Guidelines for the *in situ* Re-introduction and Translocation of African and Asian Rhinoceros

Edited by Richard H Emslie, Rajan Amin & Richard Kock

First Edition, 2009

Occasional Paper of the IUCN Species Survival Commission No. 39

SSC

Species Survival Commission

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Contributors

These guidelines were jointly compiled by the IUCN Species Survival Commission's (SSC) African Rhino Specialist Group (AfRSG), Asian Rhino Specialist Group (AsRSG) and Wildlife Health Specialist Group (WHSG) with the Re-introduction Specialist Group (RSG) providing generic reintroduction guidelines and commenting on a draft of the guidelines. The Zoological Society of London (ZSL) provided administrative support for the project and staff time.

Initial plans for the guidelines were prepared during a working group at the 2006 AfRSG meeting chaired by Richard Kock. Other working group members were, Keryn Adcock, Evan Blumer, Richard Emslie, Jeff Cooke, Holly Dublin, Jacques Flamand, Mike Knight, Rob Little, Hubert Planton, Kes Smith and the late Nico van Strien. Pritpal Soorae was unable to attend the workshop but provided background material.

An initial draft "straw dog" draft document was then compiled by the AfRSG Scientific Officer, Richard Emslie, with input from a number of experts listed below. This document was used as a starting point for an expert workshop to further develop and refine the guidelines. It was based on a number of existing documents (listed in acknowledgements below) and on written and verbal input from Keryn Adcock, Rajan Amin, Alison Kennedy-Benson, Dave Cooper, Jeff Cooke, Tony Conway, Richard Emslie, Jacques Flamand, Francis Gakuya, Markus Hofmeyr, Ben Okita-Ouma, Pete Morkel, Richard Kock, Quinton Rochat and Chris Foggin, and using earlier material supplied to the AfRSG by Pritpal Soorae and Raoul du Toit.

The document was further developed at a workshop of experts held at Ngulia, Tsavo West NP, Kenya, 29–30 October 2007, attended by Rajan Amin, Rayner Bili, Dave Cooper, Parag Jyoti Deka, Bijoy Dutta, Richard Emslie, Adhi Rachmath Hariyadi, Markus Hofmeyr, Mark Jago, Shant Jnawali, Digvijay Khati, Richard Kock, Isaac Lekolol, Pete Morkel, Sen Natham, Parag Nigam, Ben Okita, Giija Pande, Narendra Pradhan, Robin Radcliffe, Sectionov (Inov), Naresh Subedi, Herry Susilo, Bibhab Talukdar and Kanchan Thapa.

Richard Emslie, Rajan Amin and Richard Kock reviewed, edited and commented on later drafts of sections of the manuscript. Simon Morgan and Chris Kelly provided additional input on immediate post-release monitoring. Adhi Rachmat Hariyadi, Shant Jnawali, Bibhab Talukdar, Sectionov, Richard Kock, Rajan Amin and Richard Emslie provided material and comment for introductory boxes. Dave Cooper and Ben Okita provided summary information on the history of rhino translocation in Africa. Rajan Amin produced the flow diagrams.

Further comments on a revised, consolidated draft were received from Richard Kock, Pritpal Soorae, Richard Emslie, Rajan Amin, Bibhab Talukdar, Christy Williams and Mark Jago.

Final comments on greater one-horned rhino translocation issues were made in November 2008 at the joint IUCN SSC AsRSG/WHSG workshop in Guwahati, supported by Aaranyak and ZSL, and involving Bibhab Talukdar, Kushal Sarma, Bijoy Dutta, Prabhat Basumatary, Garga Das, Phulmoni Gogoi, Mohan Smith, Prasanta Boro, Raj Deka, Mridupavan Baishya, Bidyut Das, Bhaskar Choudhury, Ripunjoy Choudhury, Parag Deka and Munmun Sarma.

Richard Emslie produced the final draft including photographs using an IUCN report format and layout. This was reviewed by Rajan Amin and Richard Kock. Linda DaVolls of ZSL proof read the document, final proof reading was by Stepanie Achard, Richard Emslie, Richard Kock and Rajan Amin and the design and layout of the guidelines for publication was by Candice Chitolie.

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Figure 1. (A) Delegates attending the experts workshop to further refine and develop the guidelines relax on a fieldtrip to Ngulia rhino sanctuary (B) Delegates at the expert workshop (Photo credits: Richard Emslie).

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These guidelines follow the approach and structure of those used in the IUCN African Elephant Translocation Guidelines (Dublin & Niskanen, 2003) as well as general IUCN Re-introduction Guidelines (IUCN, 1995).

Many of the recommended best-practice guidelines for translocations of African rhinos have been derived from recommendations by the AfRSG at a continental level, and the SADC Rhino Management Group and SADC Regional Programme for Rhino Conservation at a regional level (du Toit, 2006). Many of these recommendations also form part of the various national rhino conservation plans throughout Africa.

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Executive Summary

These guidelines seek to share and synthesise knowledge and experience of rhino translocations in Africa and Asia, and to provide decision-makers and senior wildlife managers with guidelines on "best practice" for the translocation of African and Asian rhinos. They have been prepared jointly by the IUCN SSC's African Rhino Specialist Group (AfRSG), Asian Rhino Specialist Group (AsRSG) and Wildlife Health Specialist Group (WHSG) in collaboration with the Re-introduction Specialist Group (RSG).

Much of the information on translocations is either in technical journals or in unpublished reports and therefore not readily available to decision-makers and field managers in a synthesised and easily accessible format. While some of the most experienced and expert practitioners have shared their knowledge with people working in the field in both Africa and Asia at various venues (dangerous drugs course Zimbabwe, AsRSG, AfRSG, WHSG meetings and networks), it was acknowledged that such expertise should be shared more widely.

Another reason for compiling these guidelines was that technicians in the field in the past have at times been required to carry out operations in the wrong season, with unsuitable animals, to less than ideal locations, and with inadequate finance, planning, staffing or equipment. It was considered that an authoritative set of guidelines would provide a tool to help ensure minimum inputs and standardised procedures are followed, so that managers can avoid poorly planned or inappropriate translocations, poor boma management and poor releases, with possible adverse affects for the rhinos themselves, and their biological management.

If these guidelines appear biased in favour of African rhinos, this is simply because to date most rhinos translocated have been African. Expertise and input was sought from many Asian rhino range states and has been incorporated into these guidelines (as can be seen from the list of workshop delegates). The process of preparing this document also provided an opportunity to bring current and past practitioners and experts from throughout African and Asian range states together. This allowed the identification of regional problems and needs, and helped set a standard based on good and bad experience.

Translocation has become routine in a number of African range states and has played a key role in increasing both white and black rhino numbers. Thanks to translocation, there are now 10 times more southern white rhinos on earth than there would have been if there had been no translocation. Similarly, translocation has played a key role in increasing black rhino numbers in major range states.

Given high human densities and extensive settlement, sufficiently large areas of suitable and secure habitat for range expansion are more limited in many parts of Asia than in Africa. Thus opportunities to aggressively biologically manage rhino populations for rapid growth (as is being done in many African range states) are more limited in Asia. While less common than in Africa, translocations of the greater one-horned rhino have also expanded range (e.g. Nepal) and increasingly are to be used to further increase range and numbers (e.g. the Rhino Vision 2020 range expansion project in Assam). Translocations also offer possibilities to significantly improve the conservation status of Sumatran and Javan rhino as they have done for both black and white rhino in Africa.

The guidelines are structured chronologically (Figure 2). Section 1 deals with various aspects of the pre-translocation phase. Section 2 discusses the implementation of the translocation and Section 3 the post-release period. Section 4 contains a useful bullet-point list of mistakes and lessons learned from past translocation exercises.

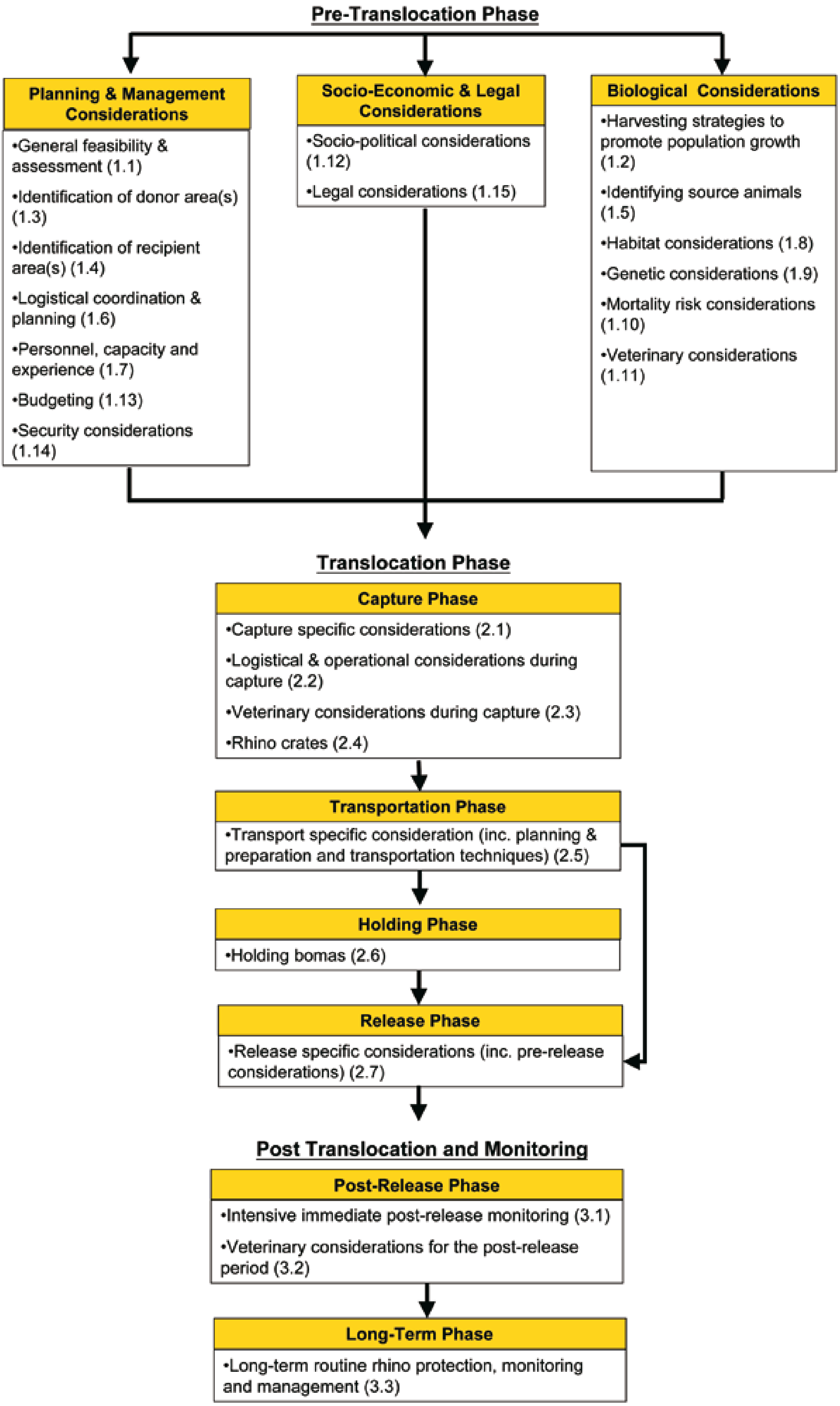

Figure 2. Flow chart showing the chronological structure of the guidelines.

These guidelines demonstrate the critical importance of using skilled practitioners in the various facets of the operation, and that operations need to be adequately resourced with a long-term commitment to protect, monitor and manage rhinos after they have been introduced. Problems arise in planning reintroductions and translocations. If there is not good scientific and technical input into the discussions, committees can make poor decisions regarding numbers of animals to remove and where to take them to. It is essential that such committees are not only comprised of senior decision-makers but that expert technical people are also involved. Decision-makers need to be aware that rhino ecological carrying capacity (ECC) (and hence productive rhino densities) can vary substantially not only from one reserve to another but also between different areas of the same park and over time in the same areas of the same park. These differences and changes need to be considered in re-introduction and rhino biological management/ translocation decision-making.

Before proceeding with a translocation careful consideration of the justification of the proposed translocation is needed. This step is especially important for reintroductions, where a feasibility study should be undertaken to determine whether or not a project should proceed as planned, whether to wait until further information is obtained, whether necessary security or infrastructure is in place, or whether or the plan should be terminated. If sufficient resources are not in place to cover routine monitoring, protection and rhino management long after the translocations have been completed then the translocations should not go ahead.

The primary reason for the majority of rhino translocations is to further demographic and genetic management of rhino metapopulations. Long-established populations, where population densities are approaching or have overshot estimated ECC are ideal candidates to supply rhino as their population growth rates may shortly decline. A number of national or organisational conservation plans and biological management policies also specify or recommend when populations should be harvested and how many rhinos should be removed in efforts to maintain rapid metapopulation growth rates.

Experience has shown that a failure to translocate from a population where numbers have changed little or declined over a period of many years can be costly. Such populations may be suffering density dependent affects on performance. If so, translocations will be required to increase performance of the remaining rhinos and boost numbers. Sub-optimal performance in many instances can be far more damaging in terms of future rhino numbers than limited outbreaks of poaching. This is because small differences in population growth rates can translate into large differences in the total numbers of rhino in just a few years. A lost rhino is a lost rhino irrespective of whether it was poached or simply failed to be born or died due to sub-optimal biological management. By removing some rhinos from these populations, the aim is to improve the nutrition of remaining females in the expectation that their breeding performance will improve.

In any intervention and particularly with one as dramatic as translocation, the health of the rhino is paramount. Veterinary expertise in wildlife health is needed for the planning and execution of rhino capture and translocation. There is increasing knowledge about the risks associated with transmission of disease or exposure of naïve animals to novel infections through movements, and much of this has come from studies undertaken opportunistically during translocations. Examples are now well documented in rhino for the trypanosomes of Africa (Mihok *et al.*, 1992, 1994; Kock *et al.*, 1999) Mortality risk will always exist in any intervention but through appropriate methods and use of drugs and knowledge these can be minimised.

When evaluating mortality risks, it is imperative that decisions on whether or not to proceed with translocations are made with consideration of the full cost:benefit trade-offs of the translocation. Extensive African experience has shown that new rhino populations established well below ecological carrying capacity in secure areas invariably perform very well after an initial settling-in phase. Thus if properly carried out, and despite the limited mortality risks involved, translocation can have a w*in:win* outcome for both donor and recipient populations, boosting overall rhino numbers and metapopulation growth rates and maintaining important genetic diversity for long-term population viability. A decision-maker who thinks that the “safe” option is to put off removing rhinos from an underperforming population until numbers have increased would be making a major mistake, unless it is clear that recent habitat changes have been favourable. The problem of inaction is exacerbated by the fact that rapid population growth is needed to maintain or limit losses of genetic diversity due to genetic drift. **Not removing can be a wrong rather than a safe option.** Similarly, the adoption of a "fortress" mentality (not wanting to remove animals from existing fenced sanctuaries) can have negative consequences for metapopulation performance once numbers of rhinos and other competitors increase inside the sanctuary.

Aside from contributing to increasing metapopulation growth rates and promoting long-term genetic conservation, the use of translocation to expand range and increase the number of populations also has strategic advantages, such as increasing a population's ability to survive poaching events or natural disasters. Having most or all of the remaining numbers of a subspecies in just one population is highly undesirable as a major disaster, such as a Tsunami, disease or a major local upsurge in poaching, could result in the extinction of that subspecies.

There can be no "one size fits all" approach to rhino capture. Specific capture, boma, transport and release methods need to be developed and used for the different species, given their different temperaments, behaviour, different reactions to drugs and habitat requirements. Approaches used will vary from operation to operation (for example a veld to veld translocation may be undertaken over a shorter distance whereas animals may be boma trained at both capture and release site in a long-distance translocation if vegetation in the recipient area is markedly different than in the donor population area).

In many African rhino range states translocation has become a routine management activity. Since the start of chemical capture of rhinos in Africa in the early 1960s, techniques have constantly evolved, with practitioners experimenting with new drug combinations, equipment and methods with a view to increasing the success rate and efficiency of translocations. For example, it is only recently that distributed releases of narcotised black rhino have routinely been used to reduce stress and mortality/injury risk to rhinos being introduced. This method also reduces the distances animals travel upon release. Similarly, the use of new immobilising/tranquiliser drug combinations has improved the physiological state of drugged white rhinos, and preliminary results suggest this new drug combination has the potential to significantly reduce the percentage of white rhino refusing to eat that in consequence have to be released from bomas. Improvements in the design of crates, boma and capture trucks have been made, and post-release monitoring protocols developed. The lesson here is that just because particular drugs, methods and equipment have been used in the past, this should not be used as a reason not to experiment with and investigate other approaches. There may be better ways to operate and capture teams should strive to refine and improve techniques. Perhaps most important of all, these guidelines show how important it is that we share experience and learn from each other. Translocation methods can be improved for all species and conditions and we should seek to improve them at every opportunity. It is hoped that these guidelines will go some way towards making existing knowledge more widely available and highlight some of the gaps in our knowledge.

While these guidelines are aimed at decision-makers and field managers, detailed technical information is available from other sources, some of which will be accessible from the Rhino Resource Center website (www.rhinoresourcecenter.com). New techniques and developments will also continue to be disseminated by the Specialist Groups.

Definitions

IUCN Position Statement on the Translocation of Living Organisms (1987)

Introduction: Introduction of an organism is the intentional or accidental dispersal by human agency of a living organism outside its historically known native range (IUCN, 1987), such as southern white rhinos to Kenya and Zambia.

IUCN Guidelines for Reintroduction (1995)

Re-introduction: An attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct (IUCN, 1995). ***Re-establishment*** is a synonym, but implies that the re-introduction has been successful (IUCN, 1995). The principle aim of a re-introduction should be to establish a viable, free-ranging population in the wild. The key difference between introduction and re-introduction is whether or not the species or subspecies is being released outside or inside its historic range.

Translocation: The deliberate and mediated movement of wild individuals or populations from one part of their range to another (IUCN, 1995).

Re-enforcement/Supplementation: Addition of individuals to an existing population of con-specifics (IUCN, 1995) e.g. to correct skewed sex ratios, improve genetic status. This type of action can pose a risk to existing wild population from factors, such as disease and fighting between supplementary and existing established rhinos. Supplementation is usually undertaken either to increase the effective founder number in a re-introduced population when it is not possible to re-introduce all founders at the same time, or to occasionally introduce new blood as part of metapopulation genetic management.

Conservation/Benign Introduction: An attempt to establish a species for the purpose of conservation, outside its recorded distribution but within appropriate habitat and eco-geographical area (IUCN, 1995). This is a feasible conservation tool only when there is no remaining secure area left within a species' historic range (IUCN, 1995).

Additional Terminology

Boma: A fenced-in enclosure or holding-pen/facility where rhinos are kept both prior to translocation over long distances (at or near capture site) and for an acclimatization period before release into a free-living situation. While this term may not be used in some countries it is in common use in the countries moving the greatest number of rhinos.

Bottlenecked population*:* A population of rhinos which has been reduced in size, effectively isolated from breeding opportunities with other populations, and whose remaining breeding individuals are unlikely to be representative of the original population as certain alleles and traits may have been lost among the survivors, while others may be under- or over-represented. The major negative genetic impacts of a bottleneck occur when the population remains at low numbers for many generations. On the other hand should numbers quickly increase following a bottleneck, loss of genetic diversity will be significantly reduced.

Captive breeding*:* Rhinos, usually in small (<10km^2) to very small areas living at compressed density and spacing, with routine partial or full food supplementation, with frequent levels of husbandry and veterinary intervention and a **manipulated breeding system** (Leader-Williams *et al.,* 1997).

Conservation purposes*:* Rhino translocation for conservation purposes aims to further demographic and/or genetic rhino conservation goals and in so doing contribute to ensuring the long-term survival of rhino species and subspecies in viable populations in natural habitats throughout historical range. Translocations may be undertaken to minimise the potential for loss of genetic diversity. Translocations also play a key role in expanding rhino range and setting up new populations of rhinos in areas of suitable habitat. Such new populations, if appropriately stocked, often initially breed rapidly after a settling-in period. Experience has shown that having rhinos spread throughout more populations in more countries and under more management models is also strategically desirable. Source animals for introductions are usually obtained by reducing rhino densities in long established populations where rhino numbers have exceeded or will soon exceed estimated MPCC (see below) and where underlying reproductive performance may have become, or is likely to become sub-optimal. The aim of such removals is to reduce pressure on the habitat in the donor population, and as a result improve the nutrition of remaining rhino cows, and by so doing ultimately improving reproductive performance in the donor populations. Translocation can be a *win:win* for both donor and recipient populations.

Custodianship*:* A management model where rhinos are allocated to a wildlife operation (which may be a private one, a communal one or even one that is under the control of another wildlife management authority in a different province, state or country) without transferring ownership of the rhinos to that operation. The question of future rights, such as ownership of progeny, can be dealt within in different ways according to national legislation and policies

Ecological Carrying Capacity (ECC): The estimated maximum number of a species (rhino) that can be sustainably supported by the resources of a specific area at a level where births tend to balance out deaths (0% growth). In practice ECC is hard to estimate, and fluctuates from year to year in response to rainfall and habitat dynamics. Numbers of large long-lived herbivores like rhinos may also overshoot ECC temporarily and are thought to have a yield density relationship which has a ramp form with density dependence only occurring at higher densities in excess of 75-80% of ECC (McCullough, 1992). However in arid areas with highly variable rainfall (CV >30%), and in Africa this is usually in areas with rainfall <400mm, populations rather will tend towards some saturation density during wet periods, without ever attaining this before drought conditions ensue limiting numbers. In such cases, the concept of a fixed carrying capacity becomes meaningless (Owen-Smith, 2001) and one is dealing with non-equilibrium dynamics being primarily controlled by external abiotic factors (rainfall) rather than internal biotic feedbacks. In such cases, there will be no density dependence in above average rainfall periods and offtake levels can be set relative to an ECC based only on limiting low rainfall periods. Despite these shortcomings and complications, ECC is a useful practical tool to help managers estimate maximum productivity carrying capacity (MPCC - the desirable stocking rate in the short–medium term at which the highest possible growth rates can be attained), as well as inform removal decision-making.

Effective population size (Ne)*:* The number of rhino which are effectively participating in breeding and the successful production of offspring; invariably this number is lower than the estimated number of animals in the population (N).

Enhancement*:* Addition of individual rhinos to an existing wild population of con-specifics. This is also referred to as supplementation.

Ex situ*:* Outside the historical range of a species (rhino) taxon.

Extensively managed*:* Rhinos kept in a large area, in the historic range of the taxon, where deliberate husbandry, food supplementation and intensive management are only occasionally undertaken. Captive breeding is the other end of the continuum where rhinos are very ***intensively managed*** (Blummer, 2006)

Founder population: This refers to the number of founders that are introduced to establish a new population. Founders should be unrelated wherever possible.

Genetic supplementation: Addition of individual rhinos to an existing wild rhino population in an effort to increase genetic heterozygosity and improve its long-term genetic viability.

Important-rated population*: A*fter *Key*-rated populations, *Important*-rated populations are the next most important populations for taxon survival at a continental level as identified by the AfRSG based on numbers and population trend over the last 3–5 years. The total number of *Important*-rated populations (all categories) is most often reported. An *Important1* population has an increasing or stable population of 20–50. The population trend in an *Important2* population is unknown or decreasing but numbers 51–100. An *Important3* population is decreasing but still contains 20–50 rhino in breeding contact in a protected area and an *Important4* population contains more than 20 animals dispersed outside or within a protected area with good potential for consolidation in an area that can take at least 20 founders.

Inbreeding depression*:* The loss of individual reproductive fitness, and thus population vigor and long-term viability, due to breeding between closely related individuals compared to less related individuals

In situ*:* Within the historical range of the rhino taxon.

Intensively managed: Rhinos kept in a small area, in or out of the historic range of the taxon, where deliberate husbandry, food supplementation and intensive management are routinely undertaken.

Key-rated population*:* The most critically important populations for taxon survival at a continental level identified by the AfRSG based on numbers, population trend over the last 3–5 years and the percentage of a subspecies conserved in the population. The numbers of *Key1,* and the total number of other *Key*-rated populations are most commonly reported A *Key1* population has an increasing or stable population that is >100 or conserves over 50% of a subspecies. A *Key2* population has an increasing or stable population that is from 51–100 or conserves over 25–50% of a subspecies. A *Key3* population has a population of over 50 rhino that is decreasing (<25%) or even if the population has suffered a rapid decline (decreasing >25%) it still conserves over 100 rhino.

Koonkie*:* The term describes a trained domestic Asian elephant (also spelt ***Kunkie)***.

Maximum Productivity Carrying Capacity (MPCC)*:* The term MPCC refers to the maximum density that a defined area can carry in the short-medium term yet still be able to reproduce at the maximum rate possible. For rhinos it is usually estimated at around 75–80% of estimated ECC.

Metapopulation: Most national and regional rhino conservation plans call for rhinos to be managed as part of a metapopulation. In effect, the various individual populations of a specific subspecies in a country or region are managed as part of the overall national or regional herd with interchange of animals (genetic material) between the constituent sub-populations. A subspecies metapopulation is not simply a set of separate rhino breeding groups within a region – there has to be some form of managed gene flow between the individual populations that make it up. Rhinos are managed as part of a metapopulation to avoid losing genetic diversity through inbreeding or genetic drift, and in so doing maintain sufficient genetic diversity for rhinos in future to be able to adapt to changing environments. Translocations within a metapopulation are likely to be necessary to maintain good population growth rates in both donor and recipient areas within a metapopulation.

Notifiable disease: A disease that must be reported when it occurs as specified under national or international law.

Pre-capture monitoring: A study of the rhinos in the source population prior to the translocation, which has the objective of identifying the most suitable individuals for the proposed translocation and monitoring of these individuals prior to their removal.

Release site(s)*:* The geographical point(s) at which rhinos are released after translocation within ecologically viable habitat selected for its potential to support a specified size of population of the taxon in the long term.

Resident population: The resident rhino population at the source or release site.

Semi-intensively managed: Rhinos kept in small (<10km^2) areas living at compressed density and spacing, with routine partial food supplementation, with a high management intensity, but with a natural breeding system, i.e. where who mates with whom is not controlled (Leader-Williams *et al.,* 1997).

Source population: The population from which the rhinos targeted for translocation will be sourced.

Spize*:* A shorthand term for a SPecies sIZE class. For example the species *Acacia nilotica can be subdivided into four spizes A.nilotica* <1m, 1–1.99m, 2–3.99m and >=4m. Black rhino dietary preference and importance ratings for different spizes of a species (e.g. *A.nilotica*) can vary from preferred to rejected and from important to unimportant. Thus rhinos are not just selecting for latin binomials (species); and if one is seeking to describe habitat in way that is relevant to rhinos it is more appropriate to use spizes rather than just species. Spizes can also be used to describe grasses in addition to browse.

Stocking rates*:* The density of rhinos in an area usually expressed in terms of rhinos/km^2 (or alternatively sometimes as km^2/rhino). Stocking rates can be compared to ECC to determine when to start translocating rhinos out of a population with a view to being productive.

Subspecies*:* Taxon of rhino that is sufficiently genetically and usually also geographically distinct to be classed as subspecies. For example there are two subspecies of white rhino. Rhino conservation plans invariably conserve subspecies separately.

