Monitoring methods and techniques for censusing black rhinoceros *Diceros bicornis bicornis* in Etosha National Park

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Water-hole census techniques as developed in Etosha for monitoring black rhinoceros are described in detail. The systematic recording of animals visiting water-holes at night yielded data on the population size and structure, and frequency of drinking of this species. Population size estimates derived from this method were compared with estimates derived from aerial census techniques. It was concluded that censusing at a water-hole accounted for 32 percent more animals than a total aerial count by helicopter, and 70 percent more animals than by using a fixed-wing aircraft.

Key words: Black rhinoceros, water-holes, observation procedures, aerial census, behaviour, identification.

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Introduction

The importance of the black rhinoceros *Diceros bicornis bicornis* (Linnaeus, 1758) population in the Etosha National Park has recently increased dramatically in view of the demise of this species elsewhere in Africa (Borner 1981; Borner & Severre 1986; Martin & Martin 1982; Penny 1987; Brooks 1989; Tatham & Taylor 1989). This population is reportedly the third largest in Africa at present. Rhinoceros horn is still a valuable commodity (Tatham & Taylor 1989; Sheeline 1987), and increased poaching may affect the Etosha population as numbers decline elsewhere.

In Etosha, the first aerial censuses were carried out in the late 1960s. These were done mainly by conducting sample counts in game concentration areas. Since the work done by Joubert in the late 1960s (Joubert 1969, 1971) rhinoceros were only monitored at water-holes on an *ad hoc* basis by area rangers, and after that in 1980 to 1983, by the late Dr. J.M. Hofmeyr (Hofmeyr 1984a, 1984b). New identification methods of individuals were tried as well, for instance the implantation of coloured reflectors in the horns. This method proved to be effective but only for a short period.

During periods when there was a full moon, systematic coverage of water-holes was done for 48 hours, and an estimation of the population density was obtained. Because of staff shortages at the time, inexperienced personnel had to be used to count and identify individuals by sketching horn shapes and ear notches. These water-hole counts were thought to be misleading as individuals in the eastern Etosha, where fountains are situated a few kilometres apart, were thought to visit a water-hole more than once during the course of one night, and more than one water-hole in a 48-hour period. Making sketches of individuals proved to be inadequate for identification, and double counts were possible.

The absence of rhinoceros at water-holes where they previously abounded, indicated that the population might be much smaller than was initially thought. It was unknown whether this could be ascribed to a real decline or the inaccuracy of the population estimation methods.

In 1986 a monitoring program aimed at the black rhinoceros was instituted in the western section of the Etosha National Park which was extended in 1988 to the rest of the park. The way the programme was implemented and the results obtained hitherto are discussed below.

Methods

1. *Observations at water-holes*
Water-holes were covered systematically during the dry months which are usually from May to October when no open veld water occurs. Teams of observers are placed at water-holes for three consecutive nights, during full-moon periods, starting six days before the date of the full moon. Keen observation and alertness is achieved during the nocturnal observations by allowing the team to rest during daytime. It is essential to have at least four to five experienced observers who are familiar with photographic equipment and rhinoceros behaviour. Trackers are also necessary to assist the observers with the observations and measurement of spoor.

(i) Equipment
A good pair of night field glasses or a pair of 8 × 40 or 10 × 40 binoculars was essential to record behaviour, age groups and sexes of individuals. A 35 mm camera with a designated speed setting of 1/125 or 1/250 sec. for flash photography minimises blurred photographs. A 200 mm telephoto lens with an aperture of f4 was used. An electronic strobe flash with a lighting distance of at least 36 m and a battery pack to ensure quick charging of the flash is a prerequisite.

Black and white print film (400 ASA) was used, and processed locally. To gain optimum flash distance, the camera and flash are set on 1600 ASA. If a flash is not designed with an ASA setting of 1600, the maximum setting should be used which is normally 800 ASA. A 300 000 to 400 000 candle power spotlight with a red filter to ensure a low intensity light source is required to positively sex the rhinoceros and to identify lions or any other potentially dangerous animals in the immediate vicinity.

(ii) Positioning of vehicle
The strategic positioning of the vehicle is most important to ensure that rhinoceros come to drink without disturbance, but also allows the observer to be close enough to determine the sexes and relative ages of individuals. If vehicles are not used, a temporary hide can be constructed (preferably pachyderm and carnivore proof) or a natural high viewpoint can be used by the observers. The following should be considered when positioning the vehicle:

- Major paths followed by rhinoceros to and from the water-hole.

