



While rhinos species are similar in many ways, they vary widely in social structure, ranging from the relatively solitary greater one-horned rhino (Laurie, 1982) to the moderately social black rhino (Kingdon, 1979) and the more gregarious white rhino (Ozren-Smith, 1975). Therefore, recommended management protocols differ across species in such areas as captive group composition and reproductive parameters. Following is a set of recommendations for basic husbandry procedures, including social groupings, reproduction, identification methods, keeper issues, day-to-day management, training methods and introduction protocols for managing conflict among individuals.

GROUP COMPOSITION IN CAPTIVITY

Reproductive success in captive rhinos across North America has been inconsistent at best (Table 3). Currently, the SSPs for all rhino species face numerous challenges. In the case of the greater one-horned rhino program, which has been relatively successful, much of the reproduction to date has involved a limited number of breeders. Additionally, the captive black rhino population suffers from high mortality rates; thus, while reproductive success is relatively good, the population is not growing. The white rhino population is in a demographic crisis and, as illustrated in Table 3, first-generation captive-born individuals are currently not reproducing in significant numbers. It has been proposed that substantial improvement of captive husbandry is needed if these programs are to contribute significantly to rhino conservation (Foose & Reece, 1994).

Much is yet to be learned regarding the social structure of rhinos in their natural surroundings; thus, the establishment of comparable social groupings in captivity has been difficult. What is evident to date, however, is that greater one-horned, black and white rhinos differ in social organization. The greater one-horned rhino is generally considered the most solitary of the three species. Apart from cow-calf pairs, groups are rare (Laurie et al., 1983). Occasionally, temporary associations of a few subadult or adult males may be observed at wallows or in grazing areas. As with all rhino species, olfactory communication is important, and animals of all ages and both sexes may defecate at a communal dung heap.

The black rhino may not be as solitary as is commonly portrayed. Black rhinos share overlapping ranges, often associating briefly at water holes or salt licks. Although females are rarely observed alone, adult males are usually solitary and possibly territorial (Estes, 1991). Cows with calves tend to stay alone; however, the twosome sometimes allow an unrelated immature male or female to join them until that individual reaches maturity (Goddard, 1967). Furthermore, bulls may tolerate other males provided they remain submissive (Hitchins, 1968).

The white rhino is considered the most gregarious of the rhino species. This species is considered semi-social, though adult males appear to be somewhat territorial and basically soli-

TABLE 3. Captive rhino reproduction in North America

	White rhino ^{a,b} n=88,137		Black ^{a,c,d} n=47,524		Greater one-horned ^{a,c} n=26,241	
	Males	Females	Males	Females	Males	Females
Percentage of total population reproductively successful	29.5	32.1	61.7	59.6	34.6	58.3
Percentage of wild-born population reproductively successful	39.1	34.5	58.6	64.3	33.3	41.7
Percentage of captive-born population reproductively successful	4.2	19.0	66.7	54.2	30	60

^a Data from historical population studbook analyses (reproductively mature animals only in a potential breeding situation)

^b Individuals assumed reproductively mature at age 7 (males) and age 6 (females), data current to 11/1/95

^c Individuals assumed reproductively mature at 4 years of age (both males and females)

^d It should be noted that while gross reproductive success is high within the North American captive black rhino population, mortality is also high; thus, the population as a whole remains in trouble.

tary. Multiple subordinate males have occasionally been observed in the same ranging area as "satellites" to a resident dominant male (Estes, 1991). Adult females occupy overlapping home ranges, typically associating in pairs consisting of a female and her most recent offspring. Furthermore, a calfless cow may tolerate one or more juveniles, or two calfless cows may associate together. Stable groups of as many as six rhinos may be formed in this way, while larger temporary aggregations of up to 12 animals have been observed.

These data on rhinoceros social organization, combined with preliminary analyses of parameters affecting reproductive success in captivity, may be used to generate recommendations regarding possible social groupings in captivity (Tables 4 and 5). It should be noted that numerous variables affect the probability of success with any captive social group, including the animals' dispositions and available holding space. Furthermore, depending on space and animal and staffing availability, institutions may be categorized as breeding or exhibit-only. Facilities that wish to hold rhinos for exhibit purposes only are advised to maintain two animals (1.1 or 0.2). In the case of the white rhino, bachelor male groups have been maintained in very large enclosures (e.g., game parks or ranches). The desire to hold exhibit animals should be expressed to the appropriate species coordinator so that pre- or post-reproductive or single-sex animals may be assigned.

For institutions that have the space and staff available for rhino breeding, it is recommended that managers commit to two pairs if holding black or greater one-horned rhinos and one male and two or more females (and a back-up male) if holding white rhinos. In addition, breeding institutions must also have space for offspring to be held for up to 3 years after birth. Within a single exhibit or holding area, the recommended minimum numbers for breeding are 1.1 (black), 1.2 (white) and 1.1 (greater one-horned). In general, it is recommended that mature males not be held together because of the increased likelihood of serious aggression. Furthermore, breeding success may be enhanced by separating males from females as little as possible, except in the case of the greater one-horned rhinoceros; males and females of this species should be kept separately and introduced only for breeding purposes. (See Introductions, this chapter.)

Grouped or multiple-species exhibits are possible for greater one-horned, black and white rhinos if ample exhibit space is available. Examples of institutions that have successfully maintained mixed-species exhibits include Fossil Rim Wildlife Center, San Diego Wild Animal Park, Columbus Zoo, Lowry Park Zoo and Riverbanks Zoo. Species that have been successfully paired in an exhibit with rhinos include saurus cranes, herons, some antelope species (nilgai, blackbuck, gaur, Persian gazelle), mouflon, zebra and some deer species. In all cases, the dispositions of the individual animals, as well as adequate space and exhibit structure (i.e., visual barriers, refuge areas, etc.), are cited as important considerations prior to attempting a mixed-species exhibit.



White rhinos are the most gregarious of the rhino species, and captive reproductive success may be correlated to herd size. Except in the case of large enclosures, black rhinos should be housed as pairs, and male and female greater one-horned rhinos should be held separately except during breeding introductions. (Photo: Knoxville Zoological Gardens)

TABLE 4. Possibilities for rhino social groupings in captivity (same exhibit)

Rhino species	Multiple animals of same sex		Multiple animals of opposite sexes
	Adult males	Adult females	
White	rare (possible in very large exhibits only)	possible and recommended	possible and recommended for breeding (optimal: one male and two or more females)
Black	not recommended	possible (in very large enclosures only)	possible and recommended for breeding (optimal: 1:1 minimum)
Greater one-horned	not recommended	possible (in very large enclosures only)	pairings recommended only during peak estrus (with the exception of very large exhibits, which may hold a single male and female together consistently)

In all cases, success of various groupings will depend on the individual animals' dispositions as well as the exhibit or holding space available. Additionally, separation capabilities should be available within all rhino-holding institutions to separate animals of either sex if necessary.