Substitution*:* The IUCN guidelines on reintroductions recommend that the individuals to be reintroduced should be of the same subspecies as those that were extirpated. In some cases, however, a subspecies may have become extinct in the wild and in captivity. A substitute form may then be chosen for possible release. Such substitutions are actually a form of benign introduction. Considerations include assessment of the value of a substitution project and the selection of a suitable substitute. Species substitutions increase biodiversity, conserve related forms, improve public awareness of conservation issues, educate the public, and may be implemented for aesthetic or economic reasons. Selection of a suitable substitute should focus on extant subspecies and consider genetic relatedness, phenotype, ecological compatibility, and conservation value of potential candidates (Seddon & Soorae, 1999). Strictly speaking the re-establishment of southern white rhino in Uganda is an ***introduction;*** as in this case a population of southern white rhino, *Ceratotherium simum simum, has been* established outside its natural range instead of *re-introducing* the indigenous northern white rhino subspecies, *C. s. cottoni* due to the latter's extreme rarity and the almost zero probability of Uganda getting any founder *C. s. cottoni* animals for the foreseeable future, and possibly ever. At the time of writing the future survival of *C. s. cottoni* is precarious and should this subspecies go extinct, the introduction of southern white rhino to Uganda would in effect have been a substitution.

Translocation: The deliberate capture and movement of wild rhinos from one area to another (invariably for the purpose of their conservation and/or management at the source site, release site or both). Translocation can be for introduction, reintroduction, supplementation, conservation introduction or substitution purposes as well as to further population management in the donor population(s) supplying the rhinos being moved.

Viable population/metapopulation: A population or metapopulation of rhinos capable of persisting in the long term (i.e. hundreds of years). In reality rhino populations in the long term will comprise a set of smaller populations (tens to hundreds) managed as one metapopulation with routine (once per generation) genetic exchange between them.

Viable habitat: Habitat with natural food and water characteristics capable of supporting a target population size of rhino (+ or – natural variation) in the long term (100s of years)

Wild rhino population: Free-living rhinos, in medium to large areas (>10 km^2) generally within the historical range of the taxon, living at natural density and spacing, without food supplementation and only occasional husbandry and veterinary intervention and a ***natural breeding system*** (i.e. no control of who mates with whom). Definition developed by an AfRSG working group (Leader-Williams *et al.,* 1997). Within wild populations rhinos are free to move where they want and to fight and mate with who they want. In captive populations mate access for example may be tightly controlled.

Acronyms

IUCN SSC	The World Conservation Union (IUCN) Species Survival Commission (SSC)
AfRSG	IUCN SSC African Rhino Specialist Group
AfESG	IUCN SSC African Elephant Specialist Group
AsRSG	IUCN SSC Asian Rhino Specialist Group
BREP	WWF/Ezemvelo KZN Wildlife Black Rhino Range Expansion Project
EKZNW	Ezemvelo-KZN-Wildlife
FZS	Frankfurt Zoological Society
GOH	Greater one-horned rhino
KWS	Kenya Wildlife Service
MET	Namibian Ministry of Environment and Tourism
NTNC	Nepal Trust for Nature Conservation
NWPTB	North West Parks and Tourism Board (South Africa)
RSG	IUCN SSC Re-introduction Specialist Group
SADC	Southern Africa Development Community
SADC RESG	SADC Rhino and Elephant Security Group
SADC RMG	SADC Rhino Management Group
SADC RPRC	SADC Regional Programme for Rhino Conservation
SANParks	South African National Parks
WHSG	IUCN SSC Wildlife Health Specialist Group
ZSL	Zoological Society of London

Introduction

Context of the guidelines

- These guidelines are part of a series of IUCN publications ranging from generic re-introduction guidelines prepared by the Re-introduction Specialist Group to species-specific guidelines, such as for African elephants, primate species etc. The guidelines have been prepared jointly by the IUCN SSC's African Rhino, Asian Rhino and Wildlife Health Specialist Groups in collaboration with the Re-introduction Specialist Group, which provided generic guidelines and commented on a draft version. The guidelines are designed to be a series for key species which are increasingly managed in this way. This publication therefore is similar in format to the IUCN SSC African Elephant Re-introduction Guidelines (Dublin & Niskanen, 2003) with modifications as appropriate, given that translocation is such a key component of rhino biological management (to meet demographic and genetic goals).

- These guidelines seek to share and synthesise knowledge and experience of rhino translocations in Africa and Asia and to provide decision-makers and senior wildlife managers with guidelines on "best practice" for the translocation of African and Asian rhinos. Through contact with expert practitioners in the field, IUCN Specialist Groups are ideally placed to assemble a group of people with a sufficient range of practical experience and skills to produce such guidelines, as well as to catalyse the production of additional manuals and papers which can be consulted by those interested in obtaining more technical detail on the subject.

- If the guidelines appear biased in favour of African rhinos, this is simply because to date most rhinos translocated have been African. Asian expertise and input was sought from Asian rhino range states and the information has been incorporated into these guidelines.

- The process of preparing this document also provided an opportunity to bring together current and past practitioners and experts from throughout African and Asian range states. This allowed the identification of regional problems and needs and helped set a standard based on experience, mistakes and lessons learned.

- In the past, technicians in the field may have been required to carrying out operations during the wrong season, with unsuitable animals, to less than ideal locations, and with inadequate finance, planning, staffing or equipment. It was felt that an authoritative set of guidelines would provide a tool to help ensure minimum inputs and procedures are followed so that poorly planned or inappropriate translocations, poor boma management and poor releases with possible adverse affects for rhinos, and their biological management, can be avoided.

- One of the reasons for compiling these guidelines was that much of the information on translocations is either in technical journals or unpublished reports and therefore not readily available to decision-makers and field managers in a synthesised and easily accessible format. While some of the most experienced and expert practitioners have shared their knowledge with people working in the field in both Africa and Asia at the annual dangerous drugs course at Malilangwe in Zimbabwe, it was also recognised that such expertise could be shared more widely.

- The target audience for these IUCN guidelines is primarily national ministers dealing with conservation/land/environment/forestry, conservation department heads and relevant staff, donors, and other stakeholders and interested parties, such as private land owners or community representatives. Decision-makers and conservation managers should consult these guidelines to ensure that what they are planning follows recommended best practices and has a good chance of being successful.

- It is hoped that the guidelines will demonstrate the critical importance of using skilled practitioners in the various facets of the operation, and that the operations need to be adequately resourced with a long-term commitment to protect, monitor and manage the rhinos after they have been introduced.

- Experts acknowledge that different methods are being used and new methods are constantly being developed, and there is much to be gained by getting experts together to share information and ideas with a view to coming up with recommended best practices as well as documenting what to avoid, to make sure mistakes from the past are not repeated.

- Wildlife management communities can change quite rapidly in some countries (even in countries which have translocated many rhinos) and a wealth of experience can be lost. Therefore it was felt that the production of these guidelines and associated detailed reference documents would help capture such wisdom and prevent it from being lost.

- In addition to practitioners maintaining personal networks, it was felt that there was a need for peer-reviewed guidelines which are not perceived as the opinion of just one person, agency or even country.

- With an increase in interest and a realisation of the possible benefits to rhino conservation in Asia, developing joint guidelines would help facilitate exchange of information and sharing the lessons learned from the translocation of thousands of African rhino to date.

- Finally, these guidelines can also provide a standard against which funding agencies can assess the suitability of proposals.

What is the scope of the guidelines?

- These guidelines have been restricted to translocations for conservation purposes (including re-introductions), recovery (including or crisis-management for all rhino taxa in Africa and Asia) and for *in-situ* and *ex-situ* populations. The focus is on recovery across former range states, where feasible. The overall objective being to re-establish significant populations managed within a metapopulation framework, and to ensure rapid metapopulation growth and long-term viability of all rhino species and, where possible, sub-species.

- Given the target audience, these guidelines do not provide the technical detail of interest to expert practitioners (e.g. details of boma design, drug combinations and exact drug dosages etc.). However, the African Rhino Specialist Group in collaboration with the Rhino Resource Center (RRC) is setting up a site on the internet whereby interested translocation practitioners can share and access this more detailed technical knowledge. At the time of publication a number of additional documents from Africa and Asia can be downloaded from the RRC site www.rhinoresourcecenter.com.

Why reintroduce or introduce rhino through translocation?

Rhino translocation may be undertaken for a number of reasons:

- Translocations are necessary to reintroduce rhinos back into former range where they have been eliminated due to poaching or through land-use changes.

- Without sufficient natural corridors between areas, natural dispersal may no longer take place and active translocation may be the only way to restock suitable habitat.

- Invariably, the key goal of national rhino conservation plans and strategies is to increase rhino numbers rapidly (with a minimum target underlying growth rate of at least 5% per annum being set by most plans in Africa). Rhino population growth rates invariably decline in populations stocked at high levels relative to estimated ecological carrying capacity (ECC). This is especially the case in enclosed, fenced populations where rhino numbers may temporarily overshoot ECC[1], before any density dependent declines in performance are observed. Translocation is used to reduce densities in such populations with a view to improving nutrition for remaining females and improving performance in these populations (e.g. as has happened in Solio Ranch and Nairobi National Park in Kenya, and Ithala and uMkhuze Game Reserves in South Africa).

- New populations (set up using translocation) which have been initially stocked well below ECC generally show rapid population growth rates (sometimes in excess of 10% per annum) if protected[2]. On the other hand, poor or negative performance may occur if new populations are initially overstocked relative to ECC, or which have been established in poor quality/ unsuitable habitat, or in areas with inadequate security. Thus while creating new populations can significantly contribute to increasing overall rhino numbers, care needs to be taken to ensure such areas have sufficient suitable habitat and security, and are not overstocked.

- Aside from contributing to increasing metapopulation growth rates and promoting long-term genetic conservation, the use of translocation to expand range and increase the number of populations has strategic advantages, such as improving the ability of a population to survive increased poaching events. Having most or all of the remaining numbers of a subspecies in just one population is highly undesirable as a major disaster, such as a Tsunami or disease, or a major local upsurge in poaching, could result in the extinction of that subspecies.

- Thus if properly carried out translocation can be a w*in:win* situation for both donor and recipient populations.

- Translocations of the greater one-horned rhino have also expanded range (e.g. Nepal) and increasingly are to be used to further increase range and numbers (e.g. the Rhino Vision 2020 range expansion project in Assam).

[1] Due primarily to fences preventing dispersal and because during the time it takes young rhino to mature and exert their full impact on the habitat more rhino can be born.

[2] However, there may be an initial settling-in period of a couple of years after establishing a new population before rapid population growth occurs.

White Rhino – Translocation A Key To Successful Conservation

Following protection and aggressive translocation, which started in 1962, the southern white rhino, *Ceratotherium simum simum* has grown from 20–50 individuals in only one population in 1895 (the iMfolozi area of what is now Hluhluwe-iMfolozi Park, South Africa) to 17,500 in 433+ populations in nine African countries with another 750 in zoos and safari parks by the end of 2007. (Figure 3).

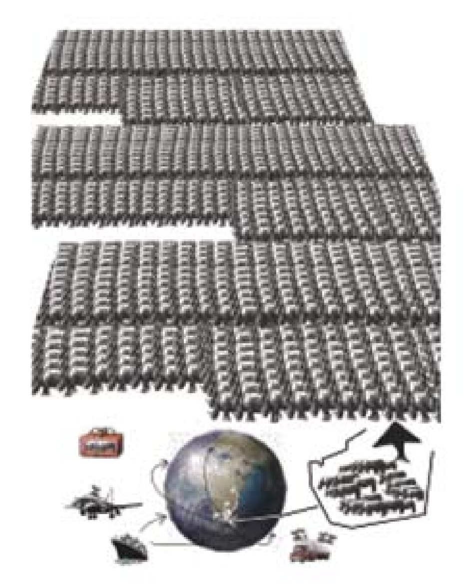

Figure 3. Illustration of role of translocation in expansion of southern white rhino from iMfolozi in KwaZulu-Natal South Africa. (Graphic credit Keryn Adcock from Adcock and Emslie 2003).

The largest single contiguous white rhino population of 9,210 in 2007 (Greater Kruger National Park) did not exist in 1960. Initially a number of separate populations were set up by translocation (Kruger NP, two other state run reserves and five privately owned reserves). Numbers grew rapidly and later the intervening fences between these areas were removed to create Greater Kruger. The original Hluhluwe-iMfolozi donor population is currently the second largest white rhino population with an estimated 2,065 in 2007.

Numbers of southern white rhino have increased to the extent that this subspecies no longer qualifies to be listed in one of the *Threatened* categories on the IUCN Red List. This represents one of the world's greatest conservation success stories. This success would not have been possible without translocation, and there are approximately ten times the number of southern white rhino in the world today than there would have been had no translocation taken place and numbers had simply been left to grow in the original population. By the end of 2007, 16,185 (88.7%) of the southern white rhino alive today were in translocated populations and zoos. Strategically translocation has provided additional security by 'spreading eggs in many baskets'. It has also helped maintain rapid metapopulation growth rates and prevent the development of artificially high densities in fenced reserves and the likely habitat changes which would have resulted.

By way of contrast there may be only one remaining wild population of northern white rhino. This population was reduced from 31 to only 4 by 2005 following a major upsurge in poaching. Recent intensive ground surveys have at the time of writing not found any sign of remaining rhinos and there may be none left. Had a second wild population been established when there were more rhinos (as was recommended), the long-term survival prospects for this subspecies would have been significantly enhanced. This example illustrates the dangers of 'keeping all eggs in one basket'.

- Translocation also offers the possibility to significantly improve the conservation status of Sumatran and Javan rhino, as it has done for both black and white rhino in Africa.
- In situations where only small numbers of outlier rhino exist, it may be better to catch and consolidate them all into a new population at a new location where improved security can be provided. This has the added genetic advantage of bringing more animals within breeding contact, as has been done for black rhino in Kenya. This perhaps could be done with some Sumatran rhino.

- Experience has shown that a failure to translocate from a population whose numbers have changed little or declined over a period of many years can be very costly. Such populations may be suffering density dependent affects on performance, and translocations will be required to increase performance of the remaining rhinos and boost numbers. In many instances, sub-optimal performance can be far more damaging than limited outbreaks of poaching. A lost rhino is a lost rhino irrespective of whether it was poached or simply failed to be born or died due to sub-optimal biological management.

- Translocation can be a useful tool for reducing human-rhino conflicts where these occur (e.g. around Pabitora, Assam, India) while at the same time providing founder numbers to restock suitable areas of former range.

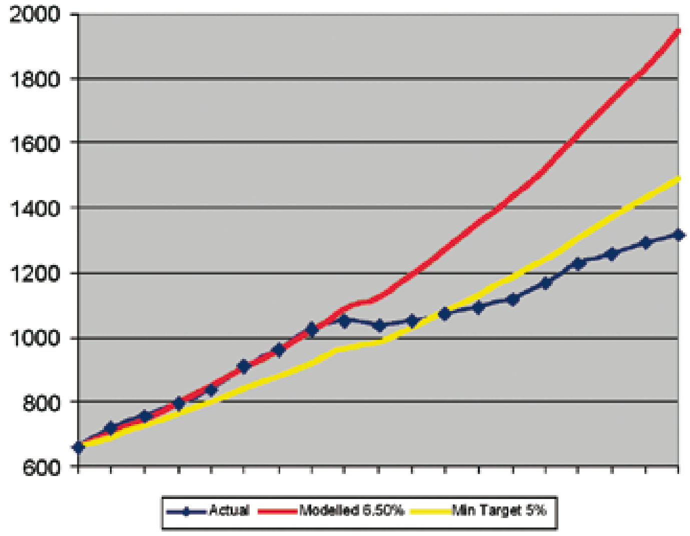

Figure 4. Changes in D.b. minor numbers in South Africa (1989-2007).

- Due to the effects of compounded growth rates, small reductions or increases in annual growth rates of rhino populations making up a metapopulation can over a few years significantly affect rhino numbers as well as the time it will take to reach conservation plan goals. For example, Figure 4 (Emslie, 2008b) shows how the South African *D. b. minor* metapopulation increased rapidly (6.6% per annum) from 1989–1996. Performance then declined in a number of larger and long-established populations where removals had been conservative (reducing metapopulation growth to only 2.1% per annum from 1996–2001). Concerns about this declining growth led to a SADC RMG Black Rhino Biological Management workshop in 2001 (Emslie, 2001). Increased removals of black rhinos and other browsers were then followed by improved growth in some of the previously sub-optimally performing populations (e.g. Ithala and uMkhuze Game Reserves). This contributed to increasing metapopulation growth (3.7% from 2001–2007). If a rapid metapopulation growth of 6.5% (similar to the 6.6% achieved for 1989–1996) could have been maintained for the whole period 1989–2007 (red line on graph), there would have been a staggering 47.5% (627) more *D.b.minor* by 2007 (1,948 vs. 1,321). Put into context this difference is equivalent to almost 95% of the total metapopulation size of 662 in 1989. A difference of only 1.5% between achieving a 6.5% or 5% growth rate over 18 years 1989–2007(red vs. yellow lines) is equivalent to 451 more rhinos. **The graph shows how small differences in growth rates matter *a lot* and demonstrate why biological management forms a key component of continental, regional and national rhino conservation plans.** Translocation is one of the main (but not only) activities that can be undertaken in an effort to maintain good growth rates.

Translocation Central to Successes in Black Rhino Conservation

In four countries (Botswana, Malawi, Swaziland and Zambia) the species has been reintroduced where it once had gone extinct.

During past periods of heavy poaching, black rhinos in major range states Kenya and Zimbabwe were translocated from areas where they were vulnerable to poachers to more secure fenced sanctuaries where rhino subsequently bred rapidly. As a result, translocated populations now conserve the majority of black rhino in Kenya and Zimbabwe.

In Kenya an increased focus on biological management for growth has resulted in the creation of new populations and recent improvements in metapopulation growth rates (Okita-Ouma *et al.,* 2007). Namibia's successful custodianship population establishment programme has also contributed to increasing rhino numbers rapidly.

The continued increase in black rhino numbers in the continent has been in part been due to the creation of new populations and the increase in rhino range. By the end of 2007, 131 populations throughout Africa conserved 4,240 black rhino and numbers of rhino and numbers of populations of all three surviving black rhino subspecies continues to increase at a continental level. Figure 5 below illustrates this trend for South Africa. Graphs for other major black and white rhino range states such as Kenya and Namibia would show a similar trend.

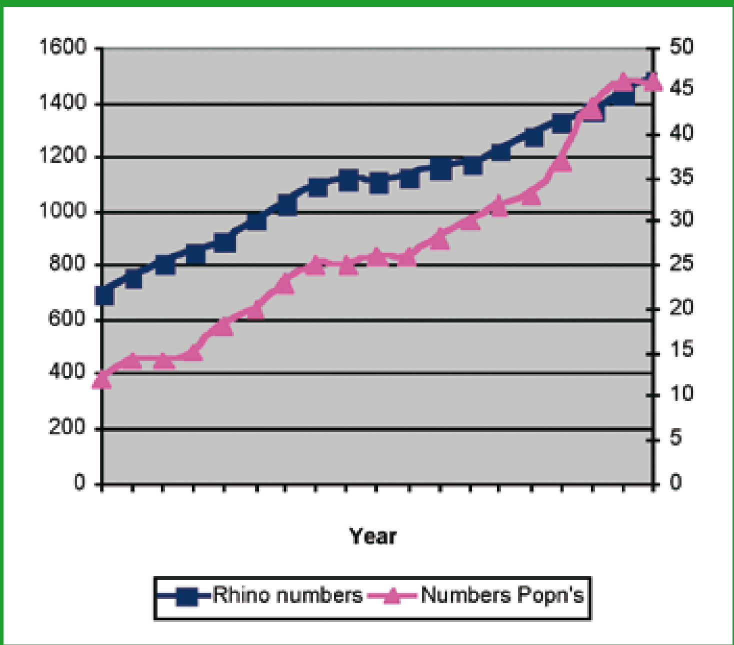

Figure 5. Graph showing increase in growth of numbers of black rhino and numbers of black rhino populations in South Africa from 1989–2007 (based on RMG data). Graph from Emslie (2008b).

Translocation of Greater One-Horned Rhino – Potential Opportunities to Increase Range

With successful conservation, numbers and densities of greater one-horned rhino (or Indian rhino) *Rhinoceros unicornis* have been increasing in existing populations, and to maintain metapopulation growth and productivity in these populations will require larger areas of new range. While expansion of existing protected areas in many cases is not feasible, opportunities exist to create additional populations in areas where suitable habitat still exists with less human encroachment. Provided these potential areas of rhino habitat can be effectively protected, they can facilitate the expansion of rhino numbers and their distribution.

The greater one-horned rhino has been exterminated from some of its key habitats due to poaching. Although the population of rhino in the wild has reached over 2600, the decrease in area of occupancy in its earlier distribution range remains a concern. Until the 1980s, rhino in Assam were found in six areas but poaching has reduced the number of areas with rhino to only three – Kaziranga National Park, Orang National Park and Pabitora Wildlife Sanctuary. In view of the need to both maintain the productivity of existing populations and to re-stock rhino in some of this species' earlier distribution range in Assam, the government of Assam with NGO support has launched the Indian Rhino Vision 2020 (IRV 2020) programme of achieving 3000 rhinos by 2020. This project initially seeks to translocate rhino from growing rhino populations in Pabitora Wildlife Sanctuary and Kaziranga National Park to Manas National Park of Assam, where a population of approximately 80 animals was exterminated by poachers during the social unrest in the area in the 1990s. This put Manas on the World Heritage Site *In Danger* list. Under IRV 2020 the plan is to translocate around 40 rhinos from Pabitora and Kaziranga to establish a rhino population in Manas National Park. Once a viable population in Manas has been established rhinos can be reintroduced to other areas.

In Nepal, the creation of additional populations in Bardia National Park and Suklaphanta Wildlife Reserve in 1986 and 2000 respectively was strategically and biologically sound. The donor population in Chitwan National Park grew rapidly from an estimated 466 animals in 1994 to 544 in 2000 (20 rhinos were also translocated to Bardia NP during this period, thus an average growth rate of approximately 4%). However there have been a number of indicators that the underlying performance of rhinos in Chitwan may have been steadily declining and therefore the removal of some animals from Chitwan through translocation was desirable on biological management as well as strategic grounds (Emslie & Williams, 2007). The new populations expanded range by 968 and 305 km^2 in Bardia and Suklaphanta respectively. A total of 83 rhinos were translocated to Bardia over an 18 year period. Ideally, the Suklaphanta population should have also been created with a minimum of 20 founders, but only four animals were translocated into the reserve. Unfortunately, deteriorating security with armed conflict and poaching has devastated the Bardia population in the last few years with rhinos only remaining in the Karnali floodplain area of the Park. The Chitwan population has also been badly affected by the poaching. These trends do not mean the policy of metapopulation management was wrong, rather the reverse. This has ensured greater resilience in the whole metapopulation. The Nepal government and its partners are working on a number of measures to secure and increase numbers in all three protected areas.

Potential of Translocation as a Management Tool to Enhance Sumatran Rhino Conservation

Poaching pressure and the drastic decline of habitat threatens the conservation of the Sumatran rhino (*Dicerorhinus sumatrensis*). In Indonesia the population of Sumatran rhino has declined by more than 50% in the past 10 years and now numbers fewer than 200 individuals, with even fewer left in Malaysia. In 1994, the Sumatran rhino was listed as occurring in 17 locations on Sumatra Island (Conservation Strategy, Anon 2007) but by 2008 only four locations still conserved good numbers of animals, namely Bukit Barisan Selatan National Park, Way Kambas National Park, Kerinci Seblat National Park and Gunung Leuser National Park).

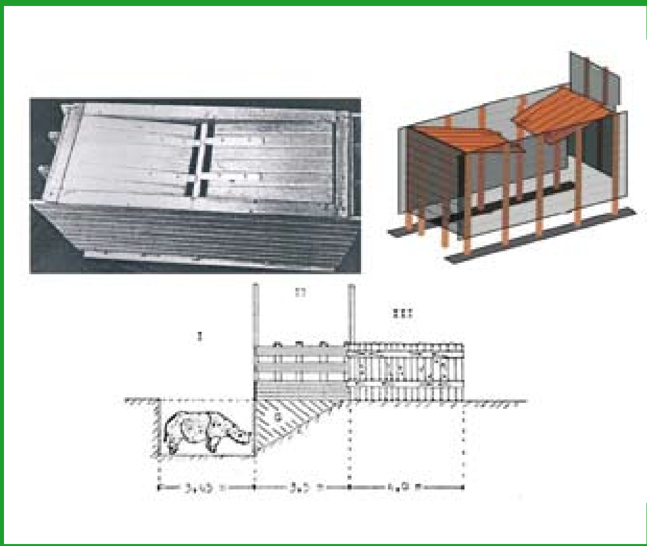

Figure 6. Pit trap (Sectionov, 2007)

Indonesia and Malaysia have some experience with translocating Sumatran rhino, but translocation of this species is very different to that practiced with African or greater one-horned rhino due to the elusive nature of this species and its dense habitat. The pit-trap capture technique illustrated left (Figure 6) (Sectionov, 2007) has proved to have a relatively low risk and was successful during early Sumatran rhino capture although numbers caught remain small. The technique does not use drugs to immobilize the animal. The use of appropriate sedatives must be considered to help calm the rhino during transport. As with all rhino translocations, the used of skilled wildlife vets and technicians is essential.

In 1988–1990, the Sumatran Rhino Trust and Department of Forestry captured and translocated around 18 rhinos to captive breeding institutions in Indonesia, England, USA and Malaysia. A further number were also captured and moved to captive breeding institutions in Malaysia. However, these programmes largely failed due to a combination of poor breeding and very high mortality rates in captivity. In 2006 the Indonesian wildlife authority also translocated two rhino from a national park to a Sumatran Rhino sanctuary. In this case the animals were caught because of security risk as they were wandering outside a national park, presumably pushed out by illegal human activities in the forest.

Opportunities exist to use translocation to consolidate outlier rhinos into a potentially viable protected population in the wild in future. Creating fenced sanctuaries or unfenced IPZs is likely to succeed, provided established populations are well protected and illegal incursions into these areas are prevented so that habitat is secured.