A pre-census survey is necessary to determine rhinoceros tracks leading to and from the water-hole. This information is required so that the vehicle is not parked in an area where the rhinoceros may detect the vehicle, consequently preventing them from coming to drink.

- Wind direction.

Positioning of the vehicle at the water-hole in relation to wind direction is the most important single factor affecting the drinking pattern of rhinoceros. Foreign scents detected by rhinoceros will either prevent them from drinking, or will produce an erratic drinking behaviour which will hamper identification. It is therefore essential for the vehicle to be parked downwind not only from the water-hole but also from the main approach routes, so that the rhinoceros do not detect the scent of the observers. Wind direction must be monitored at 30-60 min. intervals and, if necessary, the position of the vehicle should be changed at a time when it will cause the least disturbance.

• Moonlight and background.
Provided that the wind is favourable and the main rhinoceros paths are taken into consideration, the observers should be positioned to the SE, E or NE of the water-hole. The moon rises in the east and maximum advantage is therefore gained from direct moonlight on the rhinoceros, which facilitates identification. If this is not possible and the rhinoceros is silhouetted against the moonlight, identification is made easier if the animal is viewed against a light and uniform background such as grass or calcrete. Not only the position but also the correct elevation may give a favourable background.

• Distance from the water-hole.
The closer the observer is to the rhinoceros, the easier it is to identify and photograph the animal. Ideally, the vehicle should be parked 40 m from the water-hole, and large, visible calcrete rocks or other prominent markers should be positioned between the vehicle and the water (Fig. 1). These should be 20 m, 25 m and 30 m away from the water-hole or the main rhinoceros drinking area respectively. This type of marker should also be placed 20 m, 25 m and 30 m to either side of the front and rear of the vehicle, to accurately judge the distance when a rhinoceros approaches the vehicle. In Etosha, the vehicle should be removed to a safe distance when breeding herds of elephant *Loxodonta africana* (Blumenbach, 1797) come to drink. After the elephants have left, the vehicle must be driven back to the original position.

Fig. 1. Monitoring black rhinoceros in the Etosha National Park: positioning of the vehicle at a water-hole.

(iii) Photography
Recognising individuals at night is not easy but positive identification can be achieved by carrying out the following procedures.

Once the vehicle has been positioned, all equipment must be assembled, connected and placed within easy reach. Maintaining absolute silence at all times during the observation period, is very important. It is essential to take at least two photographs of the rhinoceros, one of the side, and one head on.

With the aid of white insulation tape, focusing distances of 15 m, 20 m, 25 m and 30 m on the camera lens must be marked. This simplifies and ensures the correct focusing distances at night from the individual markers. With the camera speed set on 1/125 or 1/250 sec. the aperture must be set on f4 for rhinoceros further than 15 m, and on f8-11 for rhinoceros approaching at a distance of 15 m and fewer. Ideally, the observer must be aware of the rhinoceros when it is at least 50 m to 100 m from the water-hole. This permits enough time for the observer to watch the rhinoceros with binoculars and to possibly age and sex the animal before it starts to drink.