1 (Photo: Fort Worth Zoological Park)



2 (Photo: St. Louis Zoological Park)



3 (Photo: Fort Worth Zoological Park)



4 (Photo: St. Louis Zoological Park)



5 (Photo: San Diego Zoological Society)

Aggression in rhinos ranges from ritualized to true aggression. Face-to-face staring (1) is often seen at the beginning stages of ritualized aggression and may be an opportunity for the participants to "size each other up." Ritualized aggression may subsequently proceed to fencing or sparring (2) and then charging with (3) or without (4) an open mouth threat. Aggression becomes more serious as one animal begins chasing the other (5), which may also include or lead to horn strikes and gores. At this point, aggression is more serious and may warrant intervention at the manager's discretion. Vocalizations such as snorts and bellows usually accompany aggressive encounters.

It is important to note that ritualized aggression among rhinos is commonplace. Aggression that involves chases, horn strikes and goading resulting in arterial blood flow is more serious and in the latter case requires intervention.

INTRODUCTIONS



Changing captive social groupings of rhinos through the introduction of additional individuals to an established individual, pair or group is a process requiring much care. As discussed, rhino species vary widely in social structure, and rhinos periodically vary their grouping patterns in the wild according to such factors as reproduction and the rearing of young. Social groupings in captivity, therefore, should also vary according to species, as well as to the circumstances within each institution. Rhinos may be very protective of their individual boundaries, but proper introduction procedures can minimize injury from conflict and aggression. The following section outlines general considerations for any rhino introduction and provides systematic descriptions of aggression, procedural recommendations, and descriptions of potential species-specific introduction types.

General variables that must be considered in any introduction include individual animal personalities, staff experience and confidence level, and enclosure type (i.e., indoor/outdoor, public/off-exhibit, relatively small/large). Barrier types and temperature should also be considered. Introductions often result in aggression, and it should be noted that captive rhinos of both sexes have been the aggressors (Smith, pers.comm.). Territorial defense is often limited to ritualized confrontations, in which two rhinos advance toward each other but stop nose-to-nose and engage in a staring contest to gauge each other's size and strength. Also as a part of this ritual, the two individuals may touch horns, back apart and wipe their horns on the ground (Nowak, 1991).

More intensive conflicts involve head-on charges and the infliction of injuries by horning or ramming. In general, behaviors that have been noted during rhino introductions are listed in Table 6.

It is important to note that what is often perceived as serious or dangerous aggression between rhinos is, in fact, normal behavior requiring no intervention of any kind. Along with increased size and thick skin comes decreased vulnerability compared with many other animals. Table 7 lists a descriptive hierarchy of aggression levels in rhinos.

In some cases, aggression may proceed to a point at which management should intervene to prevent serious injury. Captive managers should allow some aggression during an introduction but be prepared to intervene in the event that aggression threatens the lives of one or more rhinos. Guidelines for intervening may vary across institutions, but in general, careful consideration should be given to intervening in an introduction before aggression reaches Level 5 (acute subcutaneous wounds in which arterial blood loss is involved or likely to occur). Stopping an introduction at a level prior to this will not lessen aggression during a subsequent introduction attempt. Animals that are allowed to "settle their differences" will establish some territorial boundaries and will usually not engage in serious aggression again, with the exception of a male attempting to approach an estrus female. In sum, moderate aggression is commonplace in any rhino introduction; sparring and fighting will occur and

TABLE 5. Recommended numbers for institutional holding

Rhino species	Recommended minimum groupings for breeding ^a	Preferred optimal holding for a breeding institution	Exhibit only (per institution)
Black	1.1	2.2 (2 pairs)	1.1 or 0.2
White	1.2	2.4 (1 herd/ 1 back-up male)	1.1 or 0.2 ^b
Greater one-horned	1.1 ^c	2.2 (2 pairs)	1.1 ^c or 0.2

^a See Design. Breeding institutions must have space for offspring to be held for up to 3 years following birth.

^b Multi-male bachelor groups have been maintained in very large enclosures.

^c In the case of greater one-horned rhinos, males and females should be introduced only during the female's estrus period. Institutions with very large enclosures (e.g., San Diego Wild Animal Park) may be able to hold opposite-sex animals together consistently.

TABLE 6. Behaviors noted during rhino introductions (partial listing, all species)

Non-aggressive behaviors	Ritualized confrontations	Potential stress-related behaviors	Aggressive behaviors
Follow	Head sweep	Pacing	Charge/chase
Touch/rub/lick	Face-to face stare	Running (excessive)	Open-mouth threat
A/G investigation		Vocalization (excessive)	Sparring
		Diarrhea	Goring

See Appendix II Management Ethogram for behavior descriptions.



result in minor injuries (cutaneous wounds). However, in most cases, aggression levels prior to Level 5 may be allowed to continue using the discretion of management.

The introduction process requires much planning and cooperation among captive managers. Table 8 outlines recommended steps involved in any introduction. Familiarization through visual, olfactory and tactile contact should be permitted if at all possible prior to a full-scale introduction. If the facility permits, this may be accomplished by first placing individuals in the same barn or in nearby outdoor lots. As the animals acclimate, managers may move them to adjacent barred stalls or fenced outdoor yards. These barriers prevent confrontations leading to serious injury but allow acclimation and familiarization prior to introduction.

The actual introduction should be attempted in the largest available enclosure. Enclosures should be large enough to allow ample space for chasing, mock-fighting, aggression and defense. Prior to an attempted introduction, water pools in an outdoor enclosure should be filled with substrate to prevent injury in the event of serious aggression. The enclosure should contain visual barriers such as brush or earth piles ("run-arounds"), which give rhinos places to hide without becoming cornered or trapped and may even lessen overt aggression if a rhino is able to escape the sightline of another. An enclosure should not contain dead ends in which an individual may become trapped by an aggressor. Enclosures should allow for the use of high-pressure fire hoses, CO₂ fire extinguishers and/or vehicles to aid in separating individuals.

Animal personality and disposition should always be considered in introductions. A subordinate animal should be introduced to a more dominant animal in an enclosure familiar to the subordinate. In the case of multiple-animal introductions (such as white rhino/introduction of a new female to an established male-female group, discussed below), the most subordinate animal should be introduced to the next most subordinate, and so on. Additionally, greater aggression may be noted in some individuals in the presence of an estrus female; therefore, any introduction attempt at this time should be especially well-monitored or possibly avoided if the attempt involves a male. (Greater one-horned rhinos should be introduced only during the female's estrus period; see below.)

Appropriate personnel for first-time introductions include the primary animal manager, a vet with immobilization equipment, and the curator and keepers most familiar with rhinos. In addition, others may be needed at critical vantage points around the enclosure's perimeter so that the animals may be observed at all times in case separation becomes necessary. It should be noted that if a barn is opened and used to separate individuals, only one individual should be allowed inside the barn and must not be trapped inside by an aggressor.