Potential of Translocation to Enhance Javan Rhino Conservation

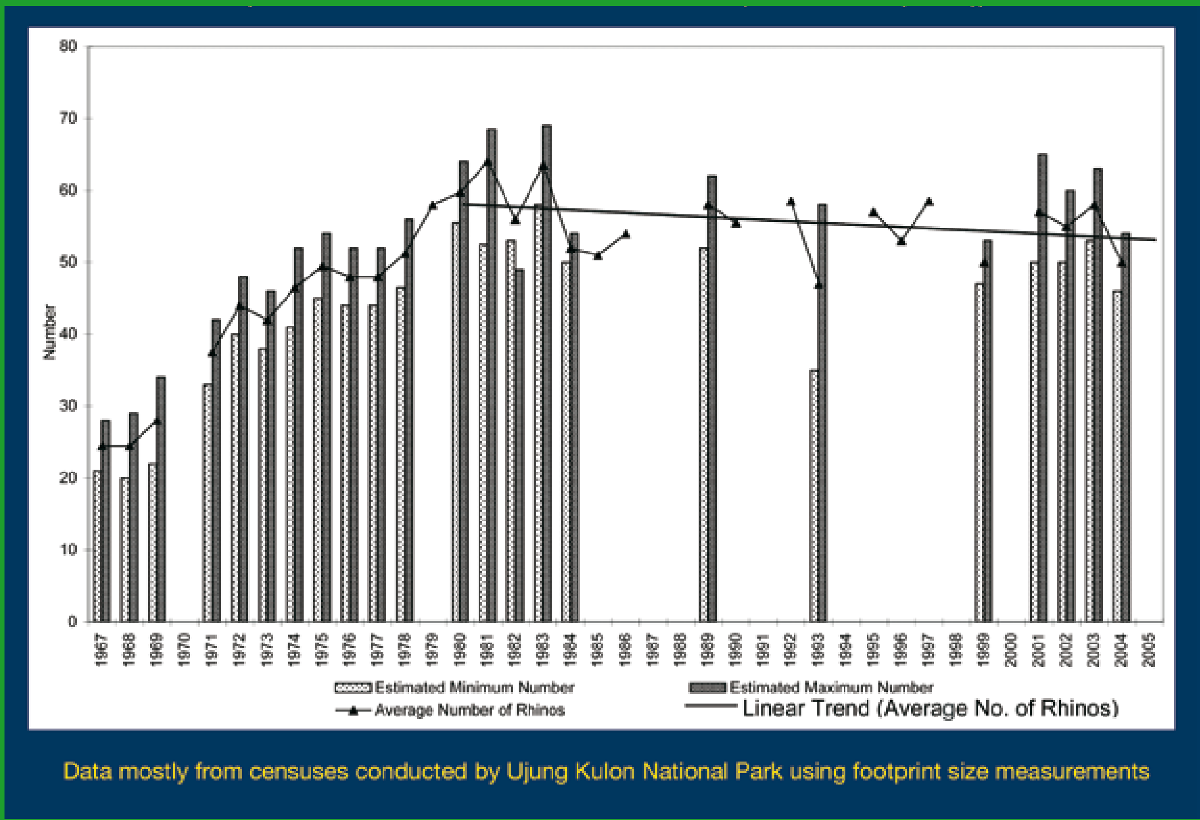

Figure 7. Population trends of Javan rhino. Graph from Gert Polet (unpublished).

Apart from a small number of rhinos in Vietnam, there are an estimated 40 Javan rhinos surviving in only one population in Ujung Kulon NP on the western most point of Sumatra. As a result of rapid human population growth and associated development and land transformation on the Island of Java this has been the only surviving population in Indonesia since 1935. The graph above (Figure 7) shows that the population has been stagnant for over 30 years and may even be declining. Limited poaching could have cancelled out births, but it is not thought this is the case as no poaching has been recorded since 1991, and the rhinos are protected and monitored by three Rhino Protection Units. More probably the population has reached or overshot carrying capacity and population performance has been negatively affected as a result. It has been hypothesised that this population might also face increased competition from Banteng.

Apart from the small number of Javan rhino in a population in Vietnam, Ujung Kulon is the last significant and known breeding population of Javan rhinos in the wild. Having only one significant breeding population is highly risky, as a single catastrophic event, such as a Tsunami, could be devastating. An upsurge of heavy poaching or a disease event could also reduce the population to a potentially non-viable number very quickly (as has happened with the northern white rhino in Garamba NP in Africa). Genetic and demographic risks of in-breeding may further threaten this population and loss of genetic diversity will have been exacerbated by the long period with no growth. To date there has not been an attempt to establish a second population elsewhere. This is unfortunate on biological-management (demographic and genetic) as well as strategic grounds. However, recognising that translocation and a metapopulation approach have been instrumental in the recovery of the African species, and that a similar approach could help the recovery of the Javan rhino, the Indonesian Government, through its recently approved Indonesian Rhino Conservation Strategy, proposes to establish a second population (known as the Rhino Century Project - Proyek Abad Badak). The pit-trap technique which has been successfully used to catch Sumatran rhino may be suitable for the capture of Javan rhino, but other potential options should be investigated.

- Translocations may also be undertaken within a metapopulation to further genetic conservation aims (usually the introduction of a rhino every 10–15 years).

- The history of rhino conservation has been one of episodic outbursts of poaching, often associated with times of civil unrest and war. Under such conditions it may not be possible to adequately secure and protect rhino populations. At other times, capacity and available resources may decline for state conservation agencies while private sector conservationists may still have sufficient resources available to effectively protect rhinos. In addition, natural disasters (e.g. a Tsunami) or disease outbreaks may threaten individual populations. It is therefore highly desirable from a strategic perspective to have rhinos widely distributed through as many populations as possible in different range states and managed under different models, on the basis that it ensures more resilience to stochastic, political and economic events. The corollary is that only having a single population of a subspecies or species makes it especially vulnerable to extinction sometime in the future. This problem is exacerbated if the population is not growing and genetic diversity (and hence long-term viability) of the population is being reduced.

Structure of the guidelines

These guidelines are organised chronologically according to the different stages of a translocation as illustrated in the flow charts in the Executive Summary (Figure 2) and at the beginning of sections 1–3 (Figures 12, 18 & 37).

Section 1 deals with various aspects of the pre-translocation phase. Section 2 discusses the implementation of the translocation and Section 3 the post-release period. Section 4 contains a useful bullet-point list of some of the main mistakes and lessons learned from past translocation exercises.

Brief history of African and Asian rhino re-introduction and translocation

White rhino

White rhino translocation history in southern Africa

Southern white rhino (*C.s.simum*) were originally widely distributed over the greater part of southern Africa. However by 1895 the sub-species had been exterminated virtually everywhere except for 20–50 that remained in the area of iMfolozi Game Reserve in Zululand, KwaZulu- Natal, South Africa. This population was vigorously protected by the then Natal Parks Board (now Ezemvelo KZN Wildlife), and by 1960 a healthy population of approximately 1,650 animals existed. It was at this point that managers began to explore options of translocating white rhino to establish breeding nuclei elsewhere in South Africa.

Pioneering work to develop immobilisation techniques for white rhinos was carried out by Tony Harthoorn and co-workers in the early 1960s. Early experiments using drugs such as the dissociative anaesthetic phencyclidine and the muscle blocking agents, gallamine triethodide and succinylcholine chloride were largely unsuccessful or dangerous, and were subsequently replaced with morphine as the primary immobilising agent, later replaced by the more potent opioid, etorphine hydrochloride (M99). The first major relocation took place between 1963 and 1964 when 97 rhino were captured, crated and driven 650km to release sites in Kruger National Park (KNP). The park eventually received 203 rhino and by 1972 a total of 1,109 white rhino had been translocated by Natal Parks Board to game reserves in southern Africa as well as to zoos and safari parks overseas. In 1989 the first game auction, which offered white rhino for sale to private reserves, was held in iMfolozi and to date over 3,500 white rhino have been either donated to formally protected areas or sold to private reserves by the Natal Parks Board/Ezemvelo KZN Wildlife. In the Greater KNP the numbers of white rhino have increased to an astonishing 9,210. South African National Parks have subsequently translocated close to 1,000 rhino from Kruger since the mid-1990s.

White rhino capture in southern Africa, and especially in South Africa, is now a routine practice, with rhinos being freely bought and sold. A minimum of 876 white rhino were traded in South Africa from 2002–2007, with roughly similar numbers from the state and private sectors. A survey in 2004 found that there were 3,240 rhinos on private land in South Africa and it is estimated that that number in 2008 may have exceeded 4,000.

Initially, darting of African rhinos tended to be on foot or from vehicles, but in major donor reserves small helicopters are now preferentially used to dart animals. Helicopters are expensive to run and this has resulted in methods and equipment being developed to speed up capture as much as possible where they are routinely used.

White rhino translocation history in East Africa

Out of range southern white rhino were introduced to a number of locations in Kenya and have since bred well with translocation contributing to further increases in numbers and range. Due to the fact that it was not possible to get indigenous northern white rhino to re-introduce into Uganda, southern white rhino from Kenya have helped to re-establish this species in Uganda. In Kenya, government policy is to support a white rhino population for the purpose of regional establishment, and with private ownership possible for this species, it is a useful tool for tourism and can help drive private sector and community wildlife conservation initiatives. The white rhino is a more visible and manageable species than the black rhino, making it an attractive commercial proposition. While the subspecies is out of range, the species is probably not alien to Kenya. This is because the two white rhino subspecies are not likely to have evolved independently, and therefore sometime in the past there must have been a continuous distribution of white rhino from east-central Africa to southern Africa prior to the ranges of the two current subspecies becoming widely separated. A fossilized skull of a white rhino from Oldupai Gorge in northern Tanzania and a fossilised jaw bone in Kenya supports this logical conclusion. Thus if one were to go back far enough in time it is probable that some form of white rhino were indigenous to Kenya.

Black rhino

Black rhino translocation history in southern Africa

In contrast to white rhino, the three surviving sub-species of black rhino (*D. b. minor, D. b. bicornis and D. b. michaeli*) occurred in much larger numbers over much of their former range (an estimated 100,000 in 1960).

Prior to the 1960s and before the advent of chemical capture, black rhino were successfully captured and relocated in East Africa using ropes and a chase vehicle, as shown in the classic John Wayne film "Hatari". The stress and trauma associated with this technique undoubtedly caused some losses and there was a need to improve methods. Chemical capture was successfully developed by Rupert Fothergill and co-workers and used in 1960 in Zimbabwe during Operation Noah, when many black rhino were saved from the rising waters of the newly built Lake Kariba. The more modern chemical immobilisation techniques used today were further developed in Kenya by Harthoorn and King and are continuously being reviewed and further improved by field vets throughout Africa.

In South Africa by 1930 only two relic breeding populations remained in iMfolozi and uMkhuze Game Reserves. Since 1930 translocation has resulted in the number of rhinos and populations steadily increasing. Between 1962 and 1970 a total of ~180 rhino were relocated to formally protected areas within KwaZulu Natal. In 1971 ten pairs were donated to the Kruger National Park, followed by an additional 47 black rhino. Additional Kruger founders were obtained from Zimbabwe. The re-established KNP population has since grown to become the second largest black rhino population in the world. Black rhino numbers have also grown in the main Namibian populations and translocations have been used to set up many new populations on state, community and private land, although in Namibia, like Kenya, all black rhinos are managed on a custodianship basis for the state. In 1990 the first breeding group of five black rhino was sold in South Africa to a private reserve for R2.2 m. Black rhino translocation has become routine in the major southern range states of South Africa, Zimbabwe and Namibia.

Cross border translocations have helped re-establish black rhino populations in South Africa (*D. b. bicornis*), as well as in Swaziland, Malawi, Botswana and Zambia (*D. b. minor*). The provision of over 20 founders to North Luangwa National Park in Zambia to re-establish black rhino in that country has been a collaborative effort within the SADC region with founder rhinos being donated by South African National Parks, North West Parks and Tourism Board, Eastern Cape Parks Board and Namibia's Ministry of the Environment and Tourism. In the latter case (Figure 8), as Namibia has the wrong subspecies for Zambia a bilateral swop deal was arranged whereby Namibian *D. b. bicornis* went to *D. b. bicornis* range in South Africa and replacement *D. b. minor* from *D. b. minor* range in South Africa were exported in their place to Zambia. In 1998 a total of 28 rhino was translocated from KZN to re-establish black rhino on a private reserve in SE Zimbabwe, and this population has bred well and should soon become a donor population. Swaziland's black rhino population was re-established with founder rhino from Zimbabwe and South Africa.

Figure 8. Photo series showing black rhino being welcomed back to Zambia during reintroduction to the country in North Luangwa NP. (A) Chief Chikwa and advisors sprinkiling mealie meal as part of a traditional blessing and naming ceremony; (B, C & D) local children celebrate the arrival of rhino with colouring/fun books, drawings and drama (Photo credits A & C: Elsabe van der Westhuizen, FZS; B: Sylvester Kampamba, FZS, D: Mike Knight).

In the early 1990s heavy poaching threatened all black rhino along the Zambezi River in Zimbabwe. Translocation was used to secure a greater number of populations in safer regions and as many animals as possible were caught and moved far from the area, especially into the Zimbabwe lowveld. Black rhinos were subsequently wiped out along the Zambezi River. The translocated black rhino in the Zimbabwe lowveld increased significantly, with many reintroduced populations being among the fastest growing in Africa. As a result of rapid population growth and declines in other areas, the re-established lowveld rhino populations have gone from being an insurance policy to become the mainstay of the Zimbabwe black rhino conservation effort, accounting for almost three-quarters of all Zimbabwean black rhino by mid-2008. However, increased poaching, land-use changes and the collapse of the Zimbabwean economy increasingly threaten even these populations.

This history demonstrates the importance of regional approaches to translocation and the value of utilizing an appropriate management model for metapopulation management to secure rhino survival.

In recent years distributed releases of founder populations of black rhino into larger areas have become the norm. In such releases animals are dropped off at different locations throughout the recipient reserve. In the past, black rhinos were released directly from crates (Figure 10) but more recently animals are darted in the create immediately before release, and as the drugs start to take effect the rhino is walked out of the crate before going down under the influence of the drugs near to the crate. All vehicles, people, crates and equipment are then removed from the area before an antidote is administered (Figure 9) entirely or partially intra-muscularly by the remaining game capture officer/vet, who will then leave the area before the rhino wakes. This release method appears to work much better than direct releases from crates or from bomas as the black rhino often start to feed immediately on waking in their new home. Stress is reduced and the introduced animals can not injure themselves by charging and attacking vehicles and crates. The reduction in black rhino mortality rates in recent years in South Africa is probably due to the use of the distributed narcotized rhino release method, combined with a shift away from introducing smaller groups into small properties to introducing bigger founder groups into much larger areas.

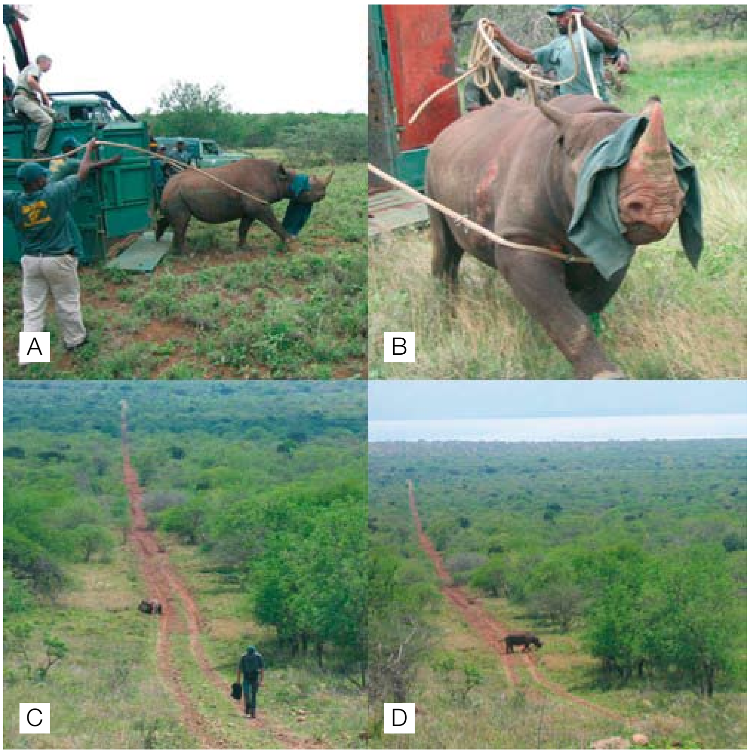

Figure 9. Sequence of photos showing a distributed release of narcotised black rhino in Pongola Game Reserve, KwaZulu-Natal South Africa. A and B show a drugged black rhino being released from a crate at the release site. This animal went down shortly afterwards and all people and equipment were removed from the site, leaving only the rhino capture officer/vet to administer the antidote. C shows the capture officer leaving the rhino after administering the antidote intramuscularly, giving the officer time to leave the area. D shows the animal walking into the bush after waking (Photo credits: Jacques Flamand WWF/EKZNW BREP project).

Figure 10. Photo series showing the technique of distributed release of black rhino directly from a crate. Black rhinos often would either charge off (A1 and A2) or spin round and attack the crate (B1 and B2) or vehicles and equipment in the surrounding area before running off. Apart from the risk of injury to the animal, this method was more stressful and black rhinos tended to move greater distances after release before settling down. This release method is no longer recommended and has been superceded by narcotised releases (see Figure 9) (Photo credits: WWF EKXNW BREP).

Black rhino translocation history in East Africa

Historically the eastern black rhino subspecies *D. b. michaeli* ranged from southern Sudan, Ethiopia, and Somalia through Uganda, Rwanda, Kenya and into north-central Tanzania (Emslie & Brooks, 1999), but in 2007 it is only found in Kenya, Tanzania and there maybe one rhino remaining in Rwanda. A further ***Key2***-rated out of range population has also been established in South Africa.

In the early 20th century *D. b. michaeli* was considered a pest and shot, with over 1000 rhino alone shot in the Kibwezi district of Kenya to make way for agricultural development. The subspecies declined further throughout its range in the 1970s and 1980s. Numbers in Kenya declined from about 20,000 to less than 400 (Western, 1982; Leader-Williams, 1988, Milliken *et al.,* 1993; Emslie & Brooks, 1999) as a result of illegal killing to supply international demand in rhino horn, primarily from Asia and the Middle East, clearing of nuisance animals for settlement and agriculture, and a severe drought during the 1980s (Martin & Martin, 1982; Martin, 1983; Leader-Williams, 1992; Nowell *et al*., 1992). The situation was eased in the late 1980s through implementation of different management strategies and the establishment of the Kenya Wildlife Service (Ritchie, 1963; Leader-Williams *et al.,* 1993; Anon., 1993; Dublin & Wilson, 1998; Emslie & Brooks, 1999).

A key strategy to reverse the rapid decline of *D. b. michaeli* was to translocate and consolidate outlier rhinos into fenced sanctuaries to provide security and enhance breeding both within and outside the range. Sanctuaries such as Ngulia in Tsavo West National Park, Lake Nakuru National Park, Solio Ranch and Nairobi National Park were amongst the first *D. b. michaeli* sanctuaries established in the 1980s and this was further expanded to other highly successful sanctuaries, such as Lewa Wildlife Conservancy, with annual growth rates temporarily reaching as high as 13% (2004). This recovery strategy has been successful (Amin *et al.,* 2006; Okita-Ouma, Amin & Kock, 2007) with numbers increasing to 700 *D. b. michaeli*: 577 in Kenya, 67 in Tanzania 54 in South Africa (out of range) and possibly one remaining in Rwanda by December 2007 (Emslie, 2008). The out of range *D. b. michaeli* population in South Africa was founded with seven rhinos translocated from Makueni in Kenya to Addo in South Africa in 1962. Only four of these animals were effective founders and in recent years additional new blood has been added to the population using animals sourced from zoos and Tanzania. This out of range *D. b. michaeli* population had increased to 54 rhinos by 2007 despite the transfer of the whole population out of Addo to another private park, and translocation of some rhinos back to former *D. b. michaeli* range in Mkomazi and Ngorongoro in Tanzania. At the time of writing plans are well advanced to re-introduce over 30 of this population into *D. b. michaeli* range in Tanzania

It should be noted that translocation of the eastern black rhino for conservation purposes started as early as the 1950s when some rhinos were translocated to zoos in North America and Europe, well before the severe decline of the 1970s. Studbook records show translocation of eastern black rhino from the wild to a North American Zoo in 1953 (Foose *et al.,* 1991). Similar movements occurred from Africa to Europe. The *D. b. michaeli* population *ex situ* has gradually increased to more than 170 animals by 2006 and some of these animals have controversially been repatriated back to Africa. Probably not so much an insurance policy, these animals are ambassadors for the species, however it should be noted that health, lack of space and management problems have constrained the viability and growth of black rhino in captivity.

In 1960s capture and translocation methods were still being developed. Before darting techniques were developed, animals were chased from a vehicle and caught using a rope. Use of rope was a risky business with high probabilities of injury to both the animal and handlers. Little was understood about the effect of these techniques to the animals but injuries and mortalities were not uncommon. Newer techniques using remotely injected chemical immobilizing agents were developed and since the 1980s there has been improved understanding of the effects of capture and translocation on the animals. A combination of the old and new methods has resulted in successful translocation of over 330 *D. b. michaeli* within Kenya since 1953 to date. Figure 11 below shows how translocation became an integral part of *D. b.michaeli* metapopulation management in Kenya between 1993 and 2007 with the translocation of 181 animals. The pattern of multiple and routine black rhino translocations across metapopulations shown in Figure 11 is repeated in other major African rhino range states South Africa, Zimbabwe and Namibia.

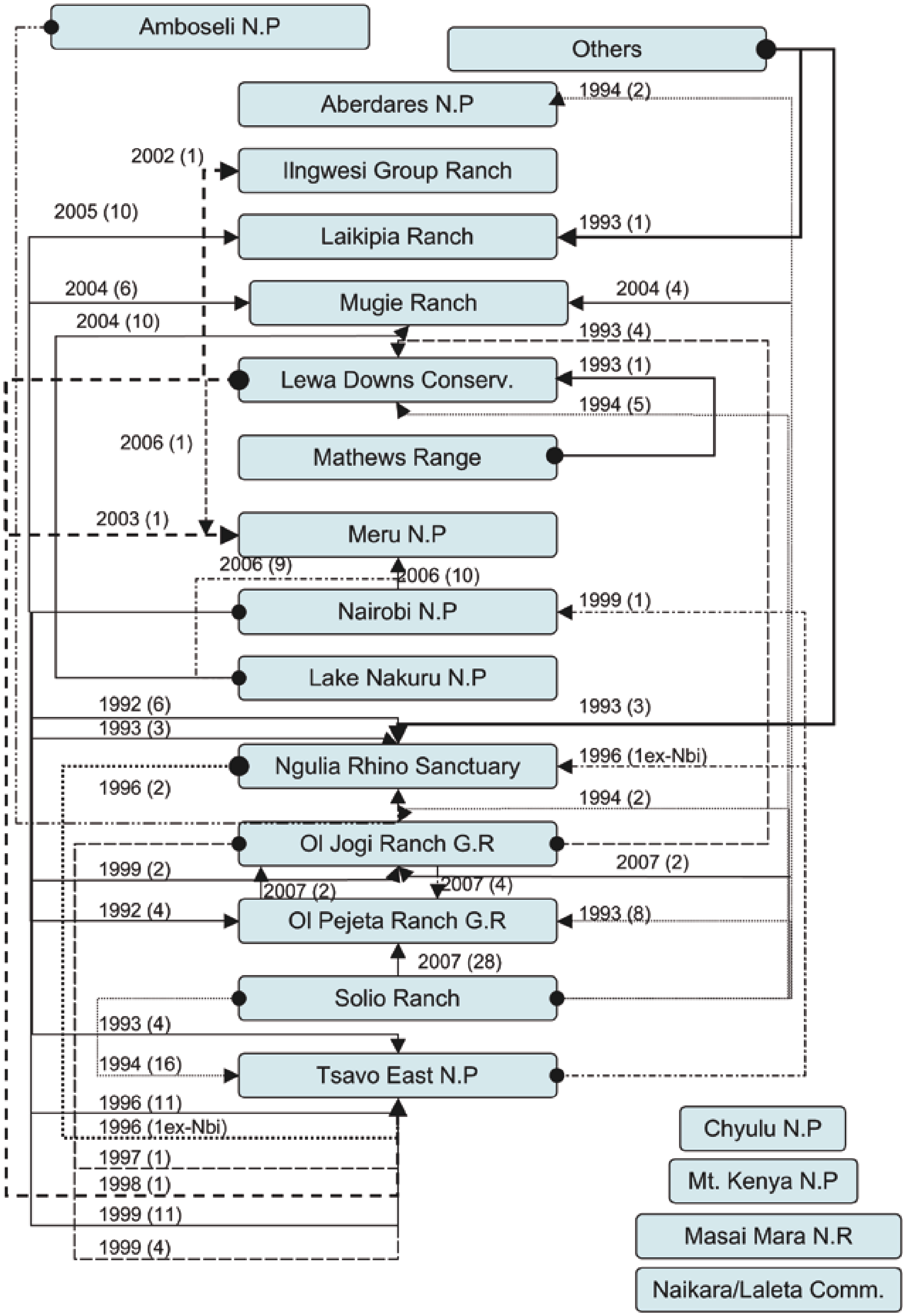

Figure 11. Translocation of *D. b. michaeli* in Kenya between 1993 and 2007 (from Okita-Ouma *et al* 2007). Figures in bracket indicate the numbers translocated.

Greater one-horned rhino

Nepal and India

While translocation has been less widespread in Asia, in the 1970s there were 8–10 translocations of rhino from Assam to Dudhwa, Uttar Pradesh, India. One mortality involving a pregnant female was recorded, and there is anecdotal evidence of one fracture case, but the translocation was otherwise successful. Calf mortality subsequently was considered to be high, including abortion and aggression-related incidents. In the 1990s, 87 greater one-horned rhino were successfully translocated from Chitwan National Park in Nepal to establish two new populations in Bardia and Suklaphanta protected areas. The total capture experience in the region of free-ranging greater one-horned rhino is in the order 100 individuals. The development of improved protocols remains constrained by this limited experience of what is still a rare procedure in the region. Capture methods have differed from Africa in that domesticated "koonkie" elephants are used as a darting platform during capture, and capture can only be undertaken during the dry season as flooding is extensive during monsoon season. Darting is carried out after a number of koonkie elephant have effectively cornered the rhino. Historically, etorphine (using the "Immobilon" preparation with acepromazine tranquiliser in combination) has been the drug of choice owing to its availability. Partial recovery/walking techniques using chemical agonist[3] antagonist combinations are currently ***not*** used with greater one-horned rhino and animals are loaded onto and moved with sled and rope techniques into waiting wooden crates and the animals recovered in the crate with diprenorphine injections. This increases the total time the rhino is immobilised by approximately 1 hour compared to African rhinos, which are partially revived and walked into crates. As expensive helicopters are not being used, speed and efficiency of capture are less of an issue. Greater one-horned rhino are usually transported and released in the recipient reserve without any boma phase. Animals that were caught for transportation to zoos in Europe and elsewhere in Nepal were usually very young (2–3 years old) and caught and placed in a pit boma (a timber lined circular hole) and kept for some weeks to adapt to artificial feeding and human presence. The wet, pond-like nature of this method ensured the animals could wallow and cool effectively. This was highly successful and tame, compliant animals were easily managed and in good health when delivered to their destinations. Greater one-horned rhinos are also moved by road using crates, as in Africa, but tranquilisation has not been routinely practiced.

Translocations are also set to increase in India as a major range expansion project in Assam gets underway. Current research to examine alternate drug combinations, including ketamine and meditomidine, which is effective with captive or tame rhino and apparently effective with young free-ranging animals. This might become a useful alternate to etorphine in certain cases, but is unlikely to be appropriate with most immobilizations of adult, healthy animals in the wild.

Sumatran rhino

Sumatran rhino have been captured successfully but due to their shy and elusive nature different capture methods have to be used compared to standard darting as practiced for white, black and greater one-horned rhino. Stockade or pit traps have been used successfully with the latter having a reduced mortality risk (see text box above). Drugs are not required to catch the animal, although as with other species the use of sedatives is advised when transporting rhino. The traps are 1.6m long, 0.75m wide and 2.0m deep (Strien, 1974). As with all rhino translocations, the used of skilled wildlife vets and technicians is essential.

[3] A chemical agonist is an agent that stimulates and blocks specific neurological receptors according to its particular affinity and the antagonist is a related agent that will preferentially occupy the same receptor and not necessarily cause the neural path to be blocked. It is in this manner that the narcotic immobilization effect of the commonly used drugs are reversed to recover the rhino.

The pit trap works passively. After being installed, it remains only a potential trap until the rhino follows the route into the trap zone. The time this will take cannot be pre-determined and this is a significant disadvantage. Trap installation along a selected track is based on the theory that Sumatran rhino are creatures of habit and regularly follow the same paths. The trap mechanism makes use of the weight of the Sumatran rhino (700–1000 kg). When the rhino passes over the sunken trap, its fore leg steps on the trap door thereby unlocking the door key so the trap door will open. While lighter animals can pass by unharmed, because of its greater weight the rhino falls into the pit trap. See Sumatran rhino text box on page 20 for illustrations of the pit trap and Sectionov (2007) for details on pit trap construction.