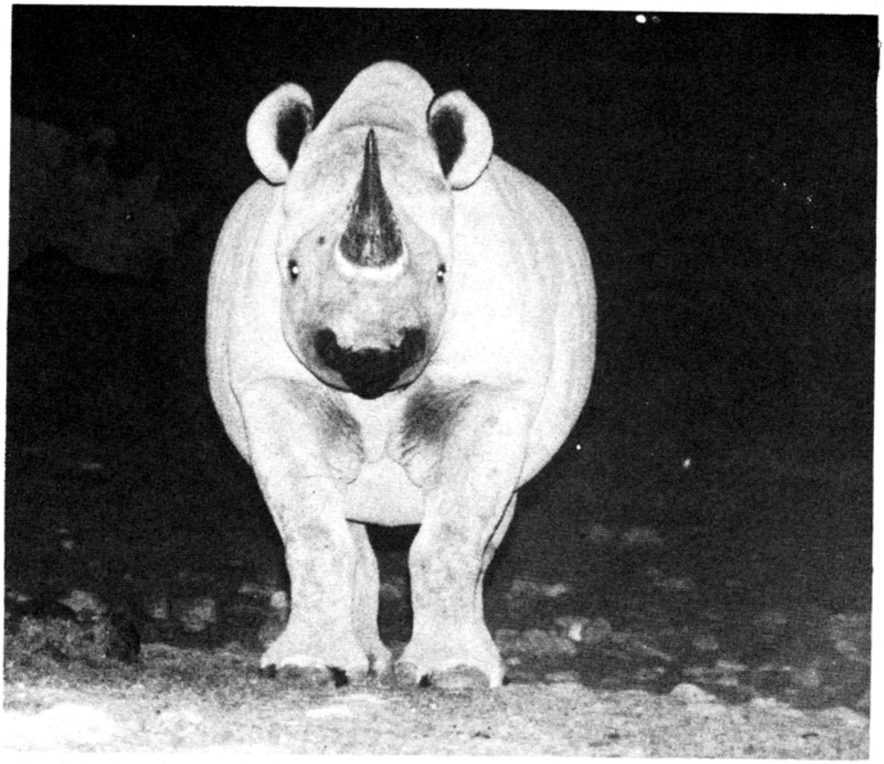

Fig. 2. A black rhinoceros interrupts its drinking to look up before the head-on photograph is taken.

Before the rhinoceros reaches the water the observer must approach the animal on foot at a slow pace, via each distance marker. If the rhinoceros senses the presence of humans, it is important to remain absolutely motionless until it begins to walk again. Once the animal has reached the edge of the water the observer should be at the 30 m mark, sitting in a haunched position. When the rhinoceros begins to drink, the 25 m mark is approached. The camera lens is set on the 25 m focusing distance. The observer patiently waits for the rhinoceros to interrupt its drinking and look up before the head on photograph is taken (Fig. 2). The flash beam often causes the animal to snort and turn sideways to investigate. At this instance the side photograph is taken. If the rhinoceros is not disturbed but rather continues drinking, the observer must wait until the rhinoceros has finished, which would be within approximately four to 12 minutes. Once the rhinoceros turns to leave, the side photograph will be possible (Fig 3).

The observer then returns to the vehicle and, with the aid of the spotlight, positively sexes the rhinoceros and identifies any signs of injury or other distinct markings. The majority of rhinoceros immediately react to a spotlight, and it should be used only as a very last resort for identification. The use of a spotlight is not recommended during the drinking period and should only be used after the rhinoceros has finished drinking. The assistant must be alert at all times during the photographic procedures. Positioned on the back of the vehicle, this person must keep a constant surveillance of the surrounding area for other rhinoceros and particularly lion *Panthera leo* (Linnaeus, 1758) and elephants that may present problems. If any of these animals are spotted, the observer must be warned verbally. If there is a likelihood of trouble, either when the rhinoceros that is being photographed charges, or lions or elephants are in the close proximity of the water-hole, the spotlight without the red filter must be used to dazzle them and frighten them off.

Fig. 3. Once the black rhinoceros turns to leave the water-hole, the side photograph is taken.

(iv) Data recorded
Essential data to be recorded with each observation of rhinoceros is set out in a prepared observation form.

• Size of the rhinoceros.
This is relative and it requires experience to assess the actual size of an adult individual. The actual size of juveniles and calves can be fairly accurately assessed by comparing it's size with that of the cow. The shoulder height of the calf should be measured against that of the cow and three age groups are expressed as a numerical fraction. Rhinoceros are only divided into four age classes e.g.: ¼ adult size new born calf (not yet weaned); ½ adult size calf (weaned); ¾ adult size sub-adult; adult (Figs. 4-6).

Fig. 4. One-quarter adult size newborn black rhinoceros calf, not yet weaned.

Fig. 5. One-half adult size black rhinoceros calf, weaned.

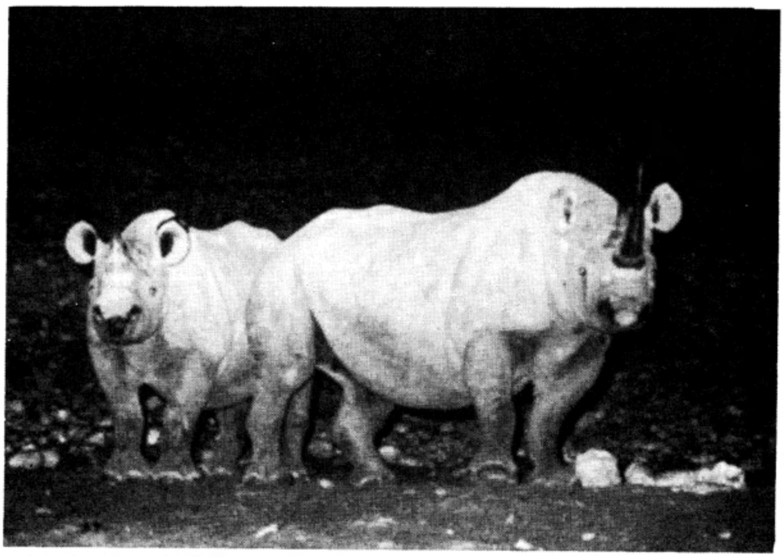

Fig. 6. Three-quarters adult size black rhinoceros, subadult.