Following are specific introduction protocols delineated by species and introduction type. As indicated previously, because of the differences in social organization and group composition, different introduction types are possible and/or recommended according to species. It should be noted again that the time required for each introduction can vary depending on the individual animal(s) and staff management expertise.

TABLE 7. Levels of aggression in rhinos

Level of Aggression	Definition
1	Rhinos are charging each other but making no physical contact.
2	Rhinos are charging each other with physical contact resulting in some cuts and scrapes to the facial area(s) of one or both of the animals.
3	Rhinos are charging each other with physical contact resulting in cuts and scrapes to the facial areas and bodies of both animals.
4	Charging and/or pursuit has proceeded to the point that one or both rhinos have been knocked down at least once. Scrapes and cuts are now deeper and more numerous.
5	Aggression and pursuit have proceeded to the point that one or both rhinos have subcutaneous wounds or arterial blood flow.

Manager's discretion must be used in evaluating levels of aggression. Duration of aggressive bouts will vary.

It should be noted that one animal may break away from the confrontation and attempt to escape. The aggressor will often pursue and begin horning the underbelly of the escapee as the two gallop around the enclosure. Often a rear leg is hooked and held aloft while the pursuit continues. If the escapee does not stop and resume a defensive posture, the animals will continue until heat or exhaustion becomes a critical factor. Aggression at this point is more serious.

WHITE RHINO

As recommended, white rhinos are preferably maintained in herd-like (male and multiple female) groups in captivity; therefore, many types of introductions may need to be attempted. Following are recommended protocols for potential white rhino introduction types.

INTRODUCTION OF A NEW MALE TO A FEMALE (OR VICE VERSA) TO FORM A PAIR

The introduction should occur in the largest lot available, following the general introduction protocols stated previously. If a single large lot is not available, adjoining lots should be opened to form a large area for the introduction. If the latter strategy is used, care should be taken to modify any resulting dead ends in the exhibit where a rhino may become trapped during an aggressive interaction.

INTRODUCTION OF A NEW FEMALE TO AN ESTABLISHED MALE-FEMALE GROUP

If given the opportunity, female white rhinos will establish social bonds with one another. A new female should be introduced to a group one female at a time. As each subgroup of females is stable, additional females may be introduced one at a time. Finally, the stable female group (including the new female) should be introduced to the male. The time required for stable integration ranges from 1 to 10 weeks.

INTRODUCTION OF A NEW MALE TO AN ESTABLISHED FEMALE GROUP

A group of females to which a male is to be introduced should be a compatible group prior to the introduction of the male. Unlike the introduction of a female to a group of females, the male should be introduced to the group as a whole rather than to one individual at a time. The reported time required for stable integration has been estimated at 5 weeks.

REINTRODUCTION OF A FEMALE WITH NEW CALF TO A MALE-FEMALE GROUP

Following parturition, the reintroduction of a female and her new calf to a group should be treated as a first-time introduction of a female to an established group. The two should be allowed to acclimate to one female at a time, successively forming larger and larger female-female-calf subgroups. The final step is introducing the entire female group (including the new female and her calf) to the male. Institutions have placed infants and their mothers back with the herd or single male as early as 2 weeks after birth.

BLACK RHINO

The social nature of the black rhinoceros is intermediate between that of the white and greater one-horned species. In general, a 1:1 pair is the recommended group size. However, when adequate space is available (See the Design chapter.), single-male-multiple-female groups are possible. Additionally, in comparison with the other rhino species, black rhinos have a much longer average birth interval. In an effort to decrease this interval and re-breed females earlier, a female black rhino should be temporarily reintroduced to the male for breeding following her first post-parturition heat. (See Calf Development for separation periods.) Following are recommended protocols for potential black rhinoceros introduction types.

TABLE 8. Steps in the introduction process

Step	Description
1	Animals in the same barn or multiple outdoor lots should have olfactory and auditory exposure to each other. If the animals are not housed near each other (i.e., enclosures on opposite sides of the zoo, etc.) they should be moved to the same exhibit area.
2	Animals should be given visual contact with each other in addition to the above sensory modalities. (Animals may be shifted within a barn or in adjacent outdoor lots.) If at any point during this process the animals display symptoms associated with stress (e.g., pacing, diarrhea, excessive vocalizations) for more than 2 to 3 hr, the introduction should return to the previous step.
3	If animals are not already positioned adjacent to each other, they should be moved closer together (e.g., to adjacent stalls or adjacent outdoor enclosures).
4	The actual introduction (full tactile exposure) should take place in the largest enclosure available and follow guidelines stated in this chapter. Preferably, the enclosure should be familiar to the least dominant animal and include ample "run-arounds."
5	Within institutions in which rhinos can be left together 24 hr a day, they should be separated during the first several nights or until they show only minor aggression.

Time spent at each step will vary and should be left to the discretion of management. Variables that must be considered in any introduction include the following: individual animal personality, staff experience and confidence level, enclosure type (i.e., indoor/outdoor, public/off-exhibit, relatively small/large), barrier type and temperature.

If an acutely stressful situation results at any stage (animals exhibiting stress-associated behaviors for more than 2 to 3 hr), the introduction should return to the previous step. Note, however, that careful consideration should be given before intervening in an introduction before Level 5 aggression is reached.

INTRODUCTION OF A NEW MALE TO A FEMALE (OR VICE VERSA) TO FORM A PAIR

The introduction should occur in the largest lot available, following the general introduction protocols stated previously. If a single large lot is not available, adjoining lots should be opened to form a large area for the introduction. If the latter strategy is used, care should be taken to modify any resulting dead ends in the exhibit where a rhino may become trapped during an aggressive interaction.

INTRODUCTION OF A NEW FEMALE TO AN ESTABLISHED MALE-FEMALE GROUP (IF ADEQUATE SPACE IS AVAILABLE)

Unlike white rhinos, female black rhinos generally do not tend to form strong pair bonds. Therefore, a new female should be introduced to an established male-female group one individual at a time, but it is not necessary that she be introduced to all females before being introduced to the male. For breeding introductions, a calf should be trained to be temporarily separated from its dam so that she can be introduced to a male. (See Calf Development, this chapter.)

INTRODUCTION OF A NEW MALE TO AN ESTABLISHED FEMALE GROUP (IF ADEQUATE SPACE IS AVAILABLE)

As previously discussed, female black rhinos do not generally tend to form strong pair bonds. However, if a multiple-female group is established and managers perceive that the females have formed strong bonds, the new male should be introduced to the females as a group rather than to one female at a time. If the females are not as compatible as managers would like but an introduction is necessary (SSP recommendation, breeding, etc.), the new male should be introduced to each female individually. Following all successful male-female introductions, the male should be introduced to all the females at the same time.

