffer)* and Defassa waterbuck *(Kobus defassa).* Less common species include western kob *(Kobus kob),* Hobor reedbuck *(Redunca redunca)* and red-flanked duiker *(Cephalotus rufilatus).* The ranch supports a large population of baboons *(Papio anubis)* while vervet monkeys *(Cercopithecus aethiops)* and patas monkeys *(Erythrocebus patas)* are common. Major game birds include helmeted Guinea fowl *(Meleagris numida),* double-spurred francolin *(Francolinus bicalcaratus)* and stone partridge *(Ptilpachus petrosus).*

METHODS

Population estimates

A line transect method which involved recording each animal observed and its perpendicular distance from the line of travel 'was used to survey the elephant population along with other wildlife species on the ranch. Our methods followed the one described by Burnham *et al.* (1980) and adapted for Nazinga by O'Donoghue (1984). Fifty-one permanently marked transect lines of varying length, evenly spaced 1.4km apart, were established to cover the entire ranch. Animal detection distances varied from 0 to 180m. Data recorded for elephants included group size, sex and age of all individuals, distance from the transect starting point, direction (magnetic azimuth) of animals when first sighted, and distance from observer to the elephant group when first sighted. Perpendicular distances from the line of travel to elephant groups were calculated later. The magnetic azimuths were measured with compasses while the sighting distances were estimated visually. In order to minimize errors introduced by visual estimates, the team leader of each survey group was trained, and the importance of accurate estimates was explained, as recommended by Scott *et al.* (1981).

In the field, teams of three observers started walking transects at dawn. Direction of travel was by compass bearing and depended upon the prevailing wind. The team leader navigated and recorded data while the other two members of the team spotted animals. Population density was estimated from the computer programme, TRANSECT, (Burnham *et al.,* 1980) which uses the Fourier series or modified Haynes techniques. However, due to the relatively low number of elephant groups sighted during the survey, an optimum nonparametric method based on ordered distances (Patil, *et al.,* 1982) provided a more appropriate method for elephant estimates whereas for other wildlife species the Fourier series was satisfactory.

Cataloguing

Cataloguing is a technique used to recognize individuals in a population through careful identification of natural markings. We used this technique as a check on accuracy of sample surveys and to obtain exact sex and age ratios. This portion of the study lasted three months. Useful animal features included frontal line, height, shape and dimensions of tusks and tails, splits on ears, and any other features or markings which were distinctive.

Age determinations

Ages of live animals in the field were estimated by use of a pair of 7x50 binoculars with graduated optical scales. The shoulder height of the target animal (as observed through the binoculars) was recorded in graduated units. The distance to the target animal was measured with a tape measure and shoulder height calculated using standard trigonometric methods. Accuracy of the method was validated using measured heights on vegetation. Elephants were then grouped into five age classes according to equations developed by Laws (1975) and criteria specific to the Nazinga elephant population (Jachmann, 1986; Damez-Fontaine, 1987). Due to the tendency of elephants to

move out of visual range of the observers before all measurements could be made, a more rapid estimate of age classes was also used. Approximately 50% of animals were aged by measurement and 50% by estimation.

Woody vegetation survey

Forty circular plots with a 30m radius, were positioned approximately five km apart on the ranch. Within each plot the numbers of each species of shrub and tree were recorded. The plot was assigned to a major vegetative type and evaluated as recently burned or not. Damage by elephants was categorized as:

1. broken branches,
2. broken stems,
3. broken tops,
4. pushed over,
5. uprooted,
6. overbrowsed, or
7. debarked.

Only trees and shrubs damaged since the previous growing season were considered. Basal diameters taken 10cm above the ground were used to assign damage to size categories.

RESU LTS

Population estimates

Fifty-one transects 665.8km were walked.

Only four elephant groups totaling 85 elephants were sighted. The estimate was 234 ± 379 elephants. The cataloguing techniques resulted in an actual count of 268 individual animals. Five major elephant clans accounted for 198 animals. Within these clans were several small family units or sub-clans. The second social grouping was composed of eight distinct family units of 51 elephants which seldom associated with a larger clan. The third grouping was composed of groups of a few bulls each and accounted for 17 individuals. The remaining elephants were loners with very localized ranges, mainly in the south western part of the ranch.

Age structure of the population

The age structure displayed is based on 118 animals, or 44% of the population. The distribution of age classes in five-year increments (Figure 3) shows a very young population with 79% of the animals being less than 15 years of age. The female: male sex ratio was 2:1 (67% to 33%). There was no significant difference in the age distribution of male and female segments of the population.