• Sex.
The only unambiguous way to determine the sex of individuals is to look at the external genitalia. Where the genitals are not visible, adult bulls may be recognised by the front horn which is thicker at the base, its more massive neck and higher withers (Fig. 7). Cows have relatively slender front horns, usually a more distended belly and are finer in bone structure (Fig. 8). An adult rhinoceros with a juvenile or calf at foot is usually a cow, but should not be confused with a bull accompanied by a subadult cow.

• Group size and structure.
Group size and structure may also serve as useful aids to identify rhinoceros of similar appearance. For instance, otherwise indistinguishable cows are easily identified by the relative sizes of accompanying calves. The age structure, rate of birth and recruitment can also possibly indicate a change over time in response to habitat change or disturbance.

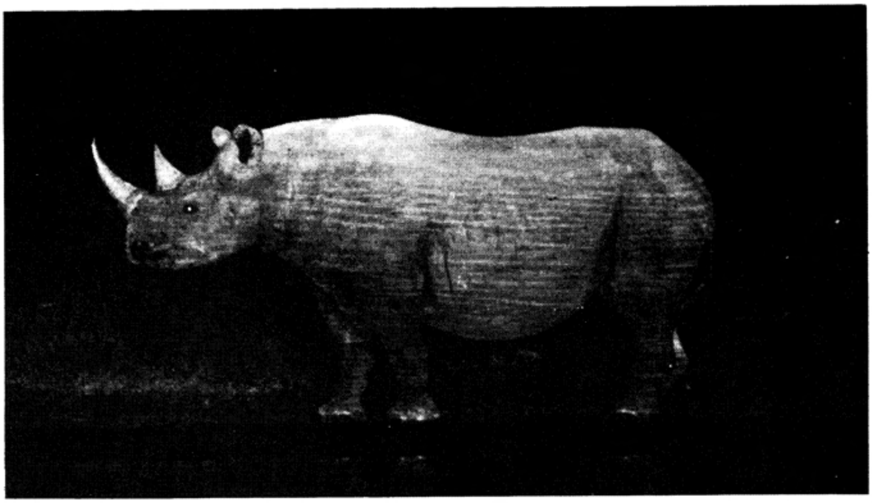

Fig. 7. A black rhinoceros cow, showing the more slender anterior horn, a more distended belly and a finer skeletal structure.

Fig. 8. A black rhinoceros bull, showing a thicker anterior horn base, a more massive neck, higher withers and a heavier skeletal structure.

• Direction of approach and departure.
Similar looking rhinoceros may be distinguished if they have different home ranges, which may be ascertained by their routes of approach and departure. This is particularly the case if two rhinoceros approach from opposite directions and depart on the same route. This requires careful observation, as a rhinoceros may for instance approach from the west, bypass the water-hole and then come in to drink at the eastern side. Constant surveillance of the surrounding area is therefore necessary. Sound may also be useful to determine the direction of approach, as rhinoceros are easily heard when they walk over rocky terrain. Giraffe *Giraffa camelopardalis* (Linnaeus, 1758) are similarly noisy but are usually easily located, whereas elephants, apart from being more silent, are massive and produce different sounds. The exact route of approach of each individual rhinoceros must be accurately plotted in order to record spoor measurements the following morning.

• Time of arrival and departure.
The time when the rhinoceros is first seen approaching the water-hole and once it departs is recorded. This indicates the time spent by individuals and groups at a water-hole, and is a measure of intraspecific contact.

• Spoor measurements.
Measurements must be obtained at the water-hole early the following morning before that of other species obscures such spoor. The width measurement of the left and right hind feet are recorded in order to identify and monitor the movements of individuals in a particular area while conducting routine vehicle, horse and foot patrols.