REINTRODUCTION OF A POST-PARTUM FEMALE (WITHOUT CALF) TO A MALE

The reintroduction of a post-partum female to a male is usually recommended for the dam to be re-bred. Therefore, this type of introduction is usually temporary, and following breeding, the female should be placed back with the newborn calf. In order to attempt this introduction, the calf must be trained to be separated from the female. (See Calf Development, this chapter.) The introduction of the post-partum female to a male should be attempted following the first post-partum heat.

GREATER ONE-HORNED RHINO

Because of the relatively more aggressive, territorial nature of greater one-horned rhinos, introductions should be attempted only for breeding purposes (one male to one female). With the exception of very large facilities, individual rhinos should be held separately in all other situations.

INTRODUCTION OF A FEMALE TO A MALE FOR BREEDING PURPOSES

Introductions should occur only for breeding purposes and when the female is in estrus. (See Table 9 for behaviors believed to be associated with estrus.) The introduction should take place in the largest area available. If two adjoining yards are opened to create a larger intro-

TABLE 9. General reproductive behaviors observed during estrus and courtship (partial listing, all species)

Female	Male
Vocalizations	Vocalizations
Urine spray/squirt	Frequent urination; urine spray/squirt
Urogenital changes (e.g., vulva swelling)	Erection
Vulva wink	Genital inspection of female (A/G investigation)
Stands for male	Flehmen response
Aggression toward male (Charge/chase; spar)	Charge/chase female
Inappetance	Chin rest
Nuzzles male's belly and/or genitals (e.g., touch/ rub/tick)	Mounts female
	Follows female
Vaginal discharge	Maintains proximity to female
Maintains proximity to male	

Estrus behaviors in the absence of a male are often difficult to distinguish. In general, increased activity, agitation, vocalizations, spray-squirting urine and a vaginal discharge have been cited. As a female approaches peak estrus, these behaviors usually intensify in frequency.

Some female rhinos have been reported to successfully breed without exhibiting any overt behavioral signs of estrus.

duction area, the female should be placed in the yard she is most familiar with first and allowed to acclimate. After she is acclimated to the yard, the male should be introduced to her. As stated in the general introduction protocols, if the facility allows, preliminary visual and tactile contact may increase the likelihood of mating success. If intervention is required because of aggression between the rhinos, the introduction should cease and be attempted at a later date. If possible, the female should be kept from entering a barn if the individuals cannot be separated in the outdoor enclosure. In all likelihood, the male will follow her into the barn, and the chances of serious injury will increase. Because the introduction should occur during estrus, an introduction may be required at any time of the day or night (Table 10; estrus duration is 24 hr, and peak conception occurs between hours 8 and 12). The rhinos should be monitored and separated following breeding.

REINTRODUCTION OF A POST-PARTUM FEMALE (WITHOUT CALF) TO A MALE

An introduction of a post-partum female to a male for breeding should occur only during the female's estrus period. It may be advisable to wait until after the first post-partum estrus cycle. The calf should not be introduced with the female when she is introduced to the male; therefore, the calf should be trained to be separated from the female to allow for the introduction of a male. (See Calf Development, this chapter.)

REPRODUCTION



Table 10 lists data currently available from captivity regarding the reproductive biology of greater one-horned, white and black rhinos. It should be noted that much is yet to be learned. In general, reproduction in the rhinoceros is characterized by a host of specialized behaviors. Though some variation may exist among the three species in terms of reproductive behaviors, data are insufficient to strictly delineate them. Particularly, estrus-specific behaviors in females are not clearly defined (Table 9). Close attention to male-female courtship interactions may provide better indicators of the onset of estrus.

Rhino courtship behavior can be very aggressive, but that is not the rule. The following is a general account adapted from Estes (1991) and husbandry workshop discussions. A bull that detects a female approaching estrus (by sampling her urine with a pronounced grimace or flehmen response) may become her consort. The courtship process may be a protracted one, as the bull remains in close proximity to the female and follows her until she comes into full estrus and will accept contact. Prior to full estrus, a female will often drive back a bull through mock charges and defensive threats. In the case of the white rhino, the bull in the herd may attempt to split any female groupings apart during courtship and breeding attempts. In some cases, these bonds may interfere with breeding success if the females are able to continually drive off an approaching male. In all rhinos, bull courtship behaviors may include retreats, circles and/or dominance and threat displays (including rushing, jabbing, puffing, and nudging with the horn or head). Aggression at this point (if the interaction becomes aggressive) may proceed to Level-4 or -5 aggression as described in Table 7. It should be noted that both sexes may participate equally in the aggression. Again, managers should use their discretion as to when to separate the rhinos if aggression proceeds to a point at which it endangers the animals.

TABLE 10. North American captive rhino reproductive statistics

	Black ^a	White ^b	Greater one-horned ^c
Gestation ^d	492-552 days (n=4)	485-518 days (n=8 births; 3 inst.)	470-516 days (n=18)
Breeding season	Peaks in May, June and Sept.	Peaks in July, Sept. and Dec./Jan.	Peaks in Jan., Mar./Apr. and Sept./Oct.
Birth peaks	Oct.-Jan., Mar., Aug.	April/May, June/July, Nov.-Jan.	Dec./Jan., May, July/Aug.
Birth intervals	mean=36.1 mo. (n=72)	mean=30 mo. (n=109)	mean=26.2 mo. (n=14)
Estrus cycle length ^d	21-28 days; peak estrus lasts 24-48 hr	27-44 days; male interested 24-48 hr, but female receptive only for 12-18 hr	34-42 days; peak estrus lasts 24 hr with optimal conception hours 8-12
Age at birth of first calf ^e	Female: mean=7.6 yrs., range=3.5-20.5 yrs. Male: mean=7.6 yrs., range=5.3-9.7 yrs.	Female: mean=10.7 yrs., range=5.6-23.5 yrs. Male: mean=15.5 yrs., range=7.2-25.2 yrs.	Female: mean=10 yrs., range=4.6-16.4 yrs. Male: mean=16.8 yrs., range=9.2-30.9 yrs.
Age at birth of last calf ^e	Female: mean=16.1 yrs., range=3.5-27.7 yrs. Male: mean=10.8 yrs., range=6.9-25.2 yrs.	Female: mean=17.1 yrs., range=7.2-31.1 yrs. Male: mean=19.7 yrs., range=7.2-29.2 yrs.	Female: mean=13.4 yrs., range=9.8-22.2 yrs. Male: mean=10.1 yrs., range=12.8-36.6 yrs.

^a Data compiled from historical studbook analyses, B. Read, Walt Disney World Co. Data for captive born individuals only.

^b Data compiled from historical studbook analyses, T. Wagener, Fort Worth. Data for both captive- and wild born individuals (n=5 for captive-born reproductively successful individuals.)

^c Data compiled from historical studbook analyses, Lindburg and Millard, San Diego Wild Animal Park. Data for captive-born individuals only.

^d Data compiled during husbandry workshop discussions; systematic data are needed.