Impacts on vegetation

The circular plots contained a total of 2,274 trees and shrubs of which 20% had some degree of damage by elephants. The most common kinds of damage were broken branches and broken stems (Figure 4). The least common form of damage was overbrowsing. The

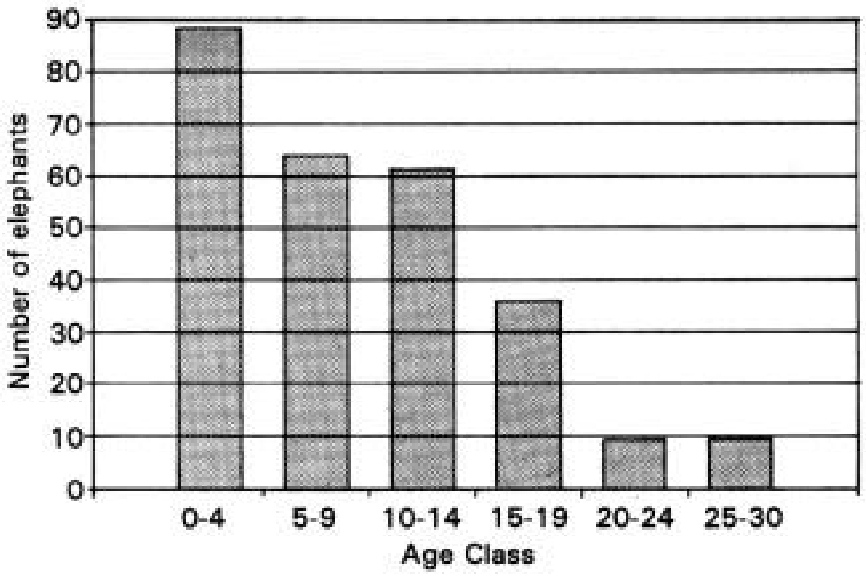

Figure 3. Age distribution of the elephant population on Nazinga Game Ranch.

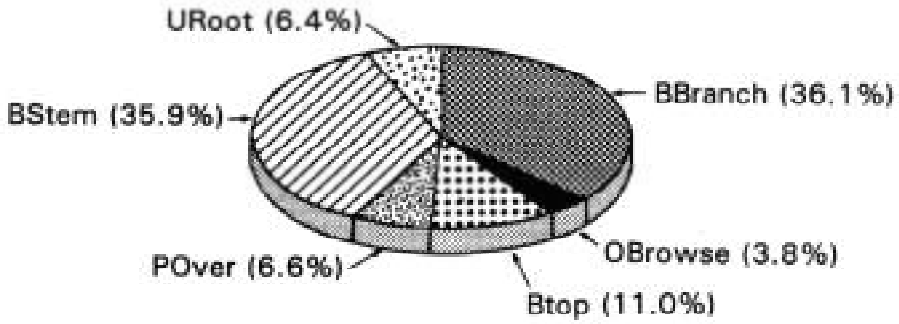

Figure 4. Frequencies on the different types of damage caused by elephants on vegetation on Nazinga Game Ranch. BBranch = broken branches, BStem = broken stems, Btop= broken tops, URoot = uprooted, POver = pushed over, OBrowse = overbrowsed.

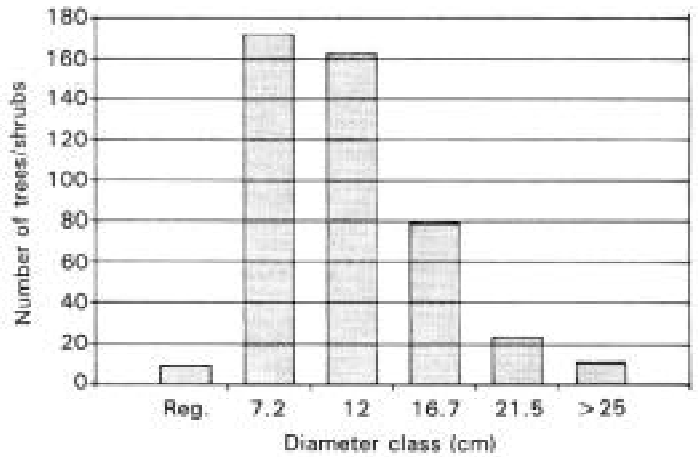

Figure 5. Elephant impact by tree/shrub diameter class on Nazinga Game Ranch. Reg = regeneration tree! shrub diameter class (3.2. - 4.8 cm).