2. *Aerial census technique*
A complete aerial census of the Etosha National Park is done biennially, during August and September. The park is divided into high and low game density strata, based on routine monthly ground surveys carried out prior to the aerial census. This is done to demarcate respectively the areas to be surveyed by helicopter and fixed-wing aircraft. The altitude above ground is standardised at 330 ft for both aircraft, and air speed is set at 100 kilometre per hour. Transect width is standardised at 1 km for the helicopter and 2 km for the fixed-wing aircraft. Previous experience gained from aerial censuses conducted in the park has indicated that an ideal time of day to count black rhinoceros is between 08:00 to 11:00, and 16:00 to 18:00 which coincides with their activity patterns and offers ideal light conditions. Rhinoceros spotted are recorded by deviation from the transect line. The fixed-wing aircraft maintains a height of 330 ft, but reduces speed to 70-80 km/h, and the rhinoceros is sexed, aged and identified as accurately as possible. The helicopter descends to a height of approximately 65 ft and reduces speed to 20 km/h or hovers. The rhinoceros is then aged, sexed, and a photograph of the side view is taken. The distribution of all individuals is plotted on 1:100 000 maps.

Results and discussion

1. *Population density and distribution*

As a result of the water-hole census method conducted during 1988, a total of 189 rhinoceros have been counted in the western half of Etosha, which is 9 402 km^2 in extent. This indicates a density as low as 2 rhinoceros/100 square kilometres. During a period of three months, six days per month, a total of 162 hours, 164 different individuals of the 189 rhinoceros counted were photographed, aged and sexed. The distribution clearly indicates that 58 percent of the rhinoceros are concentrating in the rugged mountainous areas of Otjovasandu, 18 percent in the mopane shrub of the central area, and 24 percent in the *Acacia* belts on the sweetveld areas on lime bordering the Etosha pan and in the vicinity of Okaukuejo and the southern boundary, at Ombika (Fig. 9).

Fig. 9. Population density and distribution of black rhinoceros in the central and western areas of the Etosha National Park.

2. *Comparison between the water-hole based method and aerial census*

Analysis of the results of the different census techniques in Etosha indicates that the water-hole based method for censusing black rhinoceros is more accurate than a total aerial count using a helicopter flying 500 m to 1 km transects. Thirty two percent more rhinoceros were counted at water-holes than from the air. Using a fixed-wing aircraft for censusing rhinoceros, accounts for 70 percent fewer animals than the water-hole based method (Fig. 10). The inaccuracy of the aerial census can often be ascribed to the counting of rhinoceros between 11:00 and 16:00, a period when these animals are inactive, and because the ground is covered at a relatively high speed, especially over dense bush or mountainous terrain where rhinoceros are difficult to spot.

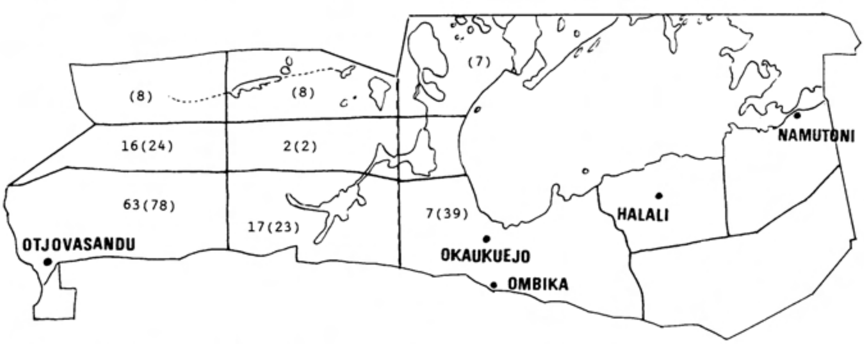

Fig. 10. Black rhinoceros aerial survey distribution and densities in Etosha National Park, compared to water-hole based surveys.

3. *Interaction and behaviour at water-hole*

From the present study it has been established that the majority of rhinoceros drink water every 72 hours. The major rhinoceros drinking time is from dusk to 03:00, with a peak drinking period between 21:00 and 24:00. Old bulls are loath to visit water-holes every night, and do so not necessarily to drink, but rather for social reasons, for example, visiting dung middens and for social contact. It is quite common in Etosha to find two to 12 rhinoceros congregating at one water-hole at the same time, showing no real signs of aggression towards one another. The majority of adult cows with unweaned calves frequently visit water-holes every 48 hours to drink. Thirsty rhinoceros often spend six to 12 minutes drinking, and cows with calves generally leave the water-hole directly after drinking, whereas bulls often remain in the immediate vicinity of the water-hole for up to eight hours.