^e Data compiled by calculating the age of the sire/dam at the birth of the first/last calf. For husbandry purposes, an approximate age at first/last successful breeding may be calculated by subtracting an estimated gestation period from the reported age of the sire or dam.

As the female comes into full estrus, she will begin to accept the bull placing his chin on her rump. (See Appendix II Management Ethogram, "chin rest.") The bull may proceed from this stage to perform repeated preliminary mounts until the female eventually stands with her tail curled for full penetration. It has been noted that the black rhino may mount with or without an erection, whereas the other two species (white and greater one-horned rhinos) generally have been reported to mount before an erection occurs. In the case of the white rhino, successful copulations have been observed in the presence of the female's calf or juvenile companion as well as other adult females. Table 9 outlines general reproductive behaviors observed in rhinos during estrus and courtship.

As previously described, greater one-horned rhinos should be introduced only when the female is in estrus. More serious aggression between opposite-sex individuals of this species has been cited. As the female rhino approaches peak estrus (as indicated by such behaviors as increased urine spraying, inappetance, increased vocalizations and vulva winking), an introduction should be attempted. It has been noted that peak estrus lasts approximately 24 hr and optimal conception chances occur between hours 8 and 12 (Table 10).

COPULATION

Copulation in the rhinoceros has been described as typically equine in position. At the culmination of courtship behaviors, a female indicates her receptivity by standing still and allowing the bull to rest his chin on her rump. He then mounts her and achieves an erection at this time if he has not already. Following repeated preliminary mounts, at full copulation, rhinos may remain coupled for 30 min to 1 hr, with ejaculations every few minutes, and multiple mounts/breedings may occur. Following breeding, the two animals show signs of fatigue and part company, although the male may remain in close proximity to the female for 2 to 6 days. Note that data on black rhinos, unlike that reported on other species, indicate that they may continually breed throughout gestation.

In captivity, breeding generally occurs throughout the year, though slight peaks may be seen in the spring and fall (Table 10). Some differences among species have been noted, but these may result from management and therefore not represent true species differences. Rhinos may successfully breed at as early as 3.5 to 5.5 years of age (females) and 5.5 to 9 years of age (males). To date, few data are available concerning behavioral indicators of sexual maturity outside of overt sexual behaviors. In the case of male white rhinos, however, increased aggression has been cited (Fouraker, pers. comm.). The average breeding lifespan of rhinos is approximately 20 to 25 years, as both males and females have not successfully bred past 36 years of age (Table 10). Please see Table 10 for species-specific trends in reproduction.

PREGNANCY AND PARTURITION

Gestation periods for the three rhino species are listed in Table 10. Table 11 lists behaviors associated with pregnancy and impending birth. In general, pregnant white rhinos will cease behaviors associated with estrus and exhibit a lack of breeding behavior. As previously described, black rhinos may breed continually throughout gestation. In all species, there may be a mucus discharge, noticeable weight gain or increase in girth size, as well as increased frequencies of defecation and urination throughout gestation.



Courtship in rhinos can be a protracted affair. A male rhino may remain in close proximity to a female and may follow her until she comes into full estrus and accepts contact. As the female comes into full estrus, she will accept the male sniffing her (1) and placing his chin on her rump (2). The male may then begin a series of mounts (3) until she will eventually stand for a full mount and copulation (4).
(Photos: Knoxville Zoological Gardens)

In both black and white rhinos, pregnant females have been observed isolating themselves from other individuals. If pregnancy is confirmed (Preliminary fecal hormone tests are available.) and/or the breeding date is known, the physical separation of the pregnant female from the bull/herd should take place as early as 30 days and as late as 24 hr prior to birth. Institutions with very large enclosures have had successful births in the yard with the male present; however, the cow and any males should be watched very closely.

The onset of birth often takes place at night or in the early morning and may last 1 to 3 hr. Parturition usually lasts 10 to 12 hr from water break, though first-time mothers may take longer to calve. The presentation of a calf is generally head-first, although rear feet presentations do occur and may take longer than head-first births. Capabilities for monitoring births remotely are advisable.

CALF DEVELOPMENT

A single calf is generally the rule. Few data are available on birth weights, but in general, calves weigh the following at birth: 27 to 41 kg (60 to 90 lb) (black, n=4), 54 to 70 kg (120 to 155 lb) (white, n=5), and 65 to 81 kg (144 to 178 lb) (greater one-horned, n=9). Immediately following birth, the newborn calf is usually cleaned by its mother and first stands within 30 min to 5 hr of birth. A newborn calf may require traction material to help steady itself. Traction materials may include sand, gravel, straw, hay or rubber matting. In all cases, both the dam and calf should be monitored closely to prevent their ingestion of the added substrates. A calf should begin nursing within 1 to 2 hr of standing (though in a single case, a calf removed from its dam for medical intervention nursed 16 hr post-birth). The dam will nurse her calf while standing or lying on her side.

Infants less than 2 months old may nurse hourly, while older calves nurse at intervals of about 2.5 hr. Few data are available on nursing durations and frequencies, but it has been reported that as the calf ages and grows stronger, nursing will usually increase in duration but decrease in frequency. It has been reported that calves may gain up to 4.54 kg (10 lb)/day for the first 10 days. The first defecation has been reported at 2 to 10 days of age (n=2). Calves may nurse for up to 2 years, although they have been observed first sampling solid food at less than 1 week to 1 month of age. Calves may be offered supplemental feedings of milk if the dam is believed to be a poor milk producer or the calf is not gaining weight. (See Hand-rearing in the Nutrition chapter.) Infant rhinos have been successfully pulled from their mothers because of rejection, medical issues related to the mother or infant, or from a failure to nurse. Otherwise, it should be noted that weaning for management purposes can be accomplished if necessary at 6 months, but 1 year is preferable. One attempt to use a surrogate mother was unsuccessful; however, hand-reared infants have been assimilated into existing groups and have shown reproductive success.

Depending on the facility and the species, a cow and her newborn calf may be reintroduced to the male/herd after 2 weeks (white rhinos) or following the cow's first heat (black rhinos). (See Introductions above for further details.) If the facility is able to run multiple female greater one-horned rhinos together, the cow and calf should not be introduced to the others for approximately 4 months following birth.

TABLE 11. Physiological and behavioral indicators of impending parturition in female rhinos (partial listing, all species)

30 days prior to birth	2 weeks prior to birth	24 to 48 hr prior to birth
Increase in teat size	Nipples enlarge	Udders increase dramatically in size
Beginnings of milk production	Nipples develop wax plugs	Inappetance
Milk may be expended with pressure on the teats	Vulva swelling occurs	Becomes irritable and aggressive to stimuli, including staff
Female may prolapse vaginally when defecating		Mucus plug forms
		Increased vulva dilation
		Increased restlessness, lies down often



Immediately following birth, the newborn calf is cleaned by its mother and should first stand within 30 min to 5 hr of birth. (Photo: San Diego Zoological Society)

Few data are available on the behavioral ontogeny of rhino calves. Both black and greater one-horned calves generally do not have peers to play with, though they are generally very curious and often chase and mock-fight with their dams or occasionally keepers. White rhino calves exhibit these behaviors toward any male, female, calf or juvenile in the herd. Non-aggressive sexual behaviors may be exhibited at as early as 18 months of age in males.