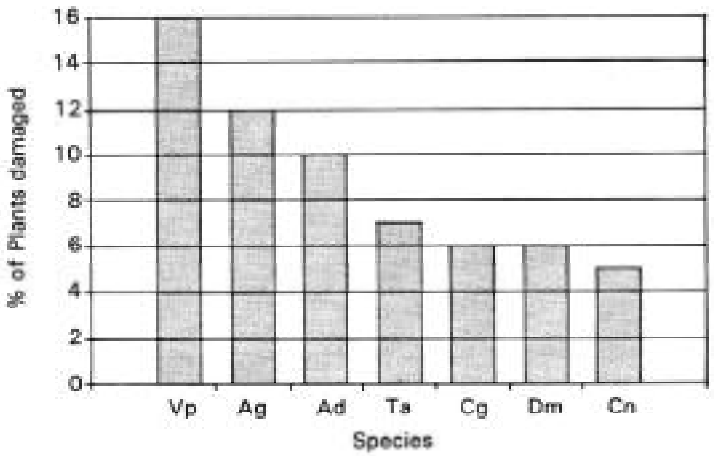

Figure 6. The 7 tree species most impacted by elephants on Nazinga Game Ranch. Vp = Vitellaria paradoxa, Ag = Acacia gourmaensis, Ad = A. dudgeonii, Ta = Terminalia avicennioides, Cg = Combretum glutinosum, Cn = C. nigricans, Dm = Detarium microcarpum.

level of impact was highest in diameter classes of 7.2cm (38% of damage) and 12cm (36% of damage) (Figure ***5)*. Seven tree species sustained two-thirds of the damage (Figure 6). Debarking was more selective and occurred most commonly on species of the genus *Lannea.* All species of this genus had some level of debarking.**

Elephant damage to woody plants on the ranch occurred in a non-random manner ($P < 0.001$), suggesting that damage is selective and highly localized. Of the 40 sample plots, 29 showed elephant damage while others were untouched. There was no significant difference between tree! shrub densities on damaged versus undamaged plots ($P > 0.025$), nor was there a correlation between numbers of damaged plants per plot and tree/ shrub density on the plot ($r=0.28$, $P > 0.025$). However, there was a correlation between numbers of woody stems damaged per plot and species richness of the plots ($r=0.80$, $P < 0.001$). Plots recently burned which had more than *5%* of stems damaged by elephants showed less woody plant regeneration than plots having only fire or only elephant damage, though the difference was not statistically significant.

DISCUSSION

Though the line transect method provided an estimate of the elephant population that was an acceptable approximation of actual numbers present, the large confidence intervals preclude its use as a reliable method on species with highly aggregated distributions. As in our study, prior estimates of the Nazinga elephant population based on the line transect (Jachmann, 1988) produced an acceptable estimate (306 ± 646) but one with large confidence intervals. An additional problem with the line transect method is its cost. Surveys were done on consecutive days using 10, three-person crews until the task was accomplished. Crew members had to be trained and paid both for training time and for survey time, making duplicate surveys prohibitively expensive. Road counts have been tried on Nazinga and provided an estimate of 293 ± 222 elephants (Jachmann, 1988). Without some kind of cataloguing scheme to supplement road surveys, this method is likely to produce double counts, the probability of which increases with survey duration. Aerial surveys of Nazinga have so far failed to provide reliable estimates. Estimates were either too large (610 animals, Jachmann, 1988) or confidence intervals were too broad (Hebier, pers. comm.). Scat counts were subject to serious errors (Eberhardt & Van Eten, 1956) and require extensive sampling to be reliable (Neff, 1968). We believe that some sort of total count with provisions to prevent double counting is best for Nazinga even though such an approach will be time consuming. This method can be combined with sex and age estimation techniques to provide the most useful data.

Criteria used to classify the Nazinga elephants into age groups were based on data from East Africa. West African elephants may not follow the same growth patterns. There is a need for quantification of the relationship between shoulder height and age in West African elephants. Regardless of any errors in age groupings, the Nazinga elephant population is composed primarily of young animals and may, therefore, be expected to increase rapidly. This potential for increase will be enhanced due to the imbalanced sex ratio that favours females. This presumption is supported by comparing the population structure in previous years (DamezFountaine, 1987) with that in 1990. Age structures in 1987 and 1990 are significantly different ($P < 0.001$) with the major differences being in the higher proportions of animals in the younger age classes in 1990. These changes may be caused either by a high birth rate combined with high calf survival, or an increase in immigration of females with calves into Nazinga, or both these factors combined.