Attempts at captive breeding have been relatively unsuccessful and this species has suffered high mortalities in captivity. Future translocations are more likely to be aimed at catching and consolidating the odd remaining outlier rhino to form consolidated viable populations in suitably protected areas of natural habitat.

Javan rhino

To date the Javan rhino have not been captured or translocated, but experience gained with catching greater one-horned and Sumatran rhino is likely to be valuable when such translocations start.

1 Pre-Translocation Stage – Primary Considerations

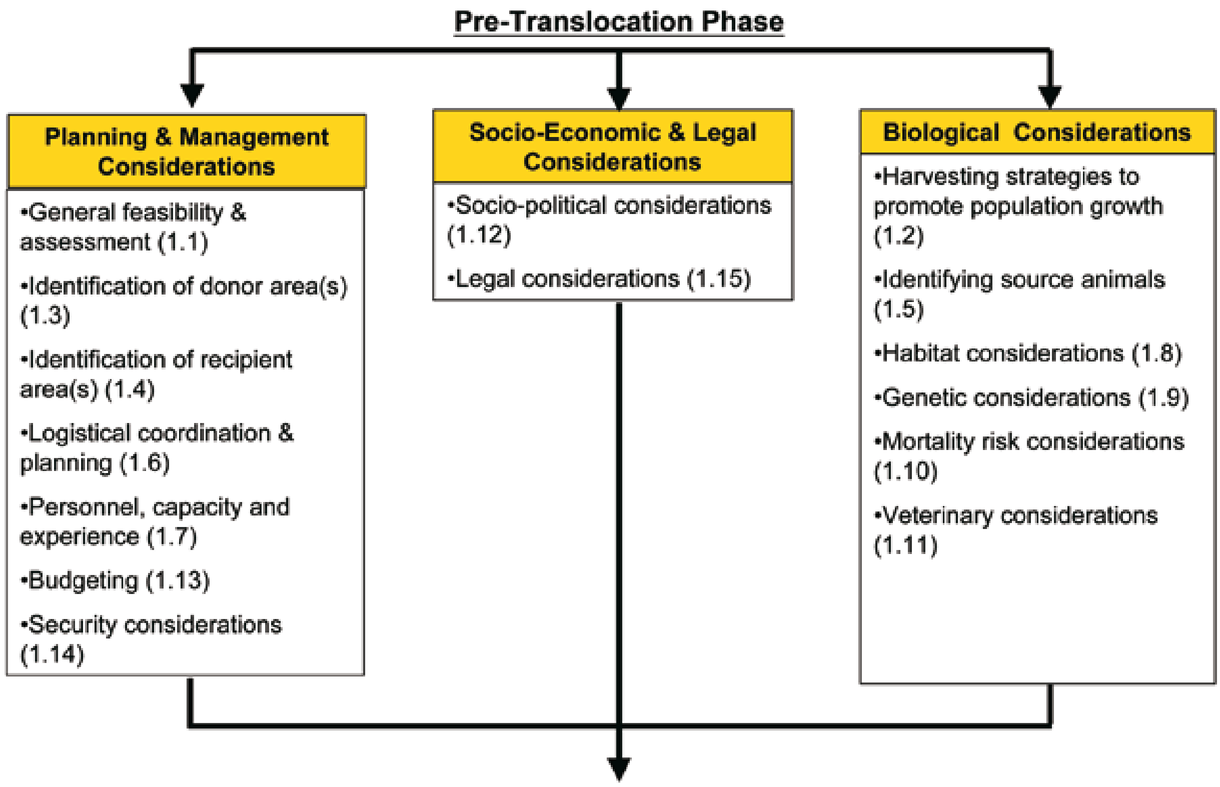

Figure 12. Flow chart illustrating components of the pre-translocation planning phase.

Rationale

Translocation and reintroduction are costly in terms of financial, human or material resources, politically sensitive and after providing protection, arguably the most important management tool for conservation of rhino. To ensure effective and efficient operations, scientifically based planning pre-translocation is the key to success.

1.1 General feasibility and assessment

Many issues need to be considered before proceeding with a translocation. These include:

- careful consideration of the justification of the proposed translocation. **This step is especially important where a feasibility study is needed to determine whether or not a project should proceed as planned, whether to wait until further information is obtained, or necessary security or infrastructure is in place etc., or whether or not the plan should be terminated;**
- defining the overall objectives of the proposed translocation;
- assessing the impact of removing animals and need to remove animals from donor populations;
- deciding how many and where animals should be removed from in each donor population;
- determining the ages and sexes and in some cases the specific animals that need to be removed;
- determining suitable release sites and specific areas for release based on screening and assessing habitat quality, estimated medium-term ecological carrying capacity (ECC), security and management capacity in potential recipient areas;

- selecting an appropriate translocation approach (e.g. field to field, boma to field, boma to boma) with this determining infrastructure (e.g. will bomas be required in the release area?);
- setting up logistical coordination and planning mechanisms;
- sorting out any socio-political issues in advance;
- sorting out any legal and permit issues in advance;
- deciding on timings of capture and introductions;
- ensuring that sufficient budgets, skilled manpower (with rhino capture experience using specialist rhino veterinarians/rhino capture officers and dedicated rhino capture teams), capture vehicles and crates, helicopters (in case of African species), koonkie elephants (in case of greater one-horned rhino), pit traps (in case of Sumatran rhino), transponders, radio-transmitters, bomas, etc. are all in place in the short term for the capture, transport, boma and immediate post-release phases, but are also in place for the necessary protection, monitoring and biological management which will be required well into the future.

1.2 Harvesting strategies to promote population growth in source populations

One of the first decisions that should be made is how many animals need to be translocated from source populations each year to maintain rapid growth rates. Desirable offtake levels will depend on the accepted and recommended harvesting strategy continentally, regionally and nationally.

1.2.1 Harvesting for growth in Africa

- African rhino conservation plans, strategies and policies (whether they are at a continental, regional or national level) have set minimum metapopulation growth targets of at least 5% per annum and sometimes higher (Kenya strategy 2007 ~ 6% in selected target populations). These minimum target growth rates are well below the suspected longer term R max (maximum sustainable per capita rate of increase) of around 9% for African rhino. Hopefully metapopulation growth will exceed these minimum target levels. This invariably requires actively managing some established populations for more rapid growth.
- Park managers are often fearful of over-harvesting their populations and historically, donor populations have tended to be under-harvested with negative consequences for metapopulation performance (Goodman, 2001). This cautionary approach is not a "safe" approach but is likely to jeopardize the achievements of national goals, and is unjustified (Goodman, 2001). **The no action equals low risk trap is one managers must conscientiously avoid** (Goodman, 2001).
- **In larger populations, IUCN SSC AfRSG, SADC RMG and SADC RPRC recommend that "Set % Harvesting" should be implemented once rhino densities exceed 50% of Estimated Ecological Carrying Capacity [ECC] (Emslie, 2001). Removals should on average be at least 5% per annum over time, but not more than 8%**[4] (Emslie, 2001; Goodman 2001). Larger removals can be undertaken 1 year with no removals over the next 2–3 years provided the offtake still averages at least 5%/annum (e.g. 15% in year 1 and no removals in years 2 and 3). With set percentage harvesting, correctly estimating ECC is less important than when seeking to manage populations at or below 75% of ECC. Theoretically a population's density should adjust to the level that can sustain the set % annual offtake to a level where births balance out those animals removed (Caughley, 1977; Goodman, 2001). What this means is that theoretically (all else being equal), if one only removes 2% per annum one cannot expect to

[4] For more details of suggested black rhino harvesting strategies for growth see the RMG Black Rhino Biological Management Workshop Proceedings (Emslie, 2001) available on the AfRSG web page.

achieve more than 2% underlying growth in the longer term. Sub-optimal performance following a period of conservative removals is therefore to be expected. Densities should also adjust under Set % Harvesting in response to any changes in underlying ECC. Annual offtakes under Set % Harvesting are also likely to vary less than under a strategy of managing populations at or below 75% of ECC (Goodman, 2001).

- When harvesting for growth from small populations mangers should either seek to maintain populations at or below 75% of estimated ECC or undertake Set % Harvesting but only removing animals every 2–3 years (e.g. 15% every 3 years, which would approximate 5% per annum).

- An exception to the above recommendations occurs in arid areas with highly variable rainfall (CV >30%) and in Africa this is usually in areas with rainfall <400mm. Populations in such areas will rather tend towards some saturation density during wet periods, without ever attaining it before drought conditions ensue, limiting numbers. In such cases the concept of a fixed carrying capacity becomes meaningless (Owen-Smith, 2001). Instead offtake levels should be set relative to estimated ECC during low rainfall periods.

- While medium-term ECC estimates are at best approximate rather than precise figures, they still can be practically useful in helping guide and inform offtake decision-making (if managing rhino populations at or below 75% of estimated ECC as well as to help decide when stocking rates have exceeded 50% of ECC and one should start Set % Harvesting). Such estimates are also useful for assessing the potential of new areas for black rhino re-establishment (including setting a desirable upper founder number in relation to ECC).

- Population performance indicators and population estimates derived every 1–3 years (preferably annually) should be reviewed and interpreted both at a park and country/ metapopulation level. Such comparative analyses can help highlight under-performing populations which might need to have their rhino densities reduced to improve their underlying performance.

- Savanna habitats can be very dynamic and habitat quality (and ECC) can decline rapidly following successive changes, increases in alien plants or negative impacts on food plants following large rises in numbers of competitor species. To avoid declines in underlying rhino performance, consideration may need to be given to temporarily increasing rhino offtake levels and/or reducing competitor densities (Brett & Adcock, 2002; Adcock *et al.* (in prep), Emslie & du Toit, 2006; Okita-Ouma *et al.,* 2007, 2008a,b). Under Set % Harvesting rhino populations should eventually stabilize at a new lower level that can sustain that level of harvesting. However, in instances where ECC is declining rapidly it may take time for underlying performance to increase without increased removals of rhinos and/or competitors.

1.2.2 Harvesting for growth in Asia

- Given high human densities and extensive settlement, sufficiently large areas of suitable and secure habitat for range expansion are more limited in many areas of Asia than in Africa. Thus opportunities to aggressively biologically manage rhino populations for rapid growth (as is being done in many African range states) are more limited in Asia.

- Nevertheless, where possible, translocation to suitable new areas should be considered in Asia (such as was done in Nepal and is being planned in Assam) in the expectation of increasing underlying performance in long-established source populations which may be showing signs of density dependent declines in performance, as well as achieving rapid growth rates in re-established populations, and in the process increasing range and overall rhino numbers and metapopulation performance. This should be continued until viable and optimal founder populations are established in new areas even if there are declines or losses after initial translocations due to unforeseen circumstances as experienced in Nepal (Bardia National Park and Suklaphanta National Reserve) provided the reasons for the declines e.g. temporary breakdown in law and order and security are no longer a threat to translocated rhinos.

- Strategically using translocation to increase the range and number of rhino populations is wise as this reduces risks compared to having all or most of a subspecies in only one or a very small number of populations (e.g. having only one confirmed breeding population of Javan rhinos in Ujung Kulon).

- The role of other factors such as poaching, heavy grazing and disturbance in some buffer zone areas (e.g. around Chitwan National Park), increases in invasive alien plants, and or the possible negative impact of potential competitors (such as Banteng in Ujung Kulon? or Impala and Nyala in Hluhluwe-iMfolozi Park and Ndumo Game Reserve) may also need to be considered when developing a strategy to grow rhino numbers rapidly.

1.3 Identification of donor area(s) which can supply founder rhino

- Established populations whose population densities have increased to the level that is approaching or have reached/exceeded estimated ECC are ideal candidates to supply rhino[5]. Monitoring of a number of indicators (underlying growth rate, average age at first calving, average inter-calving interval, ratio of calf numbers to adult females, average adult (>7 years) female months per calf born[6], mortality rates from fighting, increased amounts of unpalatable foods being eaten [if data are available to assess changes in rhino diets over time] etc.) can indicate whether or not a population is performing poorly and may be suffering from density dependent reduced performance. By reducing densities of rhinos and other potential competitors in such parks, one can free up more quality food for remaining females, and hopefully improve reproductive performance (Adcock *et al. in prep;* Brett & Adcock, 2002; Emslie & du Toit, 2006; Okita-Ouma *et al.,* 2008a,b). However it is preferable to be proactive and start removing rhino (and possibly also other competing species) to reduced densities before one starts observing declines in performance. (Figure 13).

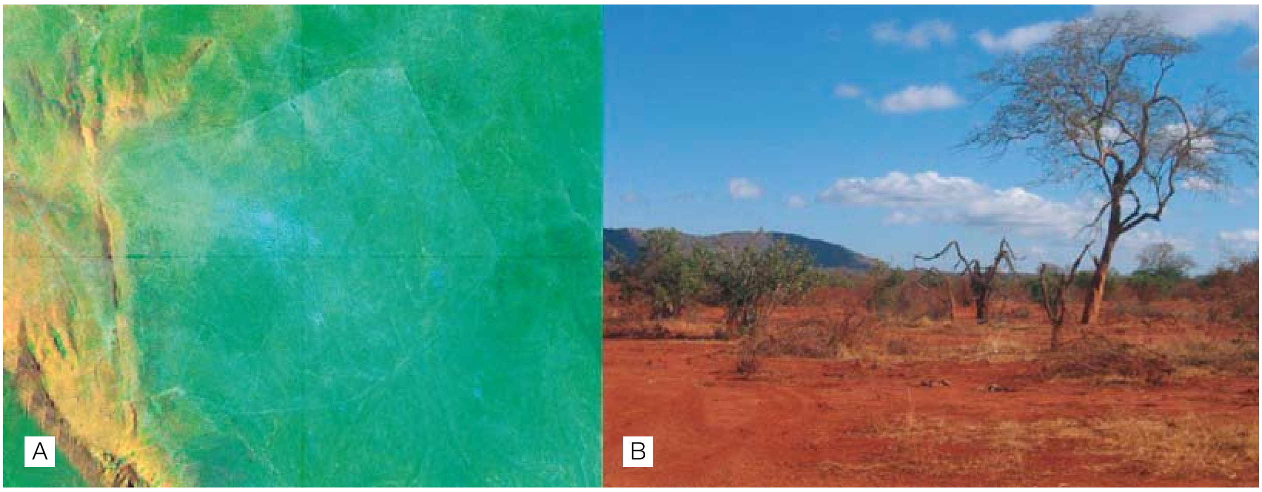

Figure 13. (A) Satellite Image of Ngulia Rhino Sanctuary (image credit Keryn Adcock) and (B) inside the sanctuary showing the negative impact that a build up of elephant and black rhino had on woody vegetation. These changes coincided with a decline in black rhino breeding performance (Okita-Ouma *et al.,* 2007). The elephants have since been removed, the sanctuary expanded and black rhino density reduced (Okita-Ouma *et al.,* 2008a & b) in an effort to increase the productivity of this population. (Photo credit: Richard Kock)

- National or organisational conservation plans and biological management policies may specify or recommend when populations should be harvested and how many rhinos should be removed. For example, the SADC RMG recommends that larger populations with densities in excess of 50% of ECC should be harvested using a set % harvesting strategy with a minimum annual

5 This approach will not hold in arid areas with high coefficients of variation in rainfall. In such cases maximum long term stocking densities will instead be limited by food availability during low rainfall periods, and the population density may never approach potential ECC of the area during wetter years.

6 This is calculated as the sum of the number of months each known female has been an adult (>7 years) in a population divided by the number of calves born. This produces an indicator similar to the observed inter-calving interval, but unlike the latter, this measure also includes data for adult females which are not breeding or which have not had more than one calf yet.

offtake of 5% of the population; or that smaller populations should be kept at, or preferably below, 75% of estimated ECC (Emslie, 2001).

- Aside from genetic management considerations, populations with densities below 50% of ECC should be left alone to grow.

- Countries and conservation agencies with plans and policies may have formal committees which meet annually to assess removals in terms of both how many animals should be removed from parks and also where they should be translocated to.

- To promote long-term genetic viability, geneticists advise that a rhino should be translocated between areas every 10–20 years to introduce new blood.

- One of the biggest mistakes decision-makers can make is to develop a "fortress" mentality when animals are being protected and conserved in fenced sanctuaries. If rhino numbers have increased to the stage that the underlying performance of the rhinos is likely to be compromised or is already suffering through factors, such as increased male fighting, long inter-calving intervals and higher juvenile mortalities), then any reluctance to remove some animals from the safety of the fenced sanctuary will ultimately reduce metapopulation performance further. Where black rhinos have to be reintroduced in stages, to reduce the risk of fighting-related mortalities, successive founder groups can initially be released into a number of adjoining sanctuaries with a view to removing fences once all the rhinos have settled and become familiar with each other through the fences. Keeping animals inside these temporary sanctuaries for longer than planned due to a fear of releasing animals may have negative consequences for rhinos if the 'temporary' sanctuaries are not large enough.

1.4 Identification of recipient area(s) for rhino

1.4.1 Suitability assessments of potential recipient reserves

- One of the most critical decisions to make is where to invest rhinos to relocate for biological management and/or strategic reasons. There usually are a range of possible options, and in order to make an informed decision it is necessary to undertake full assessment of potential areas (Emslie, 1993).

- The assessment of potential recipient areas should evaluate both non-ecological criteria (e.g. security, socio-politics, veterinary issues, fencing, ease of future translocation, whether sustainable funding is in place for future management, security of land tenure) as well as ecological assessments pertaining to habitat quality and estimated ECC for the area and whether the area falls within the natural range for the subspecies.

- Assessments should be undertaken by experts in the relevant fields, such as rhino security or rhino ECC estimation.

- If a conservation department or agency is going to undertake many translocations it may be useful for it to develop their own reserve assessment forms. For example, Ezemvelo-KZN-Wildlife, South African National Parks and the Namibian Ministry of Environment and Tourism have developed their own property/reserve assessment forms to help evaluate potential black rhino areas requesting or bidding for rhinos for reintroduction. These documents usually set minimum standards, such as minimum ECC (in terms of estimated rhino numbers the area could hold), fencing requirements and/or minimum manpower densities for law enforcement range staff. A comparison of the results of these assessments can be used to make a decision on where rhinos should go. These assessments can also be used to determine whether or not properties pass minimum standards to be allowed to receive donated rhino or bid for/buy rhino.

- To facilitate comparison between different sized areas it is important to define ECC and rhino stocking rates are expressed in terms of densities (usually as rhinos/km^2 but sometimes as km^2/rhino), rather than simply number of rhinos.

- Assessments may identify a potential area, but may conclude that certain actions are needed before translocation should go ahead (for example current security manpower densities and reserve infrastructure may not be sufficient and/or bomas or release sanctuary fencing incomplete). **If a reserve for some reason is not ready to receive rhinos they should not be translocated until such problems have been rectified.**

1.4.2 Size of Potential Recipient Reserve

- Ideally, managers should strive to introduce at least 20 unrelated founders into areas with the potential to grow to at least 50 rhino. To ensure room for growth, new areas should not be stocked more than about 40% of ECC. Thus, if the estimated ECC of an area is 0.1 rhinos/km2 (or 10 km^2/rhino) and the aim is to introduce 20 founders, the area should be at least 500 km^2 (i.e. an area to hold at least 50 rhinos (ECC) would need to be a size of 50/0.1 or 50*10 km^2).

- Countries should preferentially seek to establish larger populations rather than smaller ones as post-release mortality rates appear to be lower when bigger groups are introduced (Brett, 1988; Linklater & Swaisgood, 2008).

- Smaller groups of rhinos can be introduced into smaller areas but this should only be done if a metapopulation management structure is in place. In this scenario, much more expensive manipulative population management will be required in future, such as introduction of new blood and removal of animals to prevent fathers mating with daughters. Care must be taken to ensure that small reserves are not overstocked with founders relative to their ECC.

- Rapid expert assessments (1–2 days) per reserve must be undertaken as a minimum for initial screening. Such exercises can quickly identify and rule out unsuitable areas. However, for major introductions a more thorough assessment is usually recommended.

1.4.3 Differences in conditions between donor and recipient reserves

- Black rhino are apparently genetically tolerant of exposure to tsetse fly and trypanosomosis[7] and suffer no disease unless they have been isolated from the parasite for a long period and are suddenly exposed or suffer stress and/or induced immunosuppression (Okita-Ouma, Amin & Kock, 2007). This occurs where populations occur in disease-free zones, such as highlands, i.e. Laikipia Plateau (Foose *et al*., 1992), and animals from these areas are translocated to infected areas (e.g. Tsavo National Park) without consideration of the potential risks (Kock *et al.,* 1999; Mihok *et al.,* 1992). Irrespective of their origin, given exposure the animals adapt within a few weeks and show normal resistance to infection. This usually involves slow exposure of the translocated animals to the disease in their new home, initially by reducing density of the carrier tsetse fly around the release bomas and release area (using tsetse traps or chemical targets). Immediate high exposure through, for example, misplacement of release bomas in dense tsetse infested bush can result in mortality. On the other hand there is high susceptibility of southern white rhino to trypanosomosis caused by *T. brucei* which is prevalent in East Africa and not South Africa; whereas they appear to be reasonably tolerant to local trypanosome species in southern Africa. This is perhaps not surprising and there is no indication that reducing the infection challenge will

[7] Trypanosomosis denotes primarily any production, increase or invasion within an animal of parasites, and with black rhino it is more a general health issue than a disease per se. Trypanosomiasis indicates an unhealthy state due to tryps and is more consistent with disease.

lead to resistance as translocated animals have died some months after controlled exposure in Kenya (Kock *et al*., 2007).

- Consideration should also be given to the possible effects that differences between the habitats, soil nutrient status and or rainfall of recipient and potential donor areas may have on the success of translocations. For example, rainfall in East Africa varies from under 400mm to 1000mm per year, resulting in long periods of vegetation growth in some areas and shorter periods of prime vegetation growth in other areas. Translocating rhinos from a high rainfall zone to a lower rainfall zone was observed to affect animal health and adaptation in Ol Jogi Ranch, Kenya. Similarly, it may take time for black rhino translocated from nutrient rich succulent habitats, such as the Great Fish River Reserve to adapt to local browse conditions in more nutrient poor miombo habitats, such as North Luangwa N.P. Work is currently underway to test the hypothesis that it is not possible for black rhino females to build up condition as quickly after giving birth in nutrient poor areas, leading to increased inter-calving intervals and hence reduced population growth rates. If this is proven to be the case, and all else being equal, then animals should preferentially be translocated to nutrient rich habitats if there is a choice between a nutrient rich and nutrient poor recipient area.

1.4.4 Different ownership/management models for rhinos

- Different countries have different laws and policies in terms of whether community or private ownership and/or custodianship management of wildlife is allowed, and these have some bearing on rhino translocation options in terms of where surplus rhino can be invested.

- The majority of rhinos in Africa are still conserved in parks run by formal state conservation agencies (69.9%in 2007 down from 75.6% in 1999 AfRSG data).

- Where private ownership of rhinos is not permitted, the private sector or local communities can still play an important role in assisting state conservation agencies conserve rhinos on a custodianship basis. Irrespective of whether or not all rhinos remain the property of the state, the private sector in particular, and increasingly also communities, are playing an important role in assisting state conservation agencies in Africa conserve rhinos. Even where private ownership of rhinos is permitted, the state may choose to enter into some form of custodianship arrangement to ensure rhinos go to the best habitat available and usually to larger areas and not to smaller private properties that can afford to buy rhinos and only satisfy minimum criteria.

- Strategically having rhinos under different management models can spread risk. For example, there have been times in the past in Zimbabwe and Kenya where private sector managed reserves performed better than state run parks during periods of heavy poaching pressure.

The rest of this section summarises the main pros and cons of different rhino ownership and custodianship management models (as outlined by du Toit & Emslie (2006), quoted extensively in sections 1.4.4.x below).

1.4.4.1 Private ownership

- Pros and cons of management under a private ownership model include the following.
    - Budgets for many privately run conservation operations may be significantly higher (per km^2) than in state-run parks, facilitating high-class protection, monitoring and management.
    - Private sector involvement can wholly, or in collaboration with the state, fund and assist with the translocation and re-establishment of rhinos in a country.
    - On the negative side, depending upon the nature of contracts entered into, the state will have less influence over how rhinos are managed when under the ownership of the private sector compared to those being managed on a custodianship basis.

    - Rhinos may end up being sold to the highest bidder, not necessarily to the reserve or park with the best potential for future population growth, and sometimes to the detriment of genetic diversity. Therefore if rhinos are to be sold to the private sector they should only be sold to reserves with good potential for biological growth.

1.4.4.2 Custodianship arrangements

- A custodianship scheme refers to a situation where rhinos are allocated to a wildlife operation (which may be a private reserve, a community reserve or even one that is under the control of another wildlife management authority in a different province, state or country) without transferring ownership of the rhinos to that operation. The question of future rights, such as ownership of progeny, is dealt within in different ways according to national legislation and policies. In some situations (e.g. in KwaZulu-Natal, South Africa), a state or provincial rhino management authority might retain ownership of all founder rhino but agree to share the progeny (and any benefits derived from them) being managed by private sector or communal custodians. In countries where legislation permits private ownership of rhinos, the private owners may sometimes have reason to allocate some of their rhinos according to a custodianship arrangement (for instance, if sale prices are poor or if an owner chooses a deal that shares progeny while retaining a claim on the founder animals).

- Pros of custodianship schemes (from the perspective of a state or provincial management authority) include:
    - Rhino range can be increased at no additional cost to the state.
    - Rhino populations can grow rapidly after being re-established on custodianship properties or communal land with space to expand.
    - By letting private land owners and/or communities bear all or most of the costs of protecting and monitoring custodianship rhinos on their land, state conservation agencies are able to concentrate their (sometimes limited) resources in their own rhino parks allowing them to better conserve rhinos in state run parks.
    - Unlike sales to the highest bidder, the state can decide to allocate surplus rhinos on a custodianship basis to areas with optimum rhino conservation potential (rather than to those that merely have the most money).
    - Budgets for many privately-run conservation operations may be significantly higher than in state-run parks, facilitating high-class protection, monitoring and management.
    - Private sector involvement can wholly, or in collaboration with the state, fund and assist with the translocation and re-establishment of rhinos in a country.
    - If the state agency specifies minimum carrying capacities for areas to receive substantial founder groups of rhino on a custodianship basis, this can act as a catalyst for neighbouring landholders to take down fences and cooperate to create larger more viable conservation areas for rhino reintroductions which can take 20+ founders. This process, catalysed by rhinos as the “flagship species”, can create significant opportunities for other aspects of biodiversity conservation and can induce economies of scale in wildlife management.
    - A contract drawn up between the state and custodian can stipulate the responsibilities of the custodian (e.g. monitoring and reporting requirements) and may specify that the state is within its rights to take the rhinos out in response to a failure to meet the conditions of the contract.
    - Public sector finance laws in a country may prohibit or make difficult the giving away of state assets to the private sector/communities. By retaining ownership of founder rhinos donated under a custodianship agreement (but perhaps sharing the offspring with private sector/communities) and retaining the right to withdraw these founder animals the state agency can ensure it does not fall foul of such laws.