In general, the long term social effects of removing rhino calves from dams should be investigated. For all species, weaning or permanent separation of the calf except for medical reasons should not occur before 1 year of age. A calf can, however, be temporarily separated from its mother at as early as 1 month of age for short periods of time (e.g., re-breeding of dam). Generally, the procedure is to separate the calf for short periods of time (e.g., 15 to 20 min during cleaning) and gradually increase the separation time. If a dam is not scheduled to be re-bred, her calf may remain with her until it reaches sexual maturity (at approximately 4.5 to 5 years of age). It should be noted that available data indicate that nursing does not inhibit conception. In a herd-like situation, a female white rhino may temporarily abandon her calf during estrus and rejoin it immediately after breeding until the birth of her next calf. The first calf may be forced away before parturition of the second calf as the dam seeks to isolate herself. Following the birth of the second calf, the first calf, then a subadult, may rejoin its mother and her new calf in a social group for up to 4 years or until it reaches sexual maturity.

MANAGEMENT



IDENTIFICATION

Although physical characteristics such as horn size and shape make individual rhinos fairly easy to distinguish from one another, sound captive management requires that animals be identified through permanent and reliable methods. Trovan[®] transponders, implanted at the base of the left ear during post-natal examination or as soon after birth as possible, provide a means of permanent primary identification for all individuals. Adults that are not currently transpondered should be when the opportunity arises. Note that transponder numbers, which are assigned for identification, need to be reported to the studbook keeper. In addition to a transponder, each individual should have a secondary visual means of identification, such as an ear tag or ear notch. Photographs or sketches in the animal's records may also serve this purpose.

KEEPER TRAINING AND INTERACTION

As with any position involving the management of large animals, rhinoceros keepers should have as much formalized training and experience as possible and should be familiar with rhino behavior and husbandry. In order to ensure safety and to properly meet the requirements of management, it is recommended that more than one keeper be responsible for the care of these animals on a daily basis. Keeper interaction should be restricted to designated areas and should be conducted in accordance with institutional protocols. Finally, consistency of routine is vital in daily interaction.



Keeper interaction with rhinos is a necessary part of successful management. It is recommended that interaction be limited to designated areas and protocols (such as treatment regimens or training programs). (Photo: Fort Worth Zoological Park)

There are no conclusive data to indicate the effects of different styles of keeper interaction on rhinoceros behavior or reproductive success in captivity. Interaction styles range from no contact at all to daily hands-on contact. In an effort to create an environment patterned after the wild, however, at no time should relationships with keepers substitute for natural interaction among individuals.

It is important that rhinoceros personnel keep a daily log, noting any unusual behavioral changes. It is the responsibility of management to supply all pertinent data to the studbook keeper.

DAILY REGIMEN

Fresh water should be available at all times and should be changed daily or supplied by an automatic-fill or continuous-flow device. Regular cleaning and disinfecting should occur at a rate that inhibits the growth of algae and bacteria. Water devices should be constructed to prevent upset, spillage or leakage. Rhinos need access to water pools and/or mud baths to keep their skin healthy; mud wallows should be renovated periodically to prevent contamination. (See the Design chapter for more information on pools and wallows.)

Natural substrates should be spot-cleaned and raked daily, and hard-surfaced areas not exposed to the elements should be dry-cleaned or hosed daily and disinfected at least weekly. Indoor housing surfaces, as well as walls and rub areas, should be cleaned daily. For institutions holding free-ranging herds, these daily cleaning procedures are not practical, but periodic removal of dung heaps and the turning of soil and scattering of manure with proper equipment are necessary to reduce parasite loads. Additionally, the daily hosing or showering of rhinos in the barn with temperature-controlled water is recommended to promote healthy skin during the winter months.

In order to facilitate participation in many research programs involving rhinos, it is recommended that institutions implement training programs following the protocols recommended in the Rhinoceros Training section of this chapter. Additionally, it is recommended that some form of environmental/behavioral enrichment be integrated into daily rhino management.

ENRICHMENT



Behavioral enrichment is a well known concept in primate literature (e.g., Tripp, 1985; Bloomsmith et al., 1988; O'Neil et al., 1991) and to a lesser extent in the ursid, felid and elephant literature (e.g., Carlstead et al., 1991; Forthman et al., 1992; Hartnett, 1995; Knights, 1995). Enrichment is not commonly emphasized in ungulate management in general or with rhinos specifically. This deficit, however, should not de-emphasize the potential benefits of behavioral and environmental enrichment in rhino management.

In general, enrichment may be defined as the addition of objects or modification of management guidelines that causes a change in animal behavior to more closely resemble that of a healthy, wild conspecific (Mellen & Shepherdson, 1992). Enrichment may serve various



(Photo: Fort Worth Zoological Park)

functions, including (1) improving well-being by reducing the levels of abnormal and injurious behavior, increasing exercise, satisfying "behavioral needs" and optimizing the level of stimulation that animals receive; (2) educating zoo visitors by increasing the levels of natural and interesting behaviors, visibility and activity levels; and (3) conserving endangered species by improving the success of captive breeding and reintroduction programs (through modulation of social interactions, maintenance of health, promotion of normal physiological and psychological development, and maintenance of behaviors required for survival in the wild) (Shepherdson, 1992).

The development of an effective enrichment program requires examination of both the physical and social environments of captive rhinos. As discussed, rhino species vary in social organization. However, while the greater one-horned rhino may be considered the least social of the rhino species commonly maintained in captivity, data from wild populations indicate that individuals even of this species associate with one another at communal wallowing or grazing grounds (Nowak, 1991). Optimal group size and composition is discussed elsewhere in this chapter; however, the potential impact of group size is discussed here. Individuals and subgroups of white rhinos separate and unite frequently in both captivity and the wild (Fouraker, pers. comm.; Estes, 1991). If captive conditions allow, white rhinos should be managed in such a way as to approximate this pattern. This may involve temporarily separating an individual or individuals from the group or, conversely, allowing rhinos access to each other 24 hr a day (as conditions allow, either indoors or outdoors). Black rhinos are considered moderately social compared with white rhinos; however, institutions with larger enclosures may house them in more herd-like situations. Again, allowing compatible individuals to spend as much time as possible with each other may prove beneficial. It is recommended that greater one-horned rhinos be housed separately (except in the case of very large enclosures); however, individuals should be given both visual and olfactory access to each other.