The age structure of Nazinga elephants is similar to those of most other elephant populations across Africa in recent years. Ottichilo (1986) found that most elephants in Tsavo National Park, Kenya, were under 15 years of age, while Poole and Thomsen (1989) pointed out that most African elephant populations were young with a sex ratio skewed toward females. Poaching has been a major factor in changing age structure and skewing sex ratios. We believe that the Nazinga elephant population has been shaped by the same factors. Furthermore, the Nazinga elephants have probably sought refuge on the ranch in recent years because of poaching and other forms of harassment within and in the vicinity of the KTNP to the north.

Even though it generally appears that there is not yet an "elephant problem" in terms of vegetation impact on Nazinga, extensive tree/shrub damage is evident in some areas. Some plots in the plain-shrub savannas of the central and western portions of the ranch had up to 88% of woody stems with some form of damage. Furthermore, since impacts are greater on certain diameter classes and there is preference for some species over others, the age structure and species composition

of the woody vegetation is being changed on parts of the ranch. The heaviest damage recorded was in plots containing almost pure stands of *Acacia dugeonii* and *A. gourmaensis*. These plots contained very few stems in the lower diameter classes, suggesting that regeneration of these species was being impeded. Rood (1987) estimated that 8.3% of trees on the entire ranch was damaged by elephants. This would mean that damage has more than doubled in the six-year period since Rood's study. Fowler and Smith (1973) estimated the critical threshold for savanna elephants to be 0.5 animals! km^2, above which the habitat is likely to be altered. Jachmann (1988) suggested the same threshold density for Nazinga. The present elephant density on Nazinga is 0.3 animals/km^2 and is likely to increase in the near future. Extensive debarking, breaking off of fruit bearing branches, pushing over entire trees and altering age and species composition on woody vegetation will reduce the carrying capacity for elephants as well as having an influence on other wildlife species.

CONCLUSION

In conclusion, the Nazinga elephant population is young and has the potential for rapid increase, since it is more secure than populations in national parks. It is noteworthy that inhabitants of 11 villages adjacent to the ranch are for the most part tolerant of elephants, mainly because of other benefits derived from the ranch (Damiba & Ables, 1992). This tolerance will diminish if elephant incursions into fields and gardens increase much beyond the current level.

Tourism on the ranch has increased, and elephants are a major attraction. The tourism potential has hardly been tapped and offers a major opportunity for generating income, thus offering greater incentive to protect the elephant population. However, like most protected areas surrounded by human developments, wildlife creates conflict both within and outside its sanctuary. With elephants this problem is magnified by their capacity to alter their environment and to wreck havoc on crops and gardens.

Active management intervention is likely to become necessary for elephants on Nazinga. The hands-off policy practised in many parks and reserves around the world is often counter productive because most sanctuaries are just segments of ecosystems. Natutral population regulation of wildlife species cannot function well in smaller areas where dispersal is limited, and natural controls such as predators are absent. In the case of elephants on Nazinga, natural population controls are not likely to operate before the habitat has been drastically altered, incursions into surrounding farms have become intolerable and elephants have begun to die of starvation and disease. None of these options seems acceptable.

RECOMMENDATIONS

We recommend continual, yearly monitoring of the Nazinga elephant population to include estimates of population size, sex and age structure. Monitoring of the vegetation plots is essential to assess changes in impacts of elephants on woody vegetation. The role of fire combined with elephant impacts on woody vegetation and its regeneration should be studied more intensively, if the savanna vegetative complex is to be maintained. There is a need to document further the extent of elephant depredations on local village lands and possibly to offer assistance to villagers in terms of preventing damage and compensating damages incurred. Home range patterns and movements of ranch elephants are not well understood and need clarifying. Most importantly, the ranch management needs to be prepared for active interventions should the elephant population increase to the point where depredations on crops and serious changes in woody vegetation occur. Great care and sensitivity will be needed. "Elephants are not beetles" as Poole and Thomsen (1989) so eloquently stated and should not be controlled just to protect trees. Rather, the objective is to maintain a complex of species in balance with their environment and with each other on a long-term basis.

ACKNOWLEDGEMENTS

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