- However there are a number of cons with custodianship schemes:
    - Under a straight custodianship scheme, landowners have all the expenses and a more limited range of use options than if they owned the rhinos.
    - Custodianship properties in some countries may not have a large carrying capacity necessitating many small rhino populations fragmented over different properties. This fragmented situation requires expensive and active hands-on management, to prevent inbreeding and overstocking; which a conservation agency may increasingly struggle to afford as the need for interventions and number of custodianship populations increases.
    - If there are many different and smaller custodianship populations in a country, this may place an additional administrative management burden on a state conservation agency.
    - Custodians sometimes argue against necessary rhino management actions such as de-stocking or dehorning (in the face of a poaching threat) thus creating friction within the national rhino conservation programme. Therefore, the custodianship agreements need to be formally concluded between the parties, and it is critically important that at the outset of each restocking project agreements should be very clear about who has ultimate management control and custodians should be warned that once densities have built up rhinos are likely to be removed in future in an attempt to keep populations productive. Usually such agreements are in the form of a formal legal contract between the state agency and custodian.
    - Potentially reduced revenues for those state or provincial conservation agencies that are allowed to retain revenues from business activities (as founder animals not sold).

1.4.4.3 Large Conservancies

- Significant potential areas for rhino conservation in African can be created where private land owners or communities on communal land form conservancies (du Toit & Emslie, 2006).

- Ideally this has involved the consolidation of a number of smaller areas into one large area (with any internal fencing between properties being taken down).

- Rhinos have been the catalyst to help develop large conservancies in Zimbabwe (e.g. Save Valley), South Africa (e.g. Mun-ya-Wana) and Namibia (e.g. in the Kunene region). By cooperating and creating a larger potential area for rhinos, conservancies may then become eligible to receive black rhinos to manage on behalf of the state (when previously their component areas may have each individually not been big enough to qualify to receive even a small breeding group of rhinos). The idea is also gaining currency in Kenya at least in planning although the term has been used, perhaps incorrectly, to describe single properties in that country.

- Donor support can be allocated in ways that exert maximum leverage for the creation of these larger areas, in place of smaller, fenced-off units (du Toit, 1998). In a straight conservancy arrangement, the landowner has the opportunity to obtain rhinos without having to buy them. Depending on the prevailing land-use, this may or may not have an ecotourism benefit.

- More recently, in KwaZulu-Natal, a modified form of custodianship arrangement has been developed whereby the founder rhinos remain the property of the state conservation agency that supplied them, but subsequent offspring and any benefits derived (e.g. from their subsequent sale etc. are shared with the landowner. In this way the state becomes the part "owner" of more rhinos and private landowners have an increased incentive, based on the potential sale of some of the progeny, to breed the rhinos up rapidly.

1.4.4.4 Contractual park arrangements (for expansion of rhino range)

- Contractual parks can be a win-win option for the state (to increase the size of its National Parks), and for the private sector and/or communities (who then become part of a larger conservation area). Following negotiations and the signing of a contract between the state conservation authority and the other parties, additional areas can be contractually incorporated into existing national parks (e.g. the Greater Kruger National Park and Greater Addo Elephant National Park). The contract is likely to specify future management practices, requirements and responsibilities (security, monitoring, allowable tourism, sustainable use practices, etc.) on the private/community land, which will then acquire official park status. The development of contractual parks may be the most feasible and cost effective option available to link existing formal conservation areas, and to create much larger contiguous areas of wildlife habitat which could in time hold significant ***Key***-rated[8] rhino populations.

- This mechanism can therefore create additional rhino conservation areas with the highest possible protection under law. The taking down of boundary fences has resulted in five private reserves and two other state run reserves to the west of Kruger National Park being joined with KNP creating a larger Greater Kruger conservation area. The taking down of western boundary fences has also allowed more East-West movement of game. The expanded Greater Kruger National Park now conserves the world's largest white rhino population and second largest black rhino population.

1.4.4.5 Buffer zone management model (community forests etc)

- Areas around unfenced National Parks and Game Reserves may be declared as community forests, Buffer Zone Management Areas, Game Management Areas (GMA)/community use areas/ hunting reserves etc. Such areas can help provide habitat for any surplus rhinos that move into them. The presence of rhinos in such areas may help generate income for communities through ecotourism; and such buffer zone communities may also receive a share of the money which has been generated by the Park itself (e.g. around Chitwan National Park in Nepal) although in practice this is rarely the case and monies are often "captured" by local authorities preventing benefit reaching individual community members. Such areas can also be patrolled and act as a first line of defence when protecting rhinos in the core of the National Park (e.g. in GMAs around North Luangwa NP in Zambia).

1.4.5 Wild vs. captive or semi-captive breeding

- In keeping with the strategic approach of metapopulation management, spreading both the burden and the risk, it is desirable that a certain number of rhinos of more common subspecies are maintained within *ex situ* (outside the region) captive-breeding programmes. However, these programmes must be regionally or internationally coordinated to ensure metapopulation management amongst a number of zoos (such as the North American Species Survival Programme or European Zoo Rhino Taxon Advisory Group). Linkages with these international programmes and their member zoos can and should result in the generation of conservation funding and other support for the areas from which rhinos are sourced (Emslie & du Toit, 2006).

- Rhinos in zoos and safari parks can also act as ambassadors for the species outside of range states, and can be used to educate the public about the plight of rhinos. Captive breeding/ intensive management institutions and associations (such as the European Association of Zoos and Aquaria, the International Rhino Foundation, Zoological Society of London, Frankfurt Zoological Society, the American Zoo Association, Chester Zoo and others) are increasingly providing funds and technical support to assist *in situ* conservation efforts in Africa and Asia.

- However there is very little rationale for intensive captive or semi-captive rhino breeding programmes in Africa because of a number of problems that can arise, and the fact that invariably wild populations have performed far better for less money (Emslie & du Toit, 2007). The same principle should also hold for Asian species. For example, attempts to breed Sumatran rhinos at captive breeding centres have not been successful, and for various reasons mortality rates have been high. Alternatively, if it were possible to simply fence and protect a large enough area and stock it with captured outlier rhinos, we would likely see a better return in terms of rhino growth for a probably lower overall cost.

[8] See Definitions section for a definition

While a very small number of captive rhinos have been successfully reintroduced to the wild, in general this is a very expensive option, and caution should be taken with regard to introducing diseases, which could seriously compromise the health of potential/actual ***Key*** and ***Important*** rated rhino populations in the wild (Osofsky *et al*., 2001). Disease risks need to be considered on a case by case basis before proceeding. Currently, shortage of founder black rhino is the primary factor limiting regional rhino re-introductions and range expansion. Captive breeding institutions may start to play a more important role in future by providing surplus rhinos to aid wild re-stocking programmes. Disease issues and problems associated with getting naïve captive animals back to living in the wild may mean that such animals may be translocated to a dedicated "back to the wild" breeding reserve and the wild-born offspring used to provide future founder animals.

1.5 Identifying source animals

- Once it has been decided how many rhinos should be removed it is necessary to determine which specific animals are to be removed, or at least the desirable age and sex structure of animals to be removed. Managers need to consider not only the desirable composition of the founder group to be introduced but also how best to harvest to avoid negatively affecting the sex and age structure and subsequent performance of the source population.

- The spatial spread of removals across a reserve also needs to be considered so that easily accessible or prime habitat areas are not over-harvested and other areas left relatively untouched.

- In some instances security considerations or the application of a process-based management dispersal sink strategy (e.g. as is undertaken for white rhino in Hluhluwe-iMfolozi Park) may make it desirable to selectively harvest more rhinos in boundary or other vulnerable areas of parks.

- In order to make up the total number of founders, rhinos may need to be sourced from more than one population. Indeed, having rhinos from different populations may increase initial genetic diversity of the founder population and be highly desirable. For example, the Manas Indian rhino population is to be re-established using founders sourced from both Kaziranga National Park and Pabitora Wildlife Reserve and populations stocked with black rhino from KwaZulu-Natal, South Africa invariably have included stock derived from both historical source populations (Hluhluwe-iMfolozi and uMkhuze). Many of the initial black rhino populations in Kenya were sourced from a wide area, usually remnants in heavily poached localities e.g. Nairobi and Nakuru National Park, Solio and Lewa Ranch (Okita-Ouma, Amin & Kock, 2007). Reintroduced black rhino populations in Swaziland and Kruger National Park have included founder rhinos from both Zimbabwe and KwaZulu-Natal.

- When translocating black rhinos in particular, ideally all founder rhinos should be translocated at once or over a short period to minimise the increased chances of fighting mortalities that can occur when (as a result of staggered reintroductions over time) additional rhinos are released into areas with established resident rhinos. Staggered releases of black rhino can be done successfully using temporary fences (e.g. as was done for black rhino in Mkhaya, Swaziland, and is being done in North Luangwa National Park, Zambia). However the latter is a more expensive option and if animals are kept restricted for too long (Figure 14) there may be exhaustion or deterioration of available quality browse and loss of condition amongst the translocated animals, as experienced in 2005–2006 in Meru National Park, Kenya.

Figure 14. Low electrified fencing used to make the temporary sancturaries into which successive groups of founder black rhino were reintroduced to North Luangwa National Park, Zambia, as part of a staggered reintroduction (Photo credit: Elsabe Van der Westhuizen, FZS).

- While it is not desirable or cost effective to translocate old animals, managers should not compromise breeding performance of donor populations through a marked bias in the sex or age of animals removed, which may change the age sex structure of the donor population unfavourably. Removals with a 50:50 sex ratio are usually preferred but in smaller founder groups of, for example, only six animals, four females and two males are usually preferred, however this may leave surplus males in the donor population. Occasional movement of old, presumed sterile, female rhino has resulted in stimulation of breeding through alteration in social structure and bonding. This occurred with two sister southern white rhino in Solio Ranch Kenya, one of which was moved to Nakuru National Park. These animals were over 30 years old when moved and one has produced a calf, passing on valuable genetic characteristics. These females were above average body size and had remarkably large horns (R. Kock, pers. obs.).

- Greater one-horned rhino founder populations historically have been skewed 3:1 in favour of females as this will promote rapid breeding in the recipient population. This strategy may have little negative impact if the number of rhinos removed is very small relative to the size of the donor population. However, this markedly skewed removal policy is not recommended in the long term (especially if translocations become common place as they are in Africa) as the sex structure of the donor population will be negatively impacted over time.

- It has been suggested that a 1:4 male female sex ratio should be selected for Javan rhinos but before taking such a markedly skewed founder population from the key Ujung Kulon donor population the authority needs to be sure that the sex structure of the donor population will not be negatively affected. Population modeling could be used to evaluate the relative merits of alternative removal sex ratios seen in terms of the whole metapopulation.

- It is important that captured animals are correctly aged. Standards exist to age African rhinos on the basis of body size, horn shape and size and teeth wear and patterns (Hitchins, 1970; Emslie, Adcock & Hansen, 1995; Adcock *et.al.,* 1997; Adcock & Emslie, 2003; Morkel & Kennedy-Benson, 2007). Aging of greater one-horned rhino is based on relative body size.

- An experienced rhino capture officer or wildlife vet should be present to examine the teeth of animals prior to deciding whether to release or translocate on the basis of approximate age. If a tooth-ageing series is available then capture vets should carry a laminated copy with them in the field.

- Sexing of Javan and Sumatran rhino is difficult from sightings and usually requires a visual observation of urination. Current knowledge of sex ratios of these species is poor, which makes animal selection harder. Sexing greater one-horned rhino (except for the adult bulls) is also difficult due to the thick skin folds. The presence of a calf is a significant clue, but this may result in biased sex ratio estimates. Observers also need to be careful not to jump to conclusions when two older animals are seen together, as sometimes the suspected adult cow and large calf observed at a distance turns out on closer inspection to be an adult bull and smaller cow.

- In the case of black rhino, it has been hypothesized that social disruption and/or possible slow dispersal into over-harvested areas, coupled with a failure to reduce rhino browsing in other under or zero-harvested areas could contribute to reduced population performance in a larger park. Therefore black rhino capture should be spread over the whole removal area to avoid leaving residual areas of high density and creating low density zones, and in the process causing significant social disruption. This does not mean capture has to be evenly spread over each km^2 in a reserve, as some sites will be more suitable and accessible for capture than others. Rather, removals should be spread within the context of the scale of rhino movements and home-range sizes in a reserve.

- In the case of white rhino, in larger fenced reserves it might be highly desirable to use a sink removal strategy to create low-density zones into which surplus animals can disperse (simulating the natural regulatory process of dispersal) while leaving other areas un-harvested (Owen-Smith, 1981; 1983). In certain cases it may be desirable to locate sink removal areas around the periphery of parks and other areas at increased risk from poaching, as has been done in Hluhluwe-iMfolozi Park, South Africa.

- A vet experienced in rhino health should be a part of the team which selects the potential translocate. If the vet considers the rhino not suitable for translocation, either before or during capture, owing to health or injury, the vet should be empowered to make the final decision on the fate of the animal. In the case of the greater one-horned rhino there is a need to establish condition scoring to assist in health assessment.

- "Stray[9]" rhino, which are common in the South Asian region as a result of small open protected areas with intense human wildlife interface, are a potential source of translocates for reintroduction to new areas. They are in any case rescued if possible and translocated back into the protected area from where they came. They will not make ideal candidates for major reintroductions for behavioral reasons, as they are likely to continue to stray in new sites and there is an increased risk of these animals being stressed and carrying disease. In this case more intensive veterinary investigation and quarantine prior to return or translocation of animals to the protected areas is advisable.

- In the case of white rhino staggered releases work well. Staggered releases of greater one-horned rhinos in Nepal have also apparently worked well but due to massive losses of reintroduced rhino due to poaching and civil war, follow-up monitoring of future translocations is required. If possible, staggered releases should be avoided for black rhino due to their aggressive nature, unless temporary fencing is going to be used to keep established and new rhino apart until they get to know each other through the fence.

- In large populations such as Kruger National Park in South Africa there is some support for block removal of all sex and age classes of rhinos including breeding males as a founder group, as the group is more integrated (individuals know each other) and this should reduce post-release fighting.

- Where possible founder rhino should be unrelated (as far as is known) to maximise the initial genetic heterozygosity of the founder group.

- Young adult cows (7–15 years) are prime candidates for removal, although care needs to be taken to avoid skewing the age structure of a donor population towards older animals by continuous selective removal of young females over a long period.

9 Stray means rhino that periodically leave the protected areas to forage in adjacent farmland. In some cases like Pabitora this is almost nightly especially during winter months. They are only a considered a problem when they do not return within a reasonable period of time of a week or more.

- Animals with young calves should generally not be caught as young calves are more prone to translocation mortality risks, although under careful management those risks can be reduced to acceptable levels. Cow and calf translocations are best suited to field to field translocations. The technique must include darting of animals at release and waking them together which ensures the mother and the calf stay together.

- Calves born in bomas are often rejected by their mothers or die. Given the difficulty of visually assessing the stage of pregnancy in the field, if time permits, consider using rectal ultrasonography to identify rhino in late stages of pregnancy during capture/translocation operations (Radcliffe *et al.,* 2001). Examination of mammary glands is an alternate and practical method of assessing the stage of pregnancy and or confirming possible calves missed during the capture process necessitating release. Any such rhino can then immediately be given an antidote and released back into the field.

- Rhinos should also (as far as is known) be capable of breeding, in reasonable condition and should not be very old. For African rhinos, the AfRSG standard 1–5 (very poor–very good) body score (Adcock & Emslie, 2003) should be used as a guide to identify an appropriate candidate for translocation. Animals of fair body conditions (AfRSG score 3 and below) should not be transported unless for treatment or special attention purposes and should only be transported for short distances within the conservation area. Lame rhino or animals with injuries to sensory organs, such as the eye due to previous trauma or disease, are also less suitable for the rigours of translocation and reintroduction. Such animals should be avoided.

- In very large areas (>1,000 km^2), unless monitoring reveals black rhinos are dispersing well naturally, consider removing black rhinos from core areas when densities build up, and use these animals to set up breeding nuclei in other areas of the park.

- Rhinos should be of the correct subspecies for the proposed recipient area, with the possible exception being where it may no longer be possible to source founder rhino of the indigenous subspecies but where founder rhino of another subspecies are available to at least allow the species to be re-introduced (e.g. where it was not possible to obtain northern white rhino to reintroduce into Uganda).

- Experience with the translocation and rehabilitation of orphaned rhinos in Africa and Asia has been generally negative, with poor establishment and behavioural problems. Orphaned animals are more suited for captive breeding. Rehabilitating orphaned rhinos is also a costly exercise. In one case an orphaned black rhino moved from the Nairobi Elephant Orphanage to Tsavo East National Park first adopted hippo and after rejection, an elephant. In this case a female elephant gored the animal and it died (R. Kock, pers. obs.).

- A number of factors need to be taken into account before deciding to capture an outlier rhino.
    - **Security:** the animal is in danger of being poached or its habitat is threatened.
    - **Viability:** the animal is isolated from other rhinos, or is part of a “doomed”, unviable and/ or potentially inbred group, which through translocation would become part of a viable population.
    - **Breeding:** the animal is not breeding owing to aggression or is otherwise unviable.
    - **The costs of capture and translocation**: the cost of catching an individual rhino in particularly difficult conditions should not outweigh the small benefit to recipient population (in terms of its contribution to improved breeding output), particularly if the rhino is a male.
    - **Genetic value:** the rhino is of high genetic value because of its genetic uniqueness or remoteness from other populations, the habitat type and possible local adaptation of the rhino or source of genetic variation. This factor can be explored through genetic studies but in the end is likely to be a judgement call based on many factors.
    - **Sex of the rhino:** the animal is a female and has value/potential in increasing breeding output in a recipient population.

1.6 Logistical coordination and planning

The capture and translocation of rhino is a complex undertaking that requires accurate planning and effective coordination at all stages of the process. More often than not the key to the success or failure of any translocation operation lies in the planning and coordinating phase of the project.

It must be emphasized that the planning phase begins months and in some instances years before the actual translocation takes place. It is therefore critical that the first order of business is to convene a coordination committee that will be responsible for planning all aspects of the process, especially if rhino capture is a novel undertaking and not being undertaken by a recognised and established rhino capture team.

1.6.1 Coordination Committee

- Depending on the translocation it may be advisable to set up a regional liaison committee containing representation from the state, private and/or communities involved. The committee should be comprised of representatives from all relevant parties including technical experts in all aspects of the operation. The coordination committee should be headed by a dedicated project leader.
- Problems can arise if there is not good scientific and technical input into the discussions as committees can make poor decisions regarding numbers of animals to remove and where to take them to. It is essential that such committees are not only comprised of senior decision-makers and that expert technical people are also involved.

1.6.1.1 Long-term planning objectives

- Conservation objectives of any translocation project should be consistent with the country's conservation policies, strategies and plans.
- Sufficient funding must be available for all aspects of the operation both in terms of personnel and operational budgets.
- Managers must not only budget for the translocations but also ensure there will be sufficient long-term funding for ongoing security and monitoring. If the latter is not in place then the translocation should not take place.
- Liaison and consultation must be undertaken with interested and affected parties. This should include addressing any socio political impacts with local communities and other stakeholders who may affect the success of the operation
- For cross border translocation, the relevant legal documents pertaining to the translocation (e.g. permits for narcotic immobilizing drugs, CITES, firearm and veterinary permits, passports and visa of accompanying team members) including the necessary inter-governmental Memoranda of Understanding, must be obtained prior to the operation;
- The potential for cross border Trans Frontier Conservation Areas which could have a rhino population should be investigated. As rhino currently cross unrestricted between India and Nepal this is de facto already the case in a few locations but recognition of this fact politically with cross-border coordination of monitoring and security is needed.

1.6.1.2 Medium-term planning objectives

- Pre-capture monitoring should be undertaken in advance of the proposed translocation date to ensure that the most suitable animals are selected for translocation. Knowing where the animals are can also cut down costs by minimising capture and helicopter times.

- All the equipment needed for the operation must be available and in good working condition. This includes all specialized equipment that may need to be built to specification prior to the operation.

- Availability of transport (air/road) for delivery of animals and for personnel needs must be confirmed and secured prior to undertaking the translocation exercise.

- Contingency planning must be in place where possible to be able to respond to unexpected complications.

- Media coverage of the operation at the capture and release sites and, in most cases, at the national level in the concerned countries should be managed so that it does not stress the rhinos and compromise their safe release. Media and VIP circuses at release should be avoided.

- A post-release strategy must be designed and implemented to ensure the stated objectives of the operation are achieved.

- Experienced rhino capture teams will have a range of available reinforced steel framed wooden rhino crates of different sizes. However if standard crates are not being used then wooden rhino crates will need to be ordered and made (such as has happened in the past in Nepal). In such cases it may be necessary to arrange a carpenter to attend the capture and translocation in case running repairs are required. This will not be necessary if professionally made standard steel and/or angle iron reinforced wooden rhino crates are used.

- If catching greater one-horned rhino sufficient healthy koonkie elephants must be secured and in place to work from the start of capture. These animals should be certified tuberculosis free.

- Custom built four-wheel drive rhino capture lorries with hoist cranes, hydraulic arms or hoists or ramps with winches are routinely used by major rhino capture teams in Africa, and these should be secured for capture where possible. Cranes are the best options as they offer the greatest flexibility. Where these customised rhino capture trucks are not available a tractor and sled must be arranged if field to crate transport is required.

- If operating in a defined wilderness area or in difficult terrain it may not be possible to use rhino capture trucks. In such cases the only way to get captured rhinos out of the area may be by the use of sleds or to airlift them out using powerful military helicopters to carry the rhinos in a net sling (Figure 30). Such airlifts are very expensive, and suitably large and powerful helicopters may need to be organised some time in advance. Because of the very high ferry costs of getting such large helicopters to a reserve, it usually will be more cost effective to do occasional major removals from wilderness areas every few years rather than seek to do smaller regular annual removals.

- Radio transmitters, batteries and receivers (and collars if being used) must be obtained for post-release monitoring. Transponders also need to be sourced and should be fitted routinely to the shoulder and horn(s) of any immobilised rhino.

1.6.1.3 Short-term planning objectives

- All access roads must be serviceable and bush-clearing knives, spades, chainsaws, spare tyres and puncture repair kits should be carried in order to enable capture vehicles access to rhinos.

- All personnel requirements must be met throughout the operation.

- Ensure that sufficient capture drugs (including antidotes and necessary emergency pharmaceuticals) are in date, in good supply and readily available. A translocation must not be undertaken with a bare minimum of drugs.

- It may be advisable to form a coordination committee. This is especially recommended where translocations are not routine and the recipient country or organisation does not have rhino or rhino translocation experience. Such a committee should have representation from:
    - A dedicated rhino management team or, in their absence, qualified rhino experts.
    - A security team.
    - A veterinary team.
    - A capture team (including a "koonkie" elephant team for greater one-horned rhino and air support team for Africa)
    - Transport team.
    - Area managers for the source and release sites.
    - Communications and public relations team.
    - Financial and administrative team.
    - A permitting officer (when required).
    - A logistics officer and or team (greater one-horned rhino).
    - Higher-level authorities in source and release sites

- When translocations take place across international borders two coordinating teams (one for the source and one for the release sites) may be appointed but their activities should be closely coordinated and their responsibilities carefully outlined in a memorandum of understanding between the two countries before the start of the operation.

1.6.1.4 Regional rhino conservation bodies and international translocations

- Regional rhino conservation bodies such as the SADC Rhino Management Group and SADC Regional Programme for Rhino Conservation have also assisted with brokering and coordinating cross boundary rhino reintroductions (such as the recent reintroduction of black rhino back to Botswana and Zambia). Discussions are underway to form an East African Community Rhino Management Group and such a body could fulfil as similar role in East Africa.

1.6.2 Planning the timing of rhino relocations

- In South Asia, the best time for capturing rhino is when the temperatures are not high and the ground is not too wet for vehicle access. This generally means the winter months between November and February.

- In Africa, the capture of rhino is usually undertaken when the ground is dry so as to avoid injury to the rhino and staff, as well as damage to vehicles and equipment. Dry ground also makes areas more accessible to the capture vehicles. It is preferable to plan captures for when the vegetation is less dense and leaf cover low so as to improve the helicopter team's ability to locate and keep rhinos visual from the air. However the end of the dry season and beginning of the wet season are inappropriate times for capture because of the poor condition of the animals. It is recommended that the translocations are planned for early in the dry season when the condition of the rhinos is expected to be fairly good and the access roads have dried to facilitate capture and transport.

- Capture and translocation of rhino should be timed to coincide with the cooler hours of the day (below 25^{0}C) to avoid the risk of hypothermia and other heat related complications.

- However, as conditions may vary tremendously from site to site, knowledge of the climate and vegetation at the source and release sites is essential in order to establish the ideal time of year for translocation.

- When planning the translocation of rhino over distances requiring over 12 hours it is advisable to plan the capture time by first determining the offloading time. This applies particularly to the field delivery of rhino. The rhino must not be expected to stand unnecessarily in the crate because the delivery vehicle has arrived at the release site at night. The capture must be planned in such a way that the rhino are offloaded without any delay upon arrival at the release site.

1.6.3 Planning for procurement and logistics

- The procurement of the required drugs and equipment may take considerable time and therefore should be carried out well before the target date of the operation. Drugs and darting equipment may also be subject to certain legislative restrictions which may increase the time delays.

- Various licenses or permits may be required for rhino translocation both at source and destination and these should be acquired well before the date of the operation. Veterinary and other conservation related permits (e.g. CITES permits in both the exporting and importing countries and any internal movement permits needed) may also take considerable time to finalize. Therefore it is critical to plan a route from source to destination well in advance of the translocation. One also needs to check that there are not any restrictions on the movement of rhino through certain areas for veterinary or political reasons.

- Many capture teams, pilots and aircraft have very busy schedules and their availability must be determined and their service secured well in advance. These items are also expensive and it is usually essential that budget lines on aircraft, elephants etc. are included in organisational budgets well in advance.

- The transport vehicles and equipment used should be appropriate for the terrain at the capture site.

- All equipment and vehicles should also be serviced and in good working order to avoid break downs/problems during capture. Dedicated capture teams use the off-season when they are not catching animals to maintain and repair their equipment.

- Ground teams must also carry bush clearing equipment such as chainsaws and cane knifes as well as tools such as picks, shovels and spades, carpenters' tools.

- All role players need to be notified well in advance.

- Back up darts should be carried by the marksman.

- A communication system should be in working order and in place to allow for continuous contact between relevant field personnel especially when darting from the air and following up animals on the ground.

- A GPS to mark the point of collapse of the animal which can be determined from the air support can help the ground team access areas more efficiently. Clearly marking the field vehicle that will be first on the scene (by painting its bonnet bright orange) can help the air support crew keep the vehicle in sight facilitating the issuing of radio instructions to the ground crew as to the best route through the bush and drainage lines to an animal that has gone down.

1.7 Personnel, capacity and experience

1.7.1 Staff requirements

- The exact composition and number of personnel needed depends on the number of animals to be translocated but should always consist of at least the following:
  - Experienced capture personnel.
  - An experienced wildlife vet.
  - Experienced rhino capture officer with, where legally authorised, a dangerous drugs use certificate. The certificate should only be issued to suitably trained and tested personnel but currently in South Asia this is not the case;
  - Experienced drivers of the appropriate vehicles who preferably should have some mechanical knowledge.