Exhibit design may incorporate many features that provide enrichment to rhinos. For the most part, however, systematic data are not available to discern the specific effects of these guidelines. Many of the following recommendations are also covered in the Design chapter of this publication. In general, the larger the enclosure, the better. Preliminary trends indicate that reproductive success of white rhinos may be greater in larger enclosures (though this may be confounded by social group composition). In any case, because all rhino species can be aggressive, variability in enclosure topography and plantings are recommended. Plantings (protected from rhinos by rock aprons, etc.), rock piles and dirt mounds (or other forms of visual barriers) may help ease social tensions by partially blocking rhino sightlines. For all species, the incorporation of a mud wallow is particularly important for skin health as well as potential behavioral enrichment. Greater one-horned rhinos should also have access to a pool because of their affinity for water. Rubbing posts placed throughout the enclosure assist in the removal of dead skin and may also serve as partial visual barriers.

The husbandry routine can also serve as a form of enrichment for rhinos. Because of the natural feeding behaviors of rhinos, browse can be an effective enrichment tool (as well as an important dietary component; see the Nutrition chapter). Varying the placement or fre-



2 (Photo: Oklahoma City Zoological Park)



3 Behavioral or environmental enrichment can be a vital part of captive management. While not commonly associated with rhinos, enrichment can include large, movable objects such as boomer balls (1), rubbing posts or trees (2) or simply increasing the complexity of the enclosure(s) (3). (Photo: Fort Worth Zoological Park)

quency of browse feedings may increase rhino activity levels and stimulate the natural grazing/browsing behavior of rhinos. Training or operant conditioning programs may also serve as a form of enrichment (discussed in detail later in this chapter). Rhinos rely heavily on their olfactory sense to presumably obtain information regarding other individuals. This fact can be effectively incorporated into both the design of the indoor holding and exhibit areas as well as management regimes. Designing indoor holding so that each rhino must pass through a common area prior to its individual stall allows rhinos to consistently sniff and mark one another's dung piles. The same holds true if individuals pass through one another's exhibit lots to enter their own. Again, if animals are compatible and may be held in groups (particularly white rhinos), group indoor stalls should be incorporated into design specifications. Males, though, should be held separately when indoors. Within reason, it is recommended that dung piles not be totally removed during cleaning. This again allows rhinos to obtain information about each other using their well-developed olfactory ability. With vet and management approval, dung may be exchanged with another zoo and placed in the rhino enclosure. The novel dung may stimulate sexual activity or increase territory-marking behavior. If the institution houses more than one rhino species or subgroups of the same species, the same effect may be obtained by exchanging dung in-house.

Rhinos may also benefit from the addition of various manipulable objects. Movable objects such as stumps, logs, hard plastic balls or metal kegs may be rolled or tossed by rhinos and result in an increased activity level. Table 12 is a summary of enrichment ideas that have been successful with rhinos. In all cases, it should be noted that variability is a key to enrichment. Systematic observation of rhinos pre- and post-enrichment will help managers assess the effectiveness of each idea. Observations may vary from a simple keeper checklist to a well-developed behavioral study. In either case, such an evaluation will enable managers to most effectively modify the captive environment for rhino well-being.

RHINOCEROS TRAINING



Physical examinations, as well as numerous nutritional, reproductive and veterinary research projects, often require hands-on contact with rhinos. An alternative to manual or chemical restraint of an individual is an operant conditioning program that utilizes positive reinforcement. Such a program has many benefits, including reduced stress to the animal, more reliable sample collection, reduction of any effects of stress on the samples, less need for structural modifications to restrain animals, and behavioral enrichment (Bloomsmith, 1992; Laule, 1992). Numerous institutions have successfully trained rhinos for such procedures as blood collection and ultrasound tests, as well as basic husbandry procedures including skin and foot care (e.g., Eyres et al., 1995; Mehrdadfar, 1995; Michel & Illig, 1995; Nicholson, pers. comm.). The following section relies heavily on these works to describe the basic principles underlying a rhino-training program, as well as to document specific procedures for implementing such a program.

The first step prior to beginning any training program is to establish program goals and requirements. A training program will require much coordination among staff members including keepers, curators, veterinarians and even zoo management, as exhibit schedules

TABLE 12. Enrichment possibilities for rhinos

Structure/Furniture

Loose, heavy chain fastened at both ends 61 to 91 cm (24 to 36 in.) from the ground for rhinos to push and test strength against (acts as an artificial sparring partner)

Water pools and mud baths for bathing or wallowing

Rubbing posts to stimulate the removal of dead skin

Large, movable items such as stumps, logs, boomer balls or 208-liter (55-gallon) plastic drums

Yards connected by gates

Logs suspended on chains

Sprinklers

Increased complexity of the enclosure (e.g., dirt mounds, visual barriers)

Management

Initiate an operant-conditioning or training program

Place browse branches on the ground or hang them in high places or on stumps

Offer feed throughout the day in various places (e.g., apples in the pool)

Allow dung piles to accumulate in outdoor facilities

Exchange dung with other zoos (with vet approval; new scents may stimulate sexual activity and increase territory-marking behavior)

Vary social groupings by occasionally splitting up a herd (with approval of SSP Coordinator)

Modified from Grams & Ziegler (1995)

may be modified during training. In general, it must be understood by all parties that consistency in routine is paramount for training and that modifications will undoubtedly be made to the pre-training routine to accomplish the program goals. The feasibility of a training program should initially be evaluated by examining the tractability of the animal(s) and considering staff time and expertise. Animals should be evaluated based on their basic dispositions as well as previous histories with medical procedures. Especially nervous animals will more than likely adapt to a training program, though substantially more time may be required to meet program goals. In general, training personnel may include keepers (e.g., Michel & Illig, 1995), curators or an individual strictly responsible for training or enrichment at an institution. In any case, it is recommended that the individual(s) have a thorough understanding of basic training techniques. However, it should be emphasized that rather than the specific personnel involved, consistency in routine and a strong understanding of animal behavior are the critical elements for a successful program.

The training process itself will generally include three basic steps: (1) habituating the animal to the trainer, (2) constructing and introducing "targets," or visual areas of ideal placement for the rhino, and (3) establishing the commands necessary to steer the animal to these target areas. Additionally, although the ultimate training goal may be to collect blood from a rhino for hormonal evaluation, the accomplishment of this goal will require many steps, including training the rhino to (1) approach the trainer, (2) "target" to a specific object and/or area, (3) remain stationary for a given period of time and (4) tolerate the procedure. The duration of time at each step will vary widely across individuals, but in general, rhinos have been successfully trained for daily blood collection in as few as 3 to 5 months.

It is recommended that training begin with one individual as the primary trainer. Once the rhino reliably executes the desired behaviors, additional personnel may be included as needed. Ultimately, given the appropriate stimuli, the rhino will ideally execute the desired behaviors for a number of different personnel. Similarly, it is recommended that training be initially performed in a specific area of the enclosure. Again, however, flexibility is important so that the rhino will perform the desired behavior(s) (e.g., target to a specific area and remain stationary) in more than one area if necessary. In both cases, it should be emphasized that training commands, targets and rewards should be used only during training sessions. Additionally, at least until the desired behaviors are established, training sessions should occur in a given treatment area with no interaction other than conditioning taking place in the specific training area. The chosen commands and target objects should be carefully evaluated prior to beginning the training program. (For example, if "shift" is routinely used to shift rhinos, a more appropriate training command may be "come.") In an effort to maintain consistency across institutions and various conditions, Table 13 lists recommended voice commands to be used in rhino training.