4. *Movements between water-holes*

Because the distances between water-holes in Etosha vary between one and 30 km, (natural springs range between one and five kilometres apart, artificial water-holes 10 km-30 km apart), it was expected that rhinoceros would visit more than one water-hole per night, or within the 72 hour census period. During the recent three month census period in the western Etosha, observers identifying individuals with the aid of the identity kits have found that rhinoceros do not move between water-holes during the course of one night or the 72 hour census period. However, movements that are evident, occurred over the course of a month period.

Three rhinoceros, an adult bull and one adult cow with a half-sized calf, were found to utilise more than one water point over a period of one month. The distance between the two water points walked by these rhinoceros is 30 kilometres.

5. *Spoor measurements*

Initially spoor measurements were taken of the width and length of both hind feet. Because of certain uneven terrain such as grass-covered plains, rocky and sandy areas, it was occasionally found that the back section of the foot infrequently made proper contact with the ground surface, resulting in an inaccurate measurement of the length of the hind foot. The most accurate measurement is the greatest width, measured between the outside indentations of the toes. At present this is the only measurement recorded.

6. *Future planning*

(i) A technique has been developed to measure the length and base width

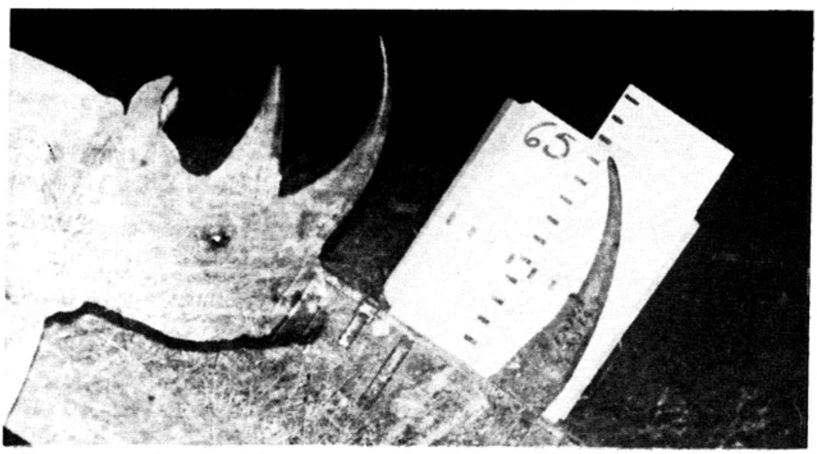

Fig. 11. A technique developed in the Etosha National Park to measure the length and width of a black rhinoceros horn without immobilising the animal. Photographed from a distance of 15 metres.

of rhinoceros horns without immobilising the animals. A measuring scale is drawn and photographs are taken of the scale from the various distances of 15 m, 20 m, 25 m and 30 metres (Fig. 11). The same camera and lens is used and the photographs of rhinoceros are developed to the same size as the scale in order to obtain precise measurements. By calculations, and the measuring and weighing of available horns in Namibia it is hoped that an estimated weight of a horn can be obtained. This scale also enables one to measure shoulder height.

(ii) It is also planned to implant radio transmitters into the back section of the horns to monitor movements.

Conclusions

In view of the aridity of the area and the presence of well spaced individual water points in Etosha, the water-hole based method has proved to be the most accurate and reliable way to census the black rhinoceros population. However, several points have emerged which contribute to the success of the techniques. It is crucial that each area ranger must have a copy of the latest identity file of rhinoceros in his area to monitor movements and identify individuals. As rhinoceros tend to become more aware of disturbances at water-holes during the nights when the moon is bright, it is necessary to start the census six days before the date of full moon. At no stage during this census period have rhinoceros shown any signs of aggressive behaviour towards the observers. They are generally not disturbed by the presence of a vehicle, and are frequently shy or inquisitive. However, this behaviour pattern depends entirely on the wind direction.

In the western parts of Etosha rhinoceros have been found to visit more than one water-hole over a period of a month, and not during the course of one night or the 72-hour census period. The major drinking times of rhinoceros are between dusk and 03:00, reaching a peak between 21:00 and midnight.

When conducting aerial surveys, flying at a height of 330 ft, rhinoceros are often disturbed by the noise of the aircraft. They frequently run away from the noise and have been known to cross transect lines. If the animal is not identified, double counts are possible.

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