- Depending on circumstances the staff composition may in addition include:
  - Field monitoring teams to locate rhinos early in the morning prior to the start of capture and to help guide in capture teams;
  - Logistics personnel;
  - Tractor and excavator drivers when capturing greater one-horned rhino.
  - Research technicians/biologists/field staff who can take photographs, measurements, complete a standardised translocation record form with details of capture/release location, ID of animal, transponder numbers, ear-notch patterns, age and sex of animals, planned destination of animal if known etc.
  - Technicians who can fit radio transmitters and transponders to horns and/or make ear-notches according to plan.
  - Media liaison and management personnel;
  - Veterinary technicians who can assist in monitoring the immobilised rhino, collect samples of blood, parasites and tissue following protocols;
  - Security/safety officer (Asia);
  - When capturing greater one-horned rhino, a suitably armed and trained officer/ranger to protect the darter and team while rhino are being tranquilized and while the team are working on the rhino. The ranger will have to be prepared to deter the target animal or another rhino, elephant, buffalo or even tiger, and where necessary, and when life is endangered, shoot the animal after giving warning shots.
  - First aid officer if other members of the team are not trained in first aid;
  - Financial and administrative staff;
  - Mechanic (or one who can be called quickly);
  - Carpenter (if using wooden crates)
  - Mahouts (elephant handlers for capture of greater one-horned rhino). It is important that the mahouts have good experience with handling rhinos, and there is one leader appointed from whom all other mahouts will take their cue (Williams, 2008).
  - Crowd controller (in Asia)
  - Transport teams

- A translocation procedure should be conducted like a military operation and in an orderly manner. This calls for strict discipline among all personnel. A management hierarchy with a clear line of command and responsibilities for the team is therefore essential. Everyone in the best rhino capture teams knows their exact role throughout the exercise. By splitting tasks amongst the team, time and money can be saved during the capture. When elephants are to be used, Mahouts should also be fully briefed explaining the exact steps to be followed during the operation.

1.7.2 Building local capacity for rhino translocation

- Some countries have not gained experience, or have lost the skills and experience required to successfully catch and translocate rhinos. In addition, the number of rhinos moved in a country annually may not justify equipping a rhino capture unit with capture trucks, crates etc. In these instances, expertise and equipment may be sourced and borrowed from a neighbouring country.

- It is recommended that where possible staff gain practical experience working with rhino capture practitioners in the field. The attendance at courses such as the Dangerous Drugs course at Malilangwe, Zimbabwe or gaining experience with rhino in captivity or with an established rhino capture team can also help build capacity.

- Regional rhino groups may help facilitate training and building of local capacity.

1.8 Habitat considerations

1.8.1 Generic considerations and approaches

- Much of the work done on estimating ECC for rhinos has been done for black rhino. The number of black rhino an area can carry is a function of available land *area* (size), habitat conditions (especially the availability of *suitable* favoured and staple food resources), rainfall and its distribution through the year, temperatures, fire regimes, soil textures and nutrient status, and competing herbivore densities (Adcock, 2001a & b; Adcock, 2006; Adcock *et al.,* 2007; Adcock *et al.,* in prep; Amin *et al.,* 2006; Okita-Ouma *et al.,* 2007).

- Increases in alien plants can significantly reduce ECC in rhino areas in both Africa and Asia.

- Rhino habitats (and their ECCs) can be very dynamic, and successive changes to vegetation (through fire, alien plants, increased browsing/grazing pressure etc.) can be positive or negative for rhino. To be of most use ECC assessments must account for all of these factors.

    - Supposing a reserve held 100 rhinos 30 years ago, but following negative habitat changes its ECC has declined by 70% to only 30 rhinos, and rhino numbers have stayed around the 30 level for the last decade. Any decision-maker who thinks that the "safe" option is to put off removing any rhinos from this area until numbers have increased would be making a major mistake, unless it is clear that recent habitat changes have been favourable. As explained earlier. a lost rhino remains a lost rhino whether it has been poached or simply has failed to be born or died soon after birth due to sub-optimal biological management; and without rapid population growth loss of genetic diversity will be greater. **Not removing can be a wrong rather than a safe option.**

- An assessment of the habitat suitability of potential recipient areas should include an estimation of the medium-term ecological carrying capacity (ECC) and likely productivity before any rhino introductions take place. The exception to this will be for very arid areas with high coefficients of variation in rainfall, where populations will never approach densities that could be supported in wetter years, as densities in such areas will be constrained by food availability in crunch drought periods.

- Rhino densities and ECC have been shown to vary widely across a species range. Therefore it is imperative that managers understand that just because a flagship population has a density of X rhinos/km^2 this does not mean that another area can also support the same density of rhinos.

- Rhino stocking densities and ECC should be scaled according to reserve size to allow direct comparisons across different sized parks (this is most commonly done using either *rhinos/km^2* or its reciprocal *km^2/rhino*).

- Whenever rhinos have been reduced to low numbers in an area or country as a result of habitat loss and poaching, be aware that existing, or the last recorded populations of a species may be located in more marginal, inaccessible or lower carrying capacity habitats or areas which may simply have had better protection, and may not represent ideal or higher carrying capacity habitat. The opposite can also hold. For example, Hluhluwe-iMfolozi Park and Kaziranga National Park have very high densities of white and greater one-horned rhino respectively, and ECC and productive stocking rates are likely to be much lower than in these source populations in most other recipient areas offering the chance of rapid population growth if rhinos can be protected. The key point to grasp is that current distribution and densities of rare species or subspecies of rhino in a few surviving populations may not be a good guide to future potential of other areas for reintroduced populations.

- For re-introductions, estimates of medium term carrying capacity for rhinos can be used to help determine the maximum desirable productive stocking density for rhinos as well as guiding decisions on the maximum number of founder rhino that should be introduced. In Africa, the AfRSG, SADC RMG and SADC RPRC have recommended that rhino are introduced at not more than ½ of the estimated maximum productivity carrying capacity (MPCC) level. MPCC for large long lived herbivores like rhinos (that are suspected of having a non-linear ramp shaped density productivity relationship), has routinely been estimated at about 75%-80% of ECC**.** Thus rhino should be introduced at no more than 40% of estimated ECC to (1) allow plenty of room for population growth, (2) delay the time when removals will be needed to maintain productivity, and (3) minimise social pressures during the settling-down phase, and thereby reduce the likelihood of post-release fighting deaths.

- Experts intuitively use a comparative approach to estimate ECC (contrasting the relative suitability of different areas). It helps if there are some rhino areas where numbers have increased and then leveled off indicating possible benchmark ECCs for these areas. ECCs for new populations can then be estimated relative to these benchmarks. When building ECC estimation models for other rhino species, the same comparative density estimation approach (which has been used successfully with black rhinos) should prove useful.

- One or more persons with proven experience in estimating rhino ecological carrying capacity should be engaged to do the habitat assessment of a new area. In Africa this is particularly important for black rhino, whose requirements are much more critical than for white rhino. For some areas it may be possible for experts to very quickly give rough estimates of ECC (e.g. 0.1 black rhinos/km^2 or 1 rhino/10km^2 for areas of Zimbabwe Lowveld habitat) without the need for a more time consuming formal habitat assessment.

- Even though modeled or expert estimates of ECC are at best crude and fairly approximate figures, experience in Africa has shown that they none the less they can be very useful practical tools to help guide and inform biological management decision-making.

- Currently the best understanding of the factors affecting rhino ECC is for the black rhino. A black rhino habitat assessment technique and related ECC estimation model has been developed by Adcock and co-workers (Adcock, 2001a & b; Adcock, 2006; Adcock *et al.,* in prep; Okita-Ouma *et al*., 2007). It predicts black rhino ECC (as estimated by experts) using data and expert estimates of ECC from 24 sites in South Africa, Namibia and Kenya (Adcock 2001b; Adcock *et al* in prep). The process of developing the RMG / Darwin Initiative ECC estimation model has been useful in identifying which variables are the best predictors of ECC (as estimated by experts). Encouragingly there is a close linear correlation between the logs of male black rhino home range sizes (Adcock, 2001b) and expert and model estimates of ECC (Adcock, 2001b) providing some confidence that the experts and model's ECC estimates are approximately correct. The model has been refined to also take into account biomass of other competing browsers (Adcock *et al*., in prep) as well as to estimate carrying capacity of areas in terms of the number of adult males they can carry. It should be realised that such estimates are approximate "ball-park" guides rather than precise accurate figures.

- With each rhino species eating different foods and living in different habitats there is a need to develop similar predictive models/expert understanding for other rhino species to help guide translocation and biological management decision-making. While the key variables to assess and their relative influence on ECC will differ from species to species, the approach that has been developed for black rhino is described in more detail below as a similar approach could be used to develop and refine ECC estimation models for other species. ECC estimation models can continue to be refined and improved as the number of reference benchmarked populations and knowledge increases.

- It is important to understand that knowledge of habitat, estimated ECC and recorded densities of rhinos in one area cannot be simply transferred and applied uncritically to other areas. Differences in food availability and species composition and size, class structure, climate, geology and soils, as well as densities of potential competing large herbivores and fire regimes all need to be taken into account when assessing ECC. For example much of the tall *Saccharum* habitat available to the reintroduced greater one-horned rhino in Suklaphanta, Nepal occurs in much drier areas than in the source Chitwan National Park population (where tall moist *Saccharum* grasslands are a key habitat). The result is that much of the drier *Saccharum* habitat in Suklaphanta is not currently being used for feeding, and estimates of ECC are likely to be inaccurate if based solely on the area of *Saccharum* habitat available without considering other factors influencing the quality of each habitat type.

- Decision-makers need to know that ECC can vary substantially not only from one reserve to another, as well as between different areas of the same park and over time in the same areas of the same park.

- The reason for using recognized rhino habitat assessment experts is that experience has shown that otherwise good ecologists or experts in other aspects of rhino conservation can significantly overestimate rhino carrying capacities with negative consequences. The costs of erring on the side of overestimating rather than underestimating ECC it is that the former can result in new and established populations being overstocked and under-harvested, which in turn is likely to negatively impact on metapopulation performance. Overestimates of ECC can also cause problems by creating unrealistic expectations in the minds of land managers.

- Knowledge of the factors affecting total rhino and male carrying capacities allows the population densities of rhinos and habitat to be managed in reserves at levels that should minimise rhino fighting deaths and poor population performance due to social pressures and food limitations.

- Habitat quality and ECC also needs to be periodically assessed in established donor populations as plant succession, habitat structural changes, competing large herbivores, alien plan invasions, fire and current total rhino and male rhino densities may have resulted in significantly reduced ECC. This information can be used to help guide translocation decision-making to help maintain donor rhino populations in a productive state.

- The smaller the potential recipient reserve for rhinos is, the more important it becomes to estimate ECC well.

- With larger areas it may be possible to quickly determine that habitat in the short-medium term will not be limiting, and that the area can easily take the proposed initial founder number. For example Manas National Park in Assam until relatively recently held significant numbers of greater one-horned rhino, before they were all poached out during the Bodo rebellion. In such cases security considerations will be far more important than any habitat or ECC considerations when deciding whether or not to reintroduce rhino, unless major habitat changes may have taken place in the short term which may have significantly reduced ECC.

- Readers should be aware that to date there has been a difference between Africa and Asia in how the area available to rhino (used in density and ECC estimations) is routinely stated. While the tables for Asian rhino below consider areas of preferred habitats; when determining average African rhino range sizes and densities in Africa, sub-optimal less-preferred habitats are included as range; and only habitats with no food such as large sodic pans, lakes, inaccessible areas and areas far from permanent water are excluded from calculations. In Asia, sub-optimal habitats in which rhino feeding is limited (e.g. Sal forest for greater one-horned rhino) are currently excluded; whereas in Africa such areas would be included in calculations with overall ECC estimates being a weighted average (relative to areas) of ECC estimates for different prime and sub-optimal habitats.

1.8.2 Black rhino

- Past experience has shown that non black rhino habitat experts may grossly overestimate black rhino ECCs.

- Black rhino ECC estimates should be revised every few years in response to habitat changes and especially levels of available suitable browse in the 0-2m height range. ECC estimation should not be done routinely to monitor year to year or even shorter term seasonal changes in resources within a park; but rather to track the impact of longer term vegetation changes.

- Free ranging black rhino ECC densities range as follows (and are particularly dependant on suitable food availability in the 0-2m height layer):
    - One to 1.5 rhino per km^2 in unbroken low thicket vegetation. The highest densities were found historically in *Commiphora/Bauhinia* thickets in Tsavo West, low *Acacia* thickets in Hluhluwe in the late 1950s early 1960s and deciduous thickets in the middle Zambezi Valley in the 1960s. These latter areas have annual rainfalls of 600 to 900mm. In East Africa, patches of ground water forest marked by an overstory forest and a dense year-round herb and shrub understory have historically supported similar very high rhino densities (for example the Lerai forests of Ngorongoro Crater).
    - 0.4-0.8 rhino per km^2 in broken thicket with acacia woodland savanna vegetation on fertile soils at 700–900 mm annual rainfall. This density can also occur in un-degraded valley bushveld vegetation at 400–500mm rainfall, especially where rainfall is spread well across the year (i.e. the dry season crunch period is not pronounced).
    - 0.2-0.4 rhino per km^2 occur commonly in 500–750mm areas where savanna bush and shrub cover is generally good, riverine or groundwater vegetation is often present in un-degraded conditions, and soils are medium to good fertility. The higher densities tend to be found in East Africa and lower densities in southern Africa.
    - 0.08–0.2 rhino per km^2 occur in cooler areas with frost, semi-arid areas of 300–550mm rainfall with a marked dry season, well-bushed but very infertile areas even at higher rainfalls; and in areas where lightly bushed open savanna or grasslands make up a larger proportion of the land area. Miombo woodlands and arid mixed Mopane woodlands with drainage lines historically can carry in the region of 0.1 rhino/km2
    - 0.03 to 0.15 rhino per km^2 in relatively well-vegetated areas of 100–250mm rainfall, and also in the open East African savanna grasslands within Serengeti-Mara ecosystem, where browse availability is very sparse.
    - 0.01 rhino per km^2 in poorly vegetated desert plains where food may be very scarce but often is of good quality and high digestibility (e.g. Kunene area of Namibia)

- Black rhino translocations should be prioritized to areas were the chances of good rhino breeding performance are better.

- Population performance has been shown (through SADC RMG status reporting) to be better in moderately mesic, semi-arid and arid areas where suitable browse species predominate. Areas with lower rainfall and with higher underlying soil fertilities and geology tend to be dominated more by browse of good digestibility and higher nutritional value compared to high rainfall and/or infertile areas.
- Black rhino performance appears to be poorer in areas of low nutrient status soils and geologies, in high rainfall areas (e.g. rainfalls >800–1000mm) and in areas where the availability of actual suitable browse for black rhino is low.
- As long as water is available, the black rhino is relatively drought tolerant when compared to grazing ungulates, and as long as suitable browse is available cyclical drought need not deter potential introductions. An example of this was seen in Ol Jogi Reserve in Kenya in the 1990s when all zebra and buffalo died out during a protracted drought but black rhino maintained condition throughout (R. Kock, pers. obs.). However, severe prolonged drought has been associated with a massive black rhino die-off where browse pressure was also high with high elephant densities (Glover *et al.,* 1964). While there may not be much food in very arid areas such as Kunene in Namibia, and black rhino ECCs are therefore low, what food there is, is often of a high quality.
- A history of sustained heavy browsing pressure can also cause negative vegetation changes with an increasing predominance of less preferred and less important browse species and spizes (i.e. those resistant to browsing) lowering black rhino carrying capacities, as has recently been documented in west iMfolozi (Emslie, R. in prep).

- For black rhino, the following factors should be assessed during habitat assessments and can be input into the SADC RMG/Darwin Initiative Black Rhino CC spreadsheet model to produce estimates of black rhino ECC for many areas with the exception of miombo and mopani dominated areas which have not yet been included in the mode (Adcock *et al.* in prep; 2007):
  - The actual **land area available** to the black rhino needs to be calculated. (Figure 15) This should exclude large water bodies, large sodic pans, areas around buildings, fenced-off camps or sections, inaccessible terrain and areas far from permanent water. A well-distributed year-round water supply with a good surrounding food supply will result in a higher carrying capacity than a few isolated water points. Restricted dry season water supply will limit carrying capacity. A widespread summer water distribution can help to spread rhino and alleviate pressure on winter feeding areas near perennial or ground water, as well as social pressure.
  - **The availability of suitable browse:** *This is the most important factor determining black rhino carrying capacity*. Each main vegetation type in the rhino area must be assessed for its area size, total browse availability and the availability of suitable black rhino browse. A standardized method for this is given in Adcock (2006). A database of known suitable and unsuitable black rhino browse is available from the African Rhino Specialist Group or the SADC Rhino Management Group.
  - **Long term mean monthly rainfall** (and annual total) determines the relative potential amounts of annual growth of browse. However, rainfall total on its own can be misleading as a guideline to ECC, as the influence of rainfall on CC acts through the standing available browse in the rhino area. If there is little standing browse there can be relatively little growth even in high rainfall areas. Actual browse availability is not correlated with rainfall.
  - **Temperatures:** Plant growth slows in months with low average temperatures (<12 degrees Celsius) and also when high average temperatures prevail (>28 degrees). The average July minimum temperatures give a useful index of temperature regime in an area. Sites averaging <3 degrees minimums in July have frequent, fairly severe frosts in peak winter months, which has a large impact on browse, while July minimums of 10 degrees plus mean very hot conditions in summer months which can dampen browse growth slightly. In-between July minimum temperatures have lesser effects on growth.
  - **Soil nutrient status** affects species composition and plant nutritional quality as well as plant growth rates, which can be twice as fast on fertile sites compared to infertile sites

(for a given rainfall / soil texture). Soil and / or geological information on each area needs to be obtained. Scholes (1990) and Scholes and Walker (1993) provided a summary of the general relationships between parent geology and resulting soil texture and nutrient status. For other geologies not covered there, information on silica content and grain sizes of different geologies can be used to assign nutrient status scores Where soil data were available, a 1–9 nutrient status score can be assigned based on the equation: Nutrient status score = %Clay score (1–3) X base status score (1–3) as per MacVicar (1991). The overall nutrient status of a rhino reserve is obtained by multiplying the nutrient status scores of each soil or geology type by the proportional area of that type in the rhino area.

- The prevailing **fire regime** can be important for black rhino CC. The appropriateness of a fire regime for black rhino needs to account for the average rainfall of the area. The ability of woody plants to withstand fire and re-grow each season is positively correlated with increasing rainfall. Fire frequency and extent are also generally positively correlated with average annual rainfall, because rainfall (along with grazing animal biomass) determines the build-up of grass fuel loads each season. Average annual rainfall thus determines the "potential" total woody cover and recovery rate of a habitat, with soil texture also influencing potential by affecting water infiltration rates and plant root resources for recovery from fire. Thus for a given rainfall (and browser density below CC), there is a fire regime which could maintain the browse at similar levels over time, while fire frequencies or severities above or below this level lead to declines or increases in browse availability for black rhino respectively.
- **Competing browser densities**: Other browsing species share habitats with black rhino, and there is theoretically a "total browser" carrying capacity for the 0-2m rhino feeding layer (determined by total available within 0-2m and the above listed factors as for rhino CC). The available resources in an area have to be partitioned between the individual browsing herbivore species present, and the different herbivores in a system compete and compensate for fluctuations in each others' numbers. Black rhino across Africa on average form 10–15% of total black rhino equivalent browsing metabolic biomass feeding in the 0–2m layer, but can form as high as 35% (K. Adcock, pers. comm). If actual browser density is at or higher than the area's browser CC, black rhino populations may be negatively affected and may not achieve their true potential numbers and growth rates. A total browser carrying capacity model for the 0–2m layer is available from the SADC RMG/Darwin Initiative.

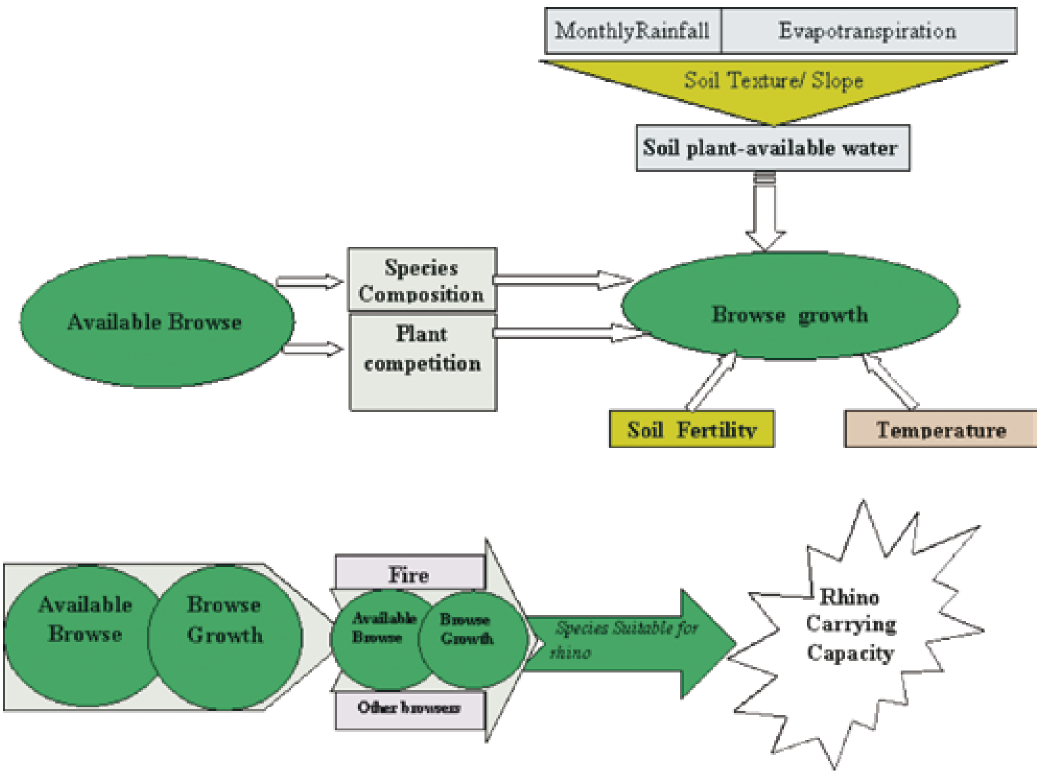

Figure 15. Illustration of how black rhino carrying capacity at the landscape level is determined by (1) the amount of browse available in the rhino area, (2) the amount of annual growth in this available browse, and (3) the species composition (suitability for rhino) of the available browse (from Adcock *et al.,* 2007). The SADC RMG / Darwin Initiative black rhino ECC carrying capacity model is based on these factors, as are estimates by experts.

In terms of browse availability black rhino take well over 90% of their food (woody and semi-woody plants and dicotyledonous annual and perennial herbs) from plant parts in the 0–2m height range. Plants can be pushed over or broken down (by black rhino, elephant or windfall) to be fed on. Available browse can be impacted by competing browser species and fire. A technique has been developed which can rapidly estimate browse availability within rhino feeding height range of 0–2m, and categorising this browse according to three palatability classes (Adcock, 2006). The amount of preferred and non-rejected browse from 0–2m is one of the key predictive variables in the black rhino ECC estimation model.

Distance to water also should be considered when assessing black rhino carrying capacity as land areas and thus browse which are greater than approximately 14km from reliable water are effectively unavailable to black rhino[10]. Food resources in such areas contribute little to black rhino diet.

The figure above shows that browse growth is also an important component of black rhino ECC and this depends on many factors, including plant species composition, competition between plants, and the amount of soil water available to the plants. This is affected by rainfall patterns, evaporation, soil texture and site location in sloping terrain (run-on / run-off). Soil fertility, temperature conditions for nitrogen mineralization and plant growth, frost incidence and the current and past browsing and burning regime will also affect browse growth.

- In fenced areas with ECCs of less than about 70 animals, the carrying capacity for "socially mature" male black rhino (10 years old or more) is far lower than that for females. Mature black rhino males are territorial and will reside in fairly well-defined ranges which overlap little with ranges of other mature territorial males. These ranges are defended against other mature males but a number (perhaps 4–7) of subordinate or subadult males may be tolerated in these territories. This social restriction may limit overall rhino densities, because the range/territory size of the rhinos is correlated inversely with ECC. Thus ECC (via its effect on range size) limits the number of ranges and territories that can co-exist in a given land area. Dispersal of subadult males and females and non-territorial males is the likely *natural* population regulation mechanism in response to range saturation at densities near CC in black rhino. The SADC RMG/Darwin Black Rhino CC model also allows the prediction of estimated male carrying capacities.

- In one long-established black rhino reserve, a decline in ECC over time due to negative habitat changes coincided with increasing male home ranges as would be expected given the correlation between the log of black rhino range sizes and log of estimated black rhino ECC (Adcock, 2001b).

1.8.3 White rhino

- Determinants of white rhino density have not yet been analysed in detail. White rhino densities which are probably near or just below ECC, range approximately as follows:
    - 1.6 to 2 per km^2 (Hluhluwe-iMfolozi Park – ideal habitat with medium to good soil fertility and 630–1000mm annual rainfall. Many upland Kenyan sites have this potential),
    - 0.3 to 0.5 per km^2 (many mixed bushveld areas of moderate fertility with +-550–700mm rainfall including Kruger National Park, Pilanesberg NP)
    - 0.1–0.2 per km^2 in less suitable, lower fertility, semi-arid (350–500mm), patchy or cooler habitats with some winter frost).
    - <0.1 per km^2 in very frosty, very sour/infertile or arid sites (<300mm).
- White rhino do not do well in wetter areas (>1000mm) with leached soils which are also prone to frequent frosts in winter. Calf survival in such areas may be poor.

N.B. where black and white rhino cohabit an area there is no evidence that one affects the ECC of the other but increased visibility of white rhino might increase the risk of poaching on the one hand and on the other hand lessen the security risk to black rhino as white rhinos are easier to find and poach.

10 In Etosha NP, Namibia in 2002 81.2% of all black rhino rhino sightings from aerial surveys and block counts occurred from 2.5km to 10km from water holes, and 95.9% of all sightings occurred within 12.5km of waterholes. Only 1.13% of 2002 sightings occurred further than 14km from a waterhole (Emslie, du Preez & Robertson 2004)

1.8.4 Greater one-horned rhino

- It has been recommended that the AsRSG sets up a working Group to develop a Carrying Capacity Model across the range of greater one-horned rhinos as has been done for black rhino in Africa. The table of observed densities in prime habitats below can be used as a starting point for developing some relative initial estimates of ECC.

Table 1. Densities of greater one-horned rhino

Rhinoceros unicornis	No. of Rhino	Area in km^2	Rhino/km^2 whole area (**potential prime habitat only**)	Potential prime habitat	Home range	Remarks
Chitwan	372	932	0.40 (**0.93**)	400 km^2	4.6 km^2	
Bardia*	31	968	0.03 (**0.38**)	80 km^2 in Karnali 50 km^2 in Babai valley	28 km^2	
Kaziranga	1855	480	3.86 (**5.30**)	350 km^2		
Dudhwa	18	27	0.67(**0.67**)	27 km^2		
Katerniaghat*	4	421	0.01 (**0.20**)	20 km^2		
Orang	68	78	0.87 (**1.36**)	50 km^2	1 km^2	
Jaldapara	108	216.51	0.50	115 km^2		
Gorumara	27	79.45	0.34	8 km^2		
Pabitora	81	38.80	2.09 (**5.01**)	16 km^2 (Reserve area only)	0.20 km^2+	Rhinos spend much time outside reserve so actual home ranges much bigger and effective rhinos/km^2 will be much lower than 5
Suklaphanta	7	305	0.02 (**0.08**)	90km^2		

*Rhinos move between Karnali area of Bardia and KaterniaGhat perhaps should be treated as one area

- When assessing ECC for greater one-horned rhino the extent of invasion by alien species like Mimosa, Mikania sp, Lantana etc needs to be considered as this can significantly reduce ECC.

- Human interference, including encroachment, cattle grazing, siltation and erosion may also reduce ECC.

- As with black rhinos the density and impact of other competing herbivores will need to be assessed as well as the food availability and quality etc.

1.8.5 Sumatran rhino

- No ECC estimation model has been developed for Sumatran rhino but historical and current estimates can be used as a starting guide.

- If numbers in an area have been significantly reduced by poaching and recorded densities are available for the area prior to increased poaching then, provided the habitat quality has not changed markedly, prior densities will provide a better indication of likely ECC of the area.

Table 2. Densities of Sumatran rhino

Sumatran Rhino	No. of Rhino	Area km^2	Rhino/km^2 whole area (**potential habitat only**)	Potential habitat	Home Range	Remarks
Way Kambas NP	30	500	0.06		18–20 km^2	
BBS NP	60	1500	0.04			
Gunung Leuser NP	50	800	0.06			
Sabah	30	600	0.05 (**0.07**)	438 km^2		

BBS NP = Bukit Barisan Selatan National Park

1.8.6 Javan rhino

- No EEC estimation model has been developed so far for Javan rhino but historical and current estimates can be used as an initial starting guide. Javan rhino used to have a wider distribution and historical records may shed more light on the range of different habitats that were used by this species.

Table 3. Densities of Javan rhino

Javan Rhino	No. of Rhino	Area km^2	Rhino/km^2 whole area (**potential habitat only**)	Potential habitat	Home Range	Remarks
Ujung Kulon	50	200	0.25 (**0.26**)	190 km2		
Vietnam	7	?				

1.9 Genetic considerations

- The long term survival of a species depends on the maintenance of as much genetic diversity as possible. Genetic concerns in small populations relate to in-breeding and out-breeding depression, loss of genetic heterozygosity, and associated loss of potential future adaptability to the environment, and reduced disease resistance.

The following guidelines represent current recommended best practice:

- The translocated rhinos should be of a subspecies that historically occurred at the release site except under exceptional circumstances (e.g. when founder northern white rhinos are not available to be reintroduced into former range, or if a decision is ever made to mix subspecies should a subspecies be reduced to a very small number of animals in the wild or all remaining animals of a subspecies are of one sex).

- Populations of one subspecies in a country or region should be managed as a single metapopulation to meet genetic and demographic conservation goals of that subspecies.

- Ideally, each rhino re-introduction project should involve at least 20 rhinos, that are, as far as is known, unrelated and able to breed (effective founders[11]). In practice this optimum founder population has rarely been sourced but as yet, and detrimental effects have not been observed. This might simply reflect the fact that the collapse of rhino populations occurred over a relatively short period (one to two generations), and that on average rhino populations remain genetically heterozygous and have resilience to inbreeding over the shorter term. However this may be temporary unless managed.

- Founder breeding groups for introductions should, where possible, and taking all other potential conflicting factors into account (e.g. ecological, disease, behavioural, adaptation), be sourced from different original genetic sources. Thus a founder group may be sourced from more than one population and sometimes more than one country/management authority. This requires significant cooperation and coordination between management authorities. This can be facilitated by parties working with regional or continental rhino conservation bodies should these exist (e.g. AfRSG, SADC Regional Programme for Rhino Conservation and SADC Rhino Management Group in the case of black rhino reintroductions to Zambia).

[11] Thus if a population is founded with four adult males, and six adult females (each of which has one calf) the effective founder population is not 16 but from 10 to 13 depending on the degree to which the fathers of the six calves were likely to be any of the four adult males imported.

- Rhinos should be introduced into an area that has sufficient carrying capacity to allow rapid population growth (which minimises loss of genetic diversity). For this reason it is recommended that new areas should not be stocked at higher than half of estimated maximum productivity carrying capacity (MPCC). MPCC is usually estimated as 75-80% of estimated medium-term ECC. Therefore if the ECC for a new reserve is 50 rhinos then no more than 20 rhinos should ideally be introduced to allow sufficient room for population growth before expensive future removals will be required to maintain population productivity.

- Ideally, each new population should be created in an area which has an estimated ECC of at least 50, and preferably more than a 100 animals. If a carrying capacity of 100 cannot be achieved, then the less desirable alternative is to maintain at least one such population within a national or regional metapopulation of this size, whilst actively managing smaller populations as part of a metapopulation. Larger populations of 50+ and preferably >100 are important reservoirs of genetic variation in a metapopulation. Bigger populations also have the advantage of needing less intensive (and less expensive) management per animal both on genetic and demographic grounds. This can be an important consideration where conservation budgets are limited but there needs to be a trade off against increased risks of losses with reduced intensity of monitoring and poaching.

- Where possible positive incentives should be created to encourage neighbouring land owners/ conservation agencies/communities to take down internal fences or barriers to movement, and in so doing create larger areas capable of taking the desired 20+ effective founders.

- The carrying capacity of a recipient area is only one criteria that needs to be considered when deciding where to translocate rhinos to. Rhinos should not be translocated to any area (no matter what its ECC is) if sufficient security is not yet in place. Less secure higher risk areas should only be tested where available secure space to set up new populations becomes limited, and there is a clear need to remove animals from existing populations showing signs of density dependent reductions in performance. In such cases there is little to loose.

- Putting smaller sub-optimal founder groups of rhinos into smaller areas where they can be well protected and managed as part of a bigger metapopulation is preferable to putting a large group of rhinos into a large area with inadequate security.

- There may be a risk in deriving founders from a small source population that itself has had a limited founder base and has stagnated through poor breeding. This "sub-sampling" of the gene pool could bottleneck the genetic diversity of the new population from the outset unless founders have been drawn from more than one source population as recommended.

- In smaller populations, surplus rhino should be removed to limit/avoid inbreeding between closely related individuals (i.e. prevent fathers mating with daughters).

- One new breeding individual per generation (approximately every 10 to 15 years) should be introduced into each smaller population from a different donor area to compensate for inbreeding, genetic drift etc. When dealing with black rhino, due to increased risks of male mortality as a result of fighting with established males, the introduction of an adult female rhino may have a higher chance of breeding and hence introducing new blood.

- Where possible, detailed population history tables documenting known and or suspected parentage of animals for all known animals in smaller populations should be maintained. The ear-notching of calves before they leave their mother enables managers to retain knowledge of who an animal's mother is after they have become independent. Population history tables should include the entire population in the case of smaller reserves, or a subset of animals in larger populations that can act as an indicator of genetic inter-relatedness. Genetic sampling can also reveal paternity.

- Rapid rates of population growth must be quickly achieved and maintained (particularly in the smaller populations) as **rapid population growth minimises loss of genetic heterozygosity** (in addition to enabling conservation target numbers to be reached sooner and creating a bigger buffer against the negative effects of poaching). In African rhino populations this has generally been the case, perhaps explaining the low levels of genetic anomalies recorded and successful recovery except in some famous examples e.g. northern white rhino. This is probably the biggest danger in Asia where stagnant populations might just fizzle out as they did in countries like China. Inbreeding increases this risk.

- Every attempt should be made to ensure that donor populations are also not negatively affected by removals.

- Where rhino populations have been established outside their historical range and there is a possibility of replacing them with rhinos of the local indigenous subspecies, consideration should be given to translocating rhinos back to their former range and re-stocking with the indigenous subspecies (as has happened in Addo Elephant National Park). However this is a very costly and time consuming exercise, and is only likely to be undertaken or recommended in selected cases with smaller populations[12]

- Although a lower priority, in certain instances genetic heterozygosity can be monitored through DNA analyses and cytogenetic studies (e.g. to indicate the extent to which specific dominant bulls have dominated breeding and may need to be replaced).

- Where source populations are part of captive managed programmes a studbook should be provided confirming there was no cross-breeding or potential for this.

12 In South Africa a large and highly productive AfRSG-rated Continentally Key 1 rhino population of over a 100 D.b.minor has been established in the Great Fish River Reserve; but following a revision of subspecies boundaries, this Reserve is now deemed to be out of range for that subspecies. However, due to its importance to subspecies metapopulation performance and species conservation, and on pragmatic logistical and cost grounds it is recommended this Key population be maintained as out of range populations provided there is no possible way that out of range D. b. minor animals can be able to access and breed with deemed indigenous D. b. bicornis animals. This can be done with adequate fencing.

1.10 Mortality risk considerations

The box below gives some statistics for mortality losses for black rhino and to a lesser extent white rhino during capture, release and the initial post-release settling in period.

SADC Rhino Management Group pooled data 1989-2006 for South African and Namibian black rhino translocations (RMG data analysed by Keryn Adcock 2008)

- 1989–1994 9.6% mortality (n=15/162 translocations)
- 1995–000 10.1% mortality (n=30/297 translocations)
- 2001–006 6.5% mortality (n=20/306 translocations)
- 1989–2006 8.5% mortality (n=65/765 translocations). See figure below for breakdown of mortalities. The reduction of mortalities in recent years is in part due to increased introductions of rhinos into bigger areas and fewer translocations of small numbers of rhinos to small properties. This is supported by the finding of Linklater and Swaisgood (2008) that black rhino post-release mortalities are higher when animals have been introduced into small populations and at higher densities.

SADC Rhino Management Group pooled data 2002-2006 for South African, Namibian and Zimbabwean black rhino translocations (RMG data analysed by Keryn Adcock 2005, in prep)

- 2002-2006 4.8% mortality (n=17 mortalities/354 translocations – data excludes three deaths of captured rhino that were primarily due to the severity of their snaring injuries and not translocation/capture related)
- Analysis of SADC RMG long term translocation data is currently underway by Linklater, Adcock and co-workers to determine the factors most associated with translocation/capture-related black rhino deaths up to the first year after release.

Zimbabwe

- 15% black rhino mortality during first 3 months post release 1986–1989 (du Toit, 1994). However much of this mortality was due to overstocking of nutrient poor habitat in the Midlands conservancy and rhinos were being removed from the Zambezi in an emergency operation due to heavy poaching in that area. Despite these mortalities, in the long run the translocation of threatened black rhinos out of the Zambezi valley to conservancies, and especially to Lowveld conservancies has been a great success. From originally being an "insurance policy" with only 19% of Zimbabwe's black rhino, under protection, numbers in Lowveld conservancies have increased to such an extent that by 2007 they conserved 72% of Zimbabwe's black rhino. By way of contrast no rhinos remain in the Zambezi valley.
- 1.2% black rhino capture/translocation mortality 2002–2006. Data excludes deaths of three captured rhino that were primarily due to the severity of their snaring injuries and thus were not translocation/capture related (SADC RMG Data).

South Africa

- Pilanesberg 1981–1989 12.5% (3/24) black rhino mortality (Adcock *et al* 1.,998). Mortality following the early releases 1981–1983 was 0% (0/19) with all three deaths being very young males (<2.5 years) during the last release into (n=5) into an established population.
- Natal Parks Board: Mortality of black rhino during early capture and transportation was 26.2% (5/19) from 1962–1965. The high mortality can be attributed to fairly unsophisticated capture and translocation techniques in the early days and also the fact that three of the animals were in poor condition at the time of capture (Hitchins 1984). This mortality rate dropped to only 2.5% (3/119) from 1966–1983 (Hitchins, 1984). Mortality post-release was 5.1% (7/130) but of these one was of unknown cause with one from a leg injury (not specified whether this was translocation related) with the remaining five animals dying from other causes unrelated to translocation (Hitchins 1984). There were no recorded post-release fighting deaths (Hitchins, 1984). Thus excluding animals that died due to being moved in poor condition, or for non-translocation reasons post-release the overall capture, translocation and post-release mortality rate was in the range of 1.5–2.9% (2-4/138). This low mortality rate could have been due to releasing 101of these animals into Ithala GR, Pilanesberg NP and Kruger NP (medium- very large areas without any rhino or where rhinos were at low densities to ECC at the time).

Kenya

- 6.6% or 8/ 121 black rhinos captured for translocation from 1984–1995 died during the capture or the translocation process (Brett 1998) A total of 111 different rhinos were introduced into new reserves with 118 translocations completed during this period. A further one translocated rhino died during re-capture. Excluding this animal and six other deaths due to non-translocation related factors (poaching, old age or other natural causes) there were a total of 16 post-release deaths (=13.6% of 118) due to other causes. Interspecific fighting with resident rhinos within the first 2 years of release (and especially during the first year) was the major cause of mortality of translocated rhinos due to other causes (12/16 or 75%) Brett (1998). The next most common cause of death was falling over cliffs (3/16). Immature females and adult males had lower survival rates and suffered higher fighting mortality than other sex/age categories. Fighting mortality was confined to animals release singly or in small groups (Brett 1998).

Figure 16 gives the breakdown of causes of capture/translocation mortalities in black rhino in South Africa and Namibia from 1989–2006 based on SADC RMG data. Fighting and stress-related deaths have been declining in recent years as a result of reduced translocation of small groups of rhinos to small properties and an increased focus on translocating rhinos to larger areas.

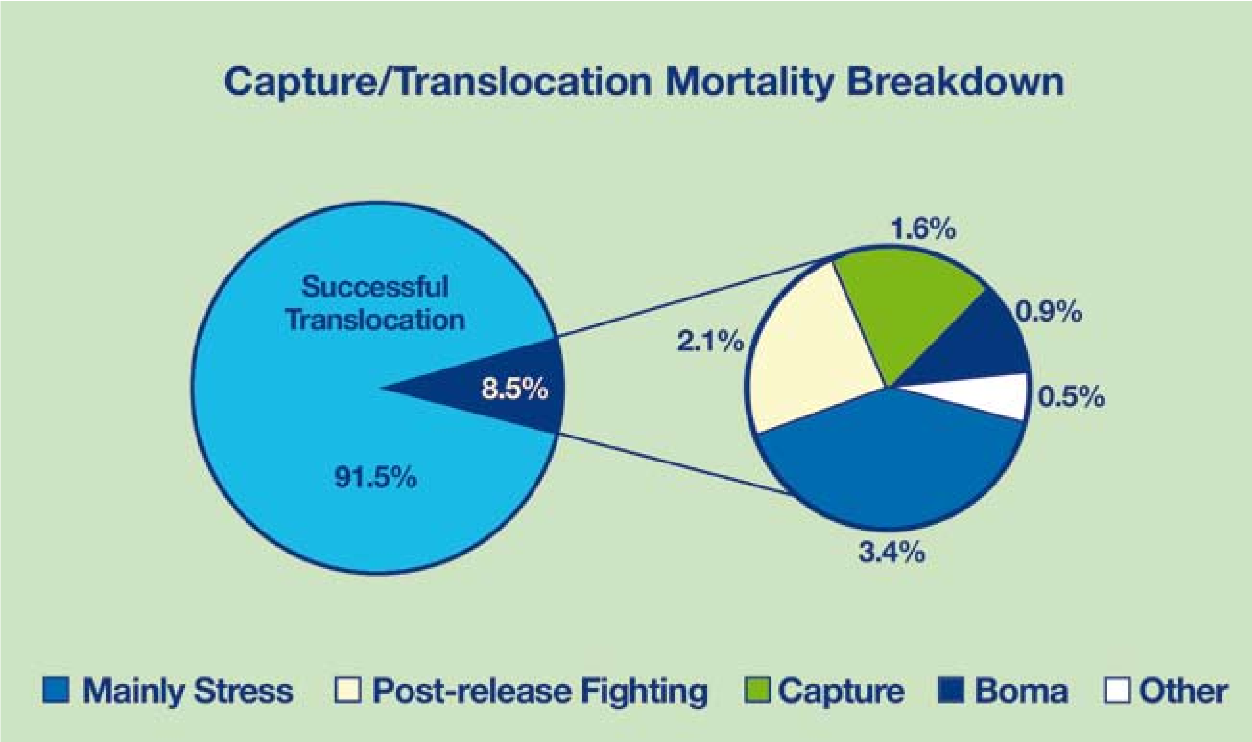

Figure 16. Mortalities during black rhino translocation in South African and Namibia over the 18 year period 1989–2006 based on an analysis of SADC RMG annual status reporting data. Of the 765 documented black rhino translocations, there were 65 capture/translocation-related mortalities (8.5%). The causes of these mortalities was mainly Stress (40.0%), Post-Release Fighting (24.6%), Capture-related 18.5%, Boma-related (10.8%) and Other (6.2%) (Figure prepared by R H Emslie based on analysis of SADC RMG data by K.Adcock in prep).

- Black rhino translocation mortalities are usually a little higher than for white rhinos due to their aggression and increased likelihood of post-release fighting. White rhinos are more prone to other causes of death, such as accidental drowning, and post-release fighting deaths are less frequent.

- Mortalities of Sumatran rhino captured using pit traps are lower than for those captured using a stockade trap (Sectionov, pers. comm.) but total numbers are low making comparisons between methods difficult.

- Between 1986 and 2003 87 greater one-horned rhino were translocated from Chitwan in Nepal to Bardia and Suklaphanta. No capture related mortalities were experienced until after release (J. Flamand, pers. comm.). However post-release monitoring was minimal, and it is therefore not known if there were translocation related mortalities in the post-release period. Recently two rhino in India were also translocated without mortality from Pabitora to Manas. The results of translocation in the 1970s to Dudhwa were reported as successful in 9/10 cases but another anecdotal report suggests one further loss due to a fracture.

- Experience has shown that a failure to make a decision to proceed with a translocation based on fear of possibly losing some animals in the process (i.e. only considering costs and not full cost:benefit trade offs) is often likely to be far more costly in terms of rhino numbers and metapopulation growth in the longer term than the apparently "safe" option of inaction. As has been mentioned earlier, a lost rhino is a lost rhino whether or not it died due to poaching or capture-related mortality or simply failed to be born due to sub-optimal nutrition caused by overstocking. In such cases there is really nothing to lose by reducing densities in an overstocked population.

- When considering translocation mortality risks, it is imperative that decisions on whether or not to proceed with translocations consider the full cost:benefit trade offs of proceeding with or not doing translocations. Similarly the fact that there is a small brokerage fee and possibly additional taxes to be paid when buying company shares/equities (i.e. a cost) is not a good reason to not to buy shares as a long term investment and instead keep your retirement savings in a low interest bank savings account as the latter will significantly under-perform the shares in the longer term.
    - For example thanks to translocation there are now 10 times more southern white rhinos on earth than there would have been if there had been no translocation.
    - Despite initial higher losses in one nutrient poor area which was overstocked, the emergency translocation of black rhinos out of the Zambezi valley (at a time of heavy poaching) and their relocation to conservancies in safer areas elsewhere has been a great success. Translocated populations now make up the large majority of Zimbabwe's rhinos.
    - Translocation and an increased focus on biological management for growth, has allowed Kenya to increase the growth rate of its black rhino metapopulation despite initial losses of rhino during or after translocations.
    - Translocation has also contributed to rapid growth in Nambian black rhino.

- Keeping many "eggs in one basket" is not strategically sound. A failure to translocate animals when there is a clear need can have disastrous consequences. For example..
    - A period of heavy poaching reduced northern white rhino in the one surviving wild population, Garamba National Park from only 30 to only four animals from 2003–2005. The failure to set up a second population has increased the chances of this subspecies' extinction in the wild. Sadly recent ground surveys have failed to find any signs of remaining rhinos and the subspecies may have become extinct or reduced to non-viable levels in the wild.
    - The performance of the remaining population of Javan rhinos in Ujung Kulon has been poor for many years (see text box in Introduction), suggesting this population may be at or close to ECC. The failure to translocate animals out of this population to date has probably significantly reduced the numbers of Javan rhinos surviving today as well as reducing genetic heterozygosity of remaining rhinos. A natural disaster such as a Tsunami or outbreak of heavy poaching could wipe out this population.
    - The importance of considering the likely *benefits* of translocation and not only the possible mortality *costs* is best illustrated by a hypothetical worked example. Let us suppose there is a single population of 50 rhinos in a population stocked at or above estimated Ecological Carrying Capacity and where numbers have remained stable for the last 10 years with births being balanced by deaths (0% growth). Suppose that instead 10 years ago, management had removed 20 rhinos to set up a second population. Given an initial 10% capture/translocation related mortality, and after a two year settling-in period of zero growth, let us then suppose these translocated rhinos grew at a rapid 9% net annual population growth rate in their new population (as many translocated populations have done). Let us further suppose that following the reduction in rhino densities in the original population, dietary nutrition improved for remaining rhino, and their underlying population growth rate improved as a result from 0% to 5% per annum. If one had proceeded with the removals 10 years ago, and despite the translocation mortalities and two year settling in period (costs); the number of rhinos in the metapopulation would have increased from 50 in one population (no removals) to 85 in two populations (49 in original population and 36 in second translocated population). Net average metapopulation growth over the period would have increased from 0% (no removals) to 5.4% (translocation to set up second population). After 10 years, if this process was repeated with translocation of a further 20 from the original population to set up a third population; then in another 10 years the metapopulation would have increased to 168 in three populations (47, 85 and 36) raising the average annual metapopulation growth rate over the twenty year period to 6.2%. While 10% (four rhinos) of the rhinos died during capture/translocation, the net gain to the metapopulation over 20 years following translocation was an additional 118 rhinos (more than double the starting number). Strategically having over three times the

number of rhinos spread across three populations represents a significant improvement. This puts the "costs" into perspective. A failure to translocate rhinos in this case was not the "safe" or strategically wise option. This example shows how Inaction or delayed action can be far more costly than any translocation losses experienced as a result of active biological management.

1.11 Veterinary considerations

1.11.1 Introduction

- In general, veterinary concerns around reintroductions are focused on the immobilization and management of rhino during the physical intervention phases of translocations. The technical data for these interventions, associated with each species, are provided elsewhere and appropriate texts are referenced in this guideline. At all times the role of the veterinarian is to ensure optimal health and welfare of the rhino in the source and recipient populations and for those individuals selected for translocation. Basic procedures are mentioned with more detailed information referenced or annexed. Health and disease of rhino are also the concern of the vet and a few general points around potential problems are dealt with here. Other veterinary related issues are also highlighted.

- The order Perissodactyla comprises of only three surviving families equids, tapirs and rhinos. From a disease risk perspective this has one advantage in that the diversity of disease agents for a species tends to be related to the population size and the numbers of closely related species. If a species has a large population and many close relatives it provides ideal conditions for parasite and pathogen evolution (Kock *et al*., 2007). The rhino is most probably fortunate in this respect with low populations and few relatives. The close relationship between rhinos and horses, especially in anatomy, physiology, parasites, disease, nutrition and response to drugs (Morkel & Kennedy-Benson, 2007) and the large amount of knowledge on horse veterinary issues provides us with opportunities to better understand diseases in rhinos.

- From a veterinary perspective a translocation can be seen as a movement of a package of biological elements including the animal, its bacteria, fungi, viruses, internal and external parasites, all of which could be potentially harmful to other rhino populations and herbivores in the release site. On the other hand, the environment at the release site might have agents to which the arriving animals have never been exposed and which could prove detrimental to their health. It is therefore a pre-condition for a successful re-introduction or supplementation that the translocated animals are healthy and not carrying any infectious or contagious diseases that they can transmit to others. Healthy animals also have more of a chance of coping with the stresses of relocation and are more able to adapt to their new environment. For these reasons, and since a number of the procedures involved in physical intervention with rhino require veterinary expertise, it is important that appropriately trained veterinarians are involved in all stages of the operation. However, despite all such veterinary precautions some mortality as a result of translocations may still be inevitable. Suggested veterinary screening protocols are provided in Annexe 1 and see Kock *et al.* in prep.

- In general, because of potential increased disease risks captive animals should generally not be introduced into established significant free-ranging populations (Osofsky *et al.,* 2001). Every translocation of captive or wild rhinos needs to be assessed by a qualified and experienced rhino veterinarian on its merits and an evaluation of possible disease risks. Re-establishment of small populations from captive locations is acceptable.

- Owing to the cryptic nature of the rhino, knowledge of disease in free-ranging populations is still scanty and most literature relates to captive rhino that show an array of bizarre conditions and these appear to relate mostly to conditions of confinement.

- In free-ranging conditions in East Africa there are reports of syndromes that often relate to periods of starvation or stress, and here opportunistic pathogens and parasites were the proximate cause of death.

- Translocation has enabled closer examination of rhino and many veterinary reports relate to these events. In these instances ill health or death can occur from trauma (during capture, transport, boma management or after release from con-specific aggression). For example Figure 16 above showed that 8.5% of black rhinos translocated in Namibia, and South Africa from 1989–2006 died from translocation related causes although mortality rates in recent years have been declining following a shift to moving bigger founder numbers to larger areas using distributed narcotized releases (Adcock *in prep* based on an analysis of SADC RMG data).

- Animals may also die from opportunistic infections or exposure to novel disease agents or toxins in the recipient area or bomas (e.g. creosote[13] in boma wood, algae and botulism) and sometimes poor nutrition with drought or if animals are overstocked. These problems are often exacerbated by stress leading to expression of latent infection with e.g. aspergillosis or piroplasms. Viral disease appears rare although various antibodies can be detected. Bacterial disease, such as tuberculosis (Keep & Besson 1973) and anthrax (de Vos, 1980), most probably do occur (cases have been confirmed in Etosha Namibia since the de Vos report) but both these diseases appear rare whilst the most common cause of death from bacteria is associated with post-traumatic wound infection with streptococci and staphylococci (Clausen & Ashford, 1980) or bone infection evident from skulls.

Figure 17. Skull and lower jaw from a black rhino *D.b. michaeli* that died on Solio Ranch, Kenya (Kock, 1999). The presumptive diagnosis was lumpy jaw an infection (rare in horses) from exposure to soil contaminated with *Actinomyces bovis* from earlier cattle occupation of the range (Photo credit: Richard Kock).

- Data on disease of rhino from Asia is relatively deficient although pasteurellosis and salmonellosis were diagnosed in cases during translocation to Dudhwa and other Terai sites. Some internal parasitic infections have been associated with mortality especially in young or stressed animals but these may be incidental findings[14]

- The case for conservation of rhino parasites is no less pertinent than conservation for the rhino itself as co-evolution has led to some rhino specific parasites (e.g. rhino bots - *Gyrostigma* spp.). For example, there are over 40 recorded species of ticks and 40 helminth species from African rhino. Pre-translocation treatment or eradication of these would not necessarily be appropriate, but treatment of pre-release or boma managed animals might be if there is illness attributed to these parasites or their presence is considered a new introduction to the recipient site.

[13] Creosote poles should never be used to build rhino bomas.

[14] 3/7 black rhino during acclimation to bomas died apparently with heavy infestation thought to have contributed to their deaths; but whether these contributed to death is not certain and filariasis with associated ulcerative dermatitis is common but of little impact.

- Trypanosomosis has been a problem for rhino exposed through translocation into tsetse fly zones with no prior exposure to trypanosomes. White rhino are more susceptible than the black rhino especially to *T. brucei* which causes encephalitis amongst other syndromes and death (Kock *et al.* 2007). Deaths have occurred with other species of Tryps e.g. 4/5 white rhino translocated to the Zambezi valley from KZN. These experiences and others strongly indicate that white rhino should ***not be translocated*** under any circumstances to areas of high tsetse and trypanosome challenge. On rare occasions with extreme stress and challenge black rhino can succumb and without previous exposure will show some anaemia, leukopaenia and thrombocytaemia (Clausen, 1981; Mihok *et al.,* 1992, 1994; Kock *et al.,* 1999). Use of targets and traps have had mixed success in preventing trypanosomosis in white rhino but are helpful with black rhino introductions (e.g. to North Luangwa in Zambia and Sasakwa in Tanzania).

- Babesiosis and theileriosis have been recorded in the black rhino under stressful or unusual environmental conditions where insect "storms" resulting in heavy tick and parasite challenge occurred (Nijhof *et al.* 2003). Here the detection of a novel parasite and apparent susceptibility of the whole population of rhino raises questions as a recent rhino introduction had occurred from South Africa where babesia sp. have been recorded as pathogens in rhinoceros (Brocklesby, 1967). However in this case deaths occurred at a time animals in the recipient population were under nutritional stress and tick loads were high at the time due to a long period of no or little burning (P. Morkel, pers. comm.) and the uniquely favourable climatic conditions for insects (Munson *et al.,* 2008). Since the introduction of control burning, return to normal climate variation and insect dynamics, and with less nutritional stress, no further rhinos have been lost to babesiosis. However, this might all be purely coincidental as increasing tolerance to an introduced babesia would be expected over time with adaptation of the rhino immune system to cope with the challenge. The return of any of the above stresses associated with disease will provide evidence of true cause and effect. A translocation recently of a Sumatran rhino *ex situ* to *in situ* captivity was vaccinated against babesia using a standard vaccine and it appears to have been challenged without ill effect (R. Radcliffe, pers. comm.).

- Proximate causes of death should always be examined in light of predisposing factors.

- International translocation needs to take account of veterinary infectious disease (OIE) requirements of the importing country and for this African Horse Sickness is an extra concern although clinical disease has never been recorded.

With so little known of infection in the rhino, any opportunity to handle a live animal or examine a carcass should involve a thorough examination and comprehensive biological sampling. Baseline studies are few with some work completed on internal parasite burdens but how significant the different species isolated are in disease pathogenesis, is poorly understood. With poaching as the main cause of death over the last 100 years in many areas it is unsurprising so little is known of disease epidemiology in rhino. However considerable work has been done (Schulz & Kluge, 1960; Round, 1964; Hitchins & Keep, 1970; Jessup *et al.,* 1992; Windsor & Ashford, 1972; Keep & Besson, 1973; Silberman & Fulton, 1979; Clausen & Ashford, 1980; De Vos, 1980; Clausen, 1981; Soll & Williams, 1985; Kock & Kock, 1990; Kock *et al.,* 1989; Kock *et al.,* 1992a; Kock *et al.,* 1992b; Mihok *et al.,* 1992, 1994; Knapp *et al.,* 1997; Kock *et al.,* 1999, 2007, in prep; Fischer-Tenhagen *et al.,* 2000; McCulloch & Achard, 1969; Williams *et al.,* 2002; Nijhof *et al.,* 2003). As populations recover and numbers increase disease patterns should emerge and will need to be studied.

1.11.2 Veterinary examination of rhino for health prior to translocation.

- Prior to translocation, the health status and prevalence of infectious diseases in the source and release populations must be established (see Kock *et al.,* 2007; Kock *et al*., in prep).

- For basic re-introduction screening protocols see Annexe 1.

1.11.3 Post-mortem examination

- As should be the case for all rhino deaths, any mortalities during or in the post-release phase should be investigated and a post mortem examination done to determine the cause(s) of death. In some countries and regions (e.g. SADC RMG, KWS) there may be a standardized mortality form that needs to be filled in and which will form part of annual status reporting.

- If there are any indications that a dead rhino has been poached or the horn(s) is/are missing then the area should immediately be treated as a crime scene and access restricted to trained individuals. It is outside the scope of these guidelines to provide details on standard scene of the crime procedures which can be followed to maximise the useful information and forensic exhibits obtained from the crime scene whilst also ensuring that any evidence collected stands up in court. In Africa specialized scene of rhino crime training is available[15] and this training has been shared with Asia. If a vet is first on the scene he/she can help secure the crime scene until a trained wildlife investigator is called in. However sometimes this might not be possible within a reasonable time frame, and given that vets are sometimes first on the scene it is advisable for rhino vets to also be included in scene of the crime training courses (along with senior park managers, specialized wildlife investigators and specialized police) so they can undertake a crime-scene investigation in the absence of a trained wildlife investigator/policeman.

- If anthrax is suspected the carcass should not be cut or opened and the body should be covered in a black plastic sheet to ensure putrifaction proceeds, destroying the vegetative form of the organism and therefore reducing the likelihood of spore dispersal. Alternate methods of disposal are burying or burning but there is no need to do this as natural decay will recycle the carcass and in the case of rhino this will be technically difficult to achieve.

1.11.4 Euthanasia

- There will be rare occasions when a rhino needs to be destroyed, and the most likely reason is severe injury from fighting or during translocation. Where the wound or damage is likely fatal and cannot be treated e.g. fractured femur or humerus, it is a matter of animal welfare and the decision on euthanasia should be left to the veterinarian responsible at the time of the injury.

- In India euthanasia of greater one-horned rhino requires a complex procedure including the ultimate decision being made by the Chief Wildlife Warden of the State and this is enforced through the Wildlife Protection Act 1972. This situation is not ideal or considerate of animal welfare during intervention procedures. In most countries the responsibility for the welfare and where necessary, euthanasia or animals, lies with the mandated veterinarian involved with the procedure such as translocation and this is considered to be "best practice".

1.11.5 Statutory veterinary requirements for animal transportation

There are animal welfare regulations in some countries which determine transportation conditions appropriate to each species. IATA provides guidance and regulations for international air transport and these general conditions are also appropriate for sea, road and rail transportation (IATA Live Animals Regulations (LAR) and can be obtained through the internet: http://www.iata.org/ps/publications/lar.htm). These should be referred to in the planning process including construction of transport crates and provision for journeys. This is not mandatory in some countries, such as India, but authorities are encouraged to consult the IATA and other experts before completing design and construction.

[15] Contact AfRSG or SADC RESG for more details.

1.12 Socio-political considerations

1.12.1 Rationale

- Rhino translocations generally involve socio-political considerations at local, national and even international levels. To ensure success, the proposed translocation should be fully understood, accepted and supported at all levels. Due consideration of socio-political issues is an important part of pre translocation planning. In many instances socio-political considerations will be as important as the biological, behavioural, veterinary, security, logistical and planning aspects.

- Unlike many other species which have a limited potential for impacts, when translocating rhinos there are many critical factors to take into account. While rhinos may be viewed as an asset when they are associated with benefits through tourism related revenues at either the source or release sites, these benefits will, in some cases, need to be balanced against possible costs that the translocated rhinos may bring in terms of their high costs of routine monitoring and management, the added danger to staff, and in unfenced areas the possible damage they may do to neighbouring communities and their crops.

- A well designed government wildlife policy can address many of the socio-political risks associated with rhino introductions. Once developed policy needs to be implemented at all stakeholder levels and modified as needed to adaptively deal with rapidly changing circumstances.

1.12.2 Source site considerations

- Potential loss of economic and other benefits that a community/conservation area may either currently receive, or perceive to be receiving from rhinos targeted for translocation from their areas may lead to rise in socio-political conflict between the wildlife agency undertaking the translocations and the communities/private land owners on whose land the rhinos involved live. Consultation will be particularly important well in advance of the removal of any rhino. There is no greater disincentive to local communities or the private sector for conserving rhinos in the future than to remove such a valuable asset without consultation. Negotiated mechanisms should be developed to directly or indirectly compensate affected stakeholders through a mediated process.

- When rhinos are being managed on a custodian basis it is also essential that rhino custodians are informed well in advance, and preferably right at the outset of the initial founding of their population, that sometime in future, once densities have built up to specified levels, some animals will need to be routinely removed to keep the population productive. If custodians are only informed near to the time of planned removals from their areas this can cause significant problems.

- Where one is seeking support of neighbouring communities in buffer zones around a park and encouraging them to build tourism ventures involving rhino (e.g. Chitwan NP in Nepal) it may not be a good idea to remove rhinos from or close to their areas unless this is absolutely necessary, and only after they have been engaged in the planning process.

1.12.3 Release-site considerations

- When reintroducing rhinos into areas they have been absent from for some time it is a good idea to involve local VIPs and community leaders. In unfenced release sites, particularly where rhinos will be attracted to and have access to crop fields (e.g. Bardia NP, Nepal), concerted and targeted consultation with local communities in the immediate area must begin well in advance of any planned translocation.

- A thorough assessment of local attitudes is necessary to ensure long-term security of the translocated animals. This is especially important if the original loss of rhinos at the release site was due to human activities.

- Potential risks to life and property by the introduced rhinos should be minimised and adequate provision made by the wildlife authorities for compensation/mitigation measures where necessary.

- Where release sites do or could hold trans-boundary populations or provide opportunity for trans-border movements by the translocated rhinos, adequate consultation must take place with all the relevant neighbouring range states. A formal Memoranda of Understanding or Agreements should be signed at the highest possible political levels to document and ensure common understanding, commitment and joint management of these individuals.

- There may also be educational opportunities to build community support for re-introduction programmes (as was done in the North Luangwa black rhino re-introduction in Zambia by getting local children to see rhinos at bomas prior to release, or talks/films at local schools during the black rhino range expansion project in KwaZulu-Natal, South Africa – this needs planning so that the release and capture can be filmed without compromising the capture and translocation process which should be undertaken with minimal disturbance).

- Wherever rhino are to be released, there should be security of land tenure.

- Area management committees linked to the national rhino conservation coordination structure should be established for more efficient coordination between all the local stakeholders.

1.13 Budgeting

- Without proper budgeting, it is not possible to determine whether the resources available are sufficient to cater for all the costs involved in rhino translocations.

- Insufficient funds, as a result of inadequate budgeting, or incomplete fundraising efforts, must not be used as an excuse for poorly planned or implemented translocations.

- Properly drafted budgets are essential for successful fundraising. It is important always to strive for the most accurate cost forecasting possible. An inability to spend committed funds, or worse, overspending (without very good reason), will not be looked upon favourably by donor organizations.

- Budgeting for a translocation operation should cover all costs of the operation and have a sufficient provision for contingencies or unforeseen expenses.

- Budgets for long term monitoring, rhino protection and biological management should not be overlooked.

- Translocation costs are not necessarily a constraint on a tight departmental budget if an efficient and cost effective method is used. For example, in Namibia single pickup vehicles and small trailers provide a highly cost effective method for capturing and moving rhino, involving small experienced teams. The use of small teams might mean slower rates of translocation but if spread over a capture season may still able to achieve set objectives, as is being done in Zimbabwe where a fixed wing aircraft is used to spot rhino, rhinos are darted from the ground, ground teams are guided in to where the rhino has gone down from the fixed-wing and where a rhino capture vehicle with crane and truck is used to transport animals singly. Swaziland has also designed and uses a portable trailer with rhino crate to move single rhinos when needed.

- Large operations can be more expensive involving a lot of personnel, large vehicles and often larger teams than necessary, but these might be preferable if many rhino have to be moved from a number of parks over a short timeframe and where (expensive) helicopters are being used to do the darting.
- Where a large specially adapted truck with a mass crate is available it is possible to transport six rhino at a time to their final destination.

1.13.1 General issues to consider for successful budgeting

- In case of a translocation involving the movement of rhinos across international borders, both the source and recipient governments must have approved any funding proposal, before it is submitted to donors.
- If the project is donor funded, it is important to ensure that all donor requirements, including the appropriate budget format, are understood before submitting the budget for approval.
- Both cash and in-kind contributions should be included in the budget.
- It is always important to provide detailed budget notes. This will help prospective donors to determine how the costs were arrived at, and will also act as a useful aide-mémoire when preparing future or revised budgets.
- Project evaluation and financial audit costs (if required by the donor) should be taken into account.
- Any administrative or management costs and cost recovery should be included.
- Qualified staff must be available to do the accounting for the project expenditure. If staff have to be hired, their recruitment costs and salaries must be included in the project's budget.
- Costing must be realistic and be based on current market rates.
- Budgeting for operations that could take place more than a year into the future must take into account the effects of inflation and possible currency fluctuations.
- One must not just budget for the translocations. It is essential to ensure there will be sufficient long-term funding for ongoing security, monitoring and biological management. If the latter is not in place then the translocation must not be undertaken.

1.13.2 Specific issues to consider when budgeting for rhino translocations

- The objectives of the translocation and the activities required to achieve them should be the primary focus of the budget and all budget lines must be clearly linked to the activities outlined in the proposal.
- The number of rhino to be moved, how many animals are to be moved in a single shipment, and the age structure and composition of targeted individuals or cow-calf groups must be determined as early as possible as this will, in turn, determine the number of days, personnel, and type of equipment required.
- The amount of food, fuel and maintenance for helicopters, fixed wing aircrafts, elephants, vehicles, tractors and machines, the distance of the capture site from the headquarters as well as distance from capture site to release site, including distances to be travelled within the capture and release sites must be estimated as carefully as possible.

- The cost of radio transmitters and receivers, immobilization drugs, vehicle and personnel costs for pre-capture and post-release intensive monitoring can be a significant component of the overall budget and must be estimated as accurately as possible.

- The cost for rhino management in boma and boma maintenance must also be estimated as accurately as possible. Logistics are critical. Feed provision is particularly important as bomas are often located in dry areas long distances from forage suppliers and collection of browse can be highly labour intensive and which rangers/scouts might be reluctant to do. Without proper supervision and management there will be a tendency to restrict feeding or have gaps which will be detrimental on the animal's health. In at least one case, failure to adequately feed rhino over an extended boma management period occurred with loss of condition which led to management conflict. This with failure to supply security rangers/scouts with water in dry observation points led to sackings and subsequent poaching was encouraged and supported by staff and ex-staff of the management authority. After the fuss and publicity of the physical part of rhino translocation there is still a job to be done and the staff left over to provide security and sustenance to rhino must be recognised and supported. The hiring of an experienced boma manager is recommended.

- Any consultancy payments to be made to the members of the multidisciplinary team or other specialized expertise must also be budgeted for.

- As unexpected events during translocation operations are common, a reasonable contingency budget to cater for such developments should be included. It is therefore recommended that all budgets should include a 10% contingency.

- Translocation proposals should, as far as possible, not be packaged as emergency appeals to donors. Ideally, translocations should fall within existing 5–10 year national rhino management plans to ensure adequate time for planning, fundraising and implementation. While donor requirements may vary it is normally recommended that the budget be laid out in such a way that it covers all the four main categories of operation costs, Planning, Pre-capture, Implementation and Post-release. Examples of the types of costs to be included under each heading are given in Table 1.

- In Asia elephants used for darting must be budgeted for (including their food and maintenance). Similarly helicopters and/or fixed wing aircraft and fuel need to be budgeted for if being used in Africa.

Table 4. Translocation costs (excluding long term cost implications for ongoing rhino protection, monitoring and biological management).

Planning	Pre-capture	Implementation	Post-release
• Preparation of capture & release sites (road repairs etc) • Costs of all items purchased before operation • Fundraising costs • Costs of publicity & awareness-raising campaigns at the release site • Personnel costs (hiring & training of staff)	• Equipment, materials & supplies (incl. radio transmitters, receivers, transponders, cameras, video cameras, memory cards & computer hardware) • Crate costs (manufacture of new or repairing old ones) • Costs of construction of pit traps (Asia) • Capture costs (drugs, staff) • Hiring elephants (Asia) • Vehicle, aircraft, helicopter (Africa) & equipment operating costs (incl. truck hiring, fuel, lubricants & maintenance costs) • Personnel costs (hiring & training of staff) • Boma construction / repair costs	• Equipment, materials & supplies • Elephants (Asia) • Aircraft & helicopter (Africa) • Vehicle & equipment hiring and operating costs during capture • Costs of transporting rhinos to release sites • Transport & accommodation costs for administrators, mangers & other staff including observers & casual labour • Coordination & communications costs • Capture site clean up costs • Personnel costs (hiring & training of staff) • Boma maintenance staff and rhino care costs including logistic provision for supply (vehicles fuel)	• Equipment (tents, GPS receivers, binoculars, boats (Asia) etc), materials & supplies • Aircraft (Africa) • Elephants for (monitoring (Asia) • Vehicle & equipment operating costs • Coordination and communication costs • Personnel costs for management & post-release intensive monitoring of rhino (hiring & training of staff)

1.14 Security considerations

1.14.1 General

- Sometimes the needs for rhino protection (which are easiest to achieve in small, highly defended fenced sanctuaries) conflict with the needs for maximizing the potential for population expansion (du Toit 2006). Holistic decision-making is required to balance the rewards in biological management of rhinos (i.e. encouraging population growth in both donor and recipient areas by spreading rhinos to new areas) against the risks (i.e. exposing the rhinos to poaching in less secure areas).

- Despite increases in rhino numbers in some species in some countries, the threats facing Asian and Africa rhino remain serious given the illegal demand for rhino horn in end user markets (either as a traditional Chinese medicine ingredient in SE Asia or for making ceremonial dagger handles in countries such as Yemen). The international horn trade ban and the domestic bans imposed in most traditional user states have driven the trade further underground, in some cases inflating prices and making illegal dealing even more lucrative. Despite efforts to close down the illegal horn trade, the illegal demand for horn persists and as a result the threat of a return to large-scale poaching is ever present. Worryingly rhino poaching has escalated recently (especially in South Africa and Zimbabwe) in the face of increasing illegal horn values which presumably reflect an increasing illegal demand. Wars, civil unrest, poverty, influxes of refugees, and internal corruption within some range states result in poachers often escaping arrest and poverty-stricken people becoming poachers to survive.

- However, despite poaching threats experience has shown that given the political will, stability and adequate field expenditure, rhinos can be successfully conserved in the wild. It is not an accident that rhinos have increased rapidly in some countries and gone extinct in others. Any country looking to re-establish rhino therefore needs to be aware that this is a big responsibility and will require significant long term investment and political will as well as manpower, capital and community engagement.

- Ironically it is not the proximity of a protected area to people that necessarily results in poaching, as many successful breeding locations have demonstrated (e.g. Nairobi National Park is adjacent to slums with literally millions of poor people with almost no poaching recorded). The vulnerability to poaching is more a result of perceived risk to benefit ratio for the criminal. Rhino are also dangerous animals and require an extended pre-attack planning period and knowledge of the terrain, rhino behavior and movement patterns. Quiet remote areas with thick bush terrain therefore can provide a degree of natural protection. Local knowledge and support may be given to poachers if there are poor relationships between the Protected Area management and communities. The corollary also holds where neighbouring communities in areas with good neighhbour relations have assisted park authorities by providing intelligence and early warnings of planned poaching attempts or arresting poachers as seen recently seen in Bardia NP. Deterrence is therefore not just a matter of military force.

- As conservation budgets continue to decline, the greatest challenges for the future of the rhinos is maintaining sufficient conservation expenditure and capacity for field action. Unless income increases from donors and other sources, or costs are reduced without affecting effectiveness, conservation programmes will be jeopardised.

1.14.2 Release-site considerations

- As general rule, proposed sites where the immediate and long-term security of the re-introduced or translocated rhino will be challenged should not be viable options.

- Minimum security for the existing and introduced populations should be ensured at the release site as history has shown protection effort needs to exceed minimum threshold levels to be effective (Leader-Williams 1988; Leader-Williams 1996; Leader-Williams et al. 1990). Security needs for the protection of rhino present a particular challenge in very large conservation areas (>3,000 sq. km) where restricted budgets are rarely able to support the required level of protection. Therefore, from a security perspective, smaller release sites (<3,000 sq. km) but which are large enough to support a viable population in the long term, may present better options for rhino re-introductions and translocations in the short to medium term.

- Regardless of the size of the chosen release site, the following security precautions should be in place:
    - Adequate levels of appropriately trained and well equipped and armed law enforcement and monitoring staff. A ratio of 10–20 sq. km per man (well equipped and trained enforcement staff) has been demonstrated to be an effective staffing level for the protection of rhino in Africa. In larger areas, (>200 km square), ground surveillance should be supplemented by a mobile specialist anti-poaching unit that can help in an emergency and also act as an internal check on other field ranger patrols (Emslie & Brooks, 1999). The combination of picket camps situated in peripheral high risk areas, complimented by an independent anti-poaching unit has proved to be extremely effective in combating poaching in big and small areas. Patrolling buffer zones around parks to detect incursions of poachers early is also a useful strategy if such zones exist around the park or rhino concentration area. In larger parks with rhinos the manpower density of at least one man per 20km^2 need not be maintained throughout the whole area if rhinos are not spread throughout, but only in the sections that contain rhino concentrations (du Toit, Mungwashu & Emslie, 2006)
    - In Asia, manpower densities of over 1 man per sq. km may be needed to ensure poaching is minimised.
    - Adequate annual operational budgets to support the field force in all their operations. The amount will vary according to local conditions but should be sufficient to support the capital investment for elephants (Asia), vehicles, fuel, equipment and construction of suitable field ranger/scout camps and related infrastructure.

- A dedicated law enforcement strategy, including the existence of a properly planned and functioning intelligence network. This will involve the use of informers in local communities to support the networks' operations. It may also involve close collaboration with the national police and/or military in the area. It is also important to create a good working relationship with the prosecuting agency who take poaching cases through the courts. Experience has shown this to be a crucial aspect of effective law enforcement. Given the increasing involvement of organized criminal syndicates in rhino poaching, it is important that neighbouring wildlife and law enforcement agencies share information, as some of these gangs operate across a number of provinces and even countries.
- A standardized system for monitoring law enforcement effort and rhino. This should be based on the protocols developed at a strategic level and disseminated to all levels of enforcement/compliance staff.
- An effective community engagement programme is in place particularly aiming the poor marginalized communities surrounding rhino areas. This includes the buffer zone initiatives in Asia to community outreach programmes in Africa.
- An effective human wildlife conflict control programme is in place in unfenced areas (e.g. Bardia National Park, Nepal)
- In addition to this, the selection of potential release sites should be carefully considered and the following high risk areas should where possible be avoided.
- Areas situated on international boundaries outside of trans-frontier conservation areas. Border areas bring additional security concerns and challenges. Overcoming these challenges requires close cooperation and coordination of law enforcement agencies between neighbouring countries, which may be compromised during times of instability.
- Areas where major development activities, such as road building or other infrastructural construction projects, large-scale agricultural schemes, or major extraction or exploitation industries are taking place. There are clear indications that such areas present high security challenges due to the increase in human activities and the transient nature of the settlements, which form around these activities.
- Areas where there is existing civil instability war or an immediate threat instability in the recipient country or neighbouring nations. Civil disturbance (and the accompanying flow of arms or planting of land mines) combined with a temporary break down of law and order have always presented a high risk to the security of rhino populations in Africa (e.g. Garamba National Park) and Asia (e.g. Manas National Park).
- Areas where there is already a high incidence of human-rhino conflict, even if the conflict is created by relatively few remaining rhino. A high incidence of human rhino conflict can lead to rhino being killed both legally and illegally in protection of life and property. These are not appropriate release sites for translocated rhino, particularly for those that were "problem animals" in their previous homes.

- Where a single horn can provide significant amounts of income to a poacher in areas where people live in poverty at high densities with low rates of local employment, rhino can become an important target species for poachers.

1.15 Legal considerations pertaining to rhino reintroductions/ translocations

- Where rhinos are legally the property of the State irrespective of the land tenure system, translocation decisions should be approved by the State body in charge of wildlife management, (e.g. for black rhinos in Kenya by the Kenya Wildlife Service and in Namibia by the Ministry of Environment and Tourism). Veterinary interventions and movements should also be approved by and led by the relevant government authority. Where rhinos are privately owned, then a legal regulatory framework must be established to ensure translocations procedures are followed.

- Both national and international legal considerations must be observed. Veterinary laws should also be observed.
- CITES regulations must be adhered to and all relevant CITES permits need to be obtained.
- Governments need to clearly set out a policy of wildlife and rhino ownership issues as this will govern possible translocation options.
- Formal approval of Public-Private partnerships may be required. However this may not be needed if conservation agency is dictating management and retaining ownership of founder rhino as is the case in the KwaZulu-Natal black rhino range expansion project.
- Contractual obligations and reporting requirements of recipients should be built into contracts of rhino custodians (e.g. as done in Namibia and in KwaZulu-Natal, South Africa)
- Other contractual conditions may hold – for example it was a condition of the sale of the out of range *D.b.michaeli* population at Addo National Park to a private owner that this owner cannot sell or give away any of these rhinos within South Africa, and they should rather be sold to zoos or be repatriated to eastern black rhino natural range.
- Import and export permits may be needed to transport rhino from one region to another within a country.
- A valid permit may be required for a government or provincial conservation agency before one can introduce or keep rhinos on a property.
- National wildlife act is updated to ensure strict penalties for rhino / wildlife poaching.

2 Implementation of the translocation

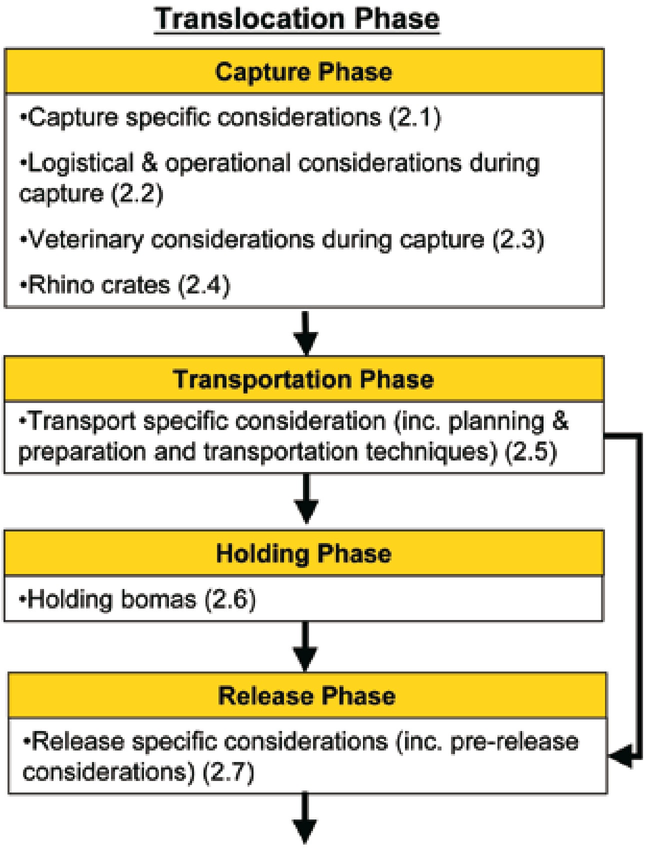

Figure 18. Flow diagram showing key stages in capture, translocation and release processes.

Rationale

The translocation of rhino is a complex undertaking that requires specialized equipment and highly trained personnel but once established can be a routine, simple and safe procedure. All aspects of the operation need to be choreographed in order to achieve the desired results. Capture, transport and release procedures should place special emphasis on ways to minimise stress and avoid injury to rhino and people.

2.1 Capture-specific considerations

- The capture methodologies for African rhino are varied and in general well established and routine with adaptation to specific ground conditions, using helicopters or ground darting approaches, and including partial reversal techniques for walking animals into crates for loading (This technique can be extended to inaccessible terrain with the African rhino: in some examples rhino have been walked as much as a kilometer to a crate and even up steep hills or on uneven ground without any significant problems). In addition there are a variety of loading and transportation systems from hydraulic lift arrangements (Figure 19) for crates onto flat bed trucks to single crates on trailers attached to standard four wheel drive vehicles.

Figure 19. Walking a partially reversed black rhino to a crate. Normally this is done using ropes and with more people to help push and guide rhino (Photo credit: Markus Hofmeyr).

- The capture of greater one-horned rhino in south Asia is somewhat different from most African rhino capture operations in that a helicopter is not used because of (a) the prohibitive costs, (b) the lack of a suitable fleshy target for a dart to enter from above (due to the dermal plates on the back), (c) the generally accepted use of koonkie elephants to access the field, and (d) because the terrain rarely allows (Figure 20) normal heavy vehicles to access where a rhino has gone down after darting.