Specific training areas and objectives will vary across institutions. Closed- or free-stall chutes (See the Health chapter.) work well for medical procedures, provided there is ample access to the animal and safety for personnel. Additionally, treatment may involve a specific section of the enclosure (e.g., requiring the animal to target parallel to enclosure cables).

TABLE 13. Recommended voice commands for rhino-training programs (adapted from AZA Elephant SSP protocols)

Command	Behavior
Move up	Move forward
Back	Move back
Over	Side-step
Steady	Hold position
Foot	Present foot
Come	Come to keeper
Target	Place head or body part at specific area
All right	Release



Successful training involves many steps including conditioning the rhino to "target" to a specific area and remain stationary. Up to 9 weeks has been reported as the maximum time necessary to train a rhino to target and remain stationary. (Photo: Milwaukee Zoological Society)

To habituate the rhino to the presence of the trainer, regular 10-min training sessions may be effective. Again, it should be emphasized that the amount of time required will depend on the tractability of the individual; conditioning may take longer for certain animals. During these sessions, the primary objective is to establish trust. By noting generalized behaviors and body positions of the animal, the trainer should be able to discern the point at which the rhino is relaxed with his/her presence. At this point, the trainer may begin shaping the desired behavior. If, for example, the desired behavior is standing for blood collection from the ear, the first step is to encourage the rhino to approach the trainer using voice commands (e.g., "come"). Following each successive approximation of the behavior, another command should be given, such as "good," which serves as a "bridge" to link the behavior to the reinforcement, which is given concurrently. A positive reinforcer should increase the frequency of the desired behavior. Examples of successful reinforcers include food (e.g., apples, bananas, grain) and, to a lesser extent, tactile stimulation (e.g., belly scratching with a push broom, Michel & Illig, 1995). It is important to note that the bridge and the reinforcement should be given only for the approximation of the desired behavior. Otherwise, additional behaviors performed in conjunction with the desired one will also be reinforced.

After the successful completion of the approach behavior (after a few weeks), the trainer can introduce a "target," or object easily visible to the rhino [e.g., the trainer's hand or a 2.54-cm- (1-in.)-diameter lid to a 18.9-liter (5-gallon) bucket] for the placement of a specific body part (e.g., head or hindquarters). At this point the trainer should encourage the rhino to approach the target on command (e.g., "target") using the same basic procedure of reinforcing approximations of the desired behavior. Training sessions at this point should last 10 to 30 min. Alignment with both head and body targets places the rhino in position for such procedures as blood collection from the ear vein, rectal temperature readings or venipuncture. Following successful targeting, the next step is encouraging the rhino to remain stationary for a given period of time (using the command "stay" or "steady," for example). Up to 9 weeks has been reported as the time necessary to train a rhino to consistently perform these behaviors.

Once these behaviors have been established, the final step involves desensitizing the rhino to the medical equipment (if applicable). At this point, additional personnel who will be performing the procedure (if applicable) can be introduced to the process. Initially, the collection area should be manipulated (e.g., touching and pinching the ear, cleaning the colon of feces). Any materials that will be used should slowly be introduced (e.g., probe, tourniquet, iodine, tube and syringe). These introductions should continue until the rhino shows no reaction to the equipment. The final stage prior to the actual procedure may include pressure from a blunt needle or insertion of a reproductive probe until the rhino shows no reaction.

There are some general considerations that should be noted during all phases of conditioning. If at any point during training there is regression, the trainer should revert to a point in the training where the rhino is comfortable and then slowly proceed again. While this may add to the total time required for conditioning, the probability of overall success is increased. Additionally, once the procedure is routine for the rhino, the trainer should periodically lead



Target training is an especially effective form of conditioning. Training a rhino to follow a target enables zoo personnel to position the animal for such procedures as blood collection, rectal temperature readings, venipuncture or ultrasonography. (Photo: Fort Worth Zoological Park)

the rhino in performing the desired behaviors if they are not otherwise performed regularly (e.g., weekly blood collection for hormonal analyses). In the absence of regular performance, this variable reinforcement will help prevent the behaviors from extinguishing.

RHINOCEROS SHIPPING PROTOCOL



Pat Morris, DVM, and Michael Fouraker

The crating and shipping of rhinos is one of the most difficult shipment procedures in zoos. While rhinos themselves are fairly hardy, the limitations of temperament, peculiarities of chemical immobilization, and rigorous shipping equipment necessitates a strict yet flexible protocol for optimizing successful crating and shipping.

PRE-SHIPMENT MEDICAL PROCEDURES

Communication at the veterinary level between receiving and shipping institutions prior to rhino translocations is essential in order to discuss specific institutional and/or state requirements. Standard medical procedures for all moves should include the following: (1) a TB test within 6 months of shipment or as particular state, federal or international requirements dictate, (2) brucellosis serology, (3) a visual physical examination, (4) two negative fecal screens 30 days prior to shipment and (5) a review and update of inoculations. (See the Health chapter.) In addition, medical or research protocols defined by the SSP should be reviewed during the planning process.

CRATING

Crating is the recommended transport method, although transport in trailer stalls has also been successful. It is important in the latter case that a reinforced trailer be used. In all situations, the animal's behavior and conditions should be constantly monitored. Typical problems that can occur in shipping include the following: (1) animals destroying and/or climbing out of the crate top; (2) animals becoming inverted in the crate and unable to right themselves; (3) animals destroying end panels or doors, resulting in eye, horn or facial injuries; and (4) prolonged, excessive exertion resulting in hyperthermia and/or myopathy.

DESIGN

The International Air Transport Association (IATA) crate design specifications are illustrated in Figure 4. Crates are usually constructed of wood or wood with steel reinforcements. Crate dimensions should be determined by the animal's size (Table 14), but in general, the crate should be 0.3 m (1 ft) longer and wider than the animal when it is lying on its side. Crates with bars situated at the head end will decrease injuries to the head and face. Horizontal bars at the head end should be avoided, as they tend to cause horn breakage and/or damage. Crates with bars and doors at both ends are optimal.

TABLE 14. Approximate crate dimensions by species (modified from IATA, 1995)

Species	Length	Height
Black rhino	271 cm (107 in.)	191 cm (75 in.)
White rhino	475 cm (187 in.)	221 cm (87 in.)
Greater one-horned rhino	335 cm (132 in.)	201 cm (79 in.)

Crate dimensions should be determined by the animal's size, but in general, the crate should be 0.3 m (1 ft) longer and wider than the animal when it is lying on its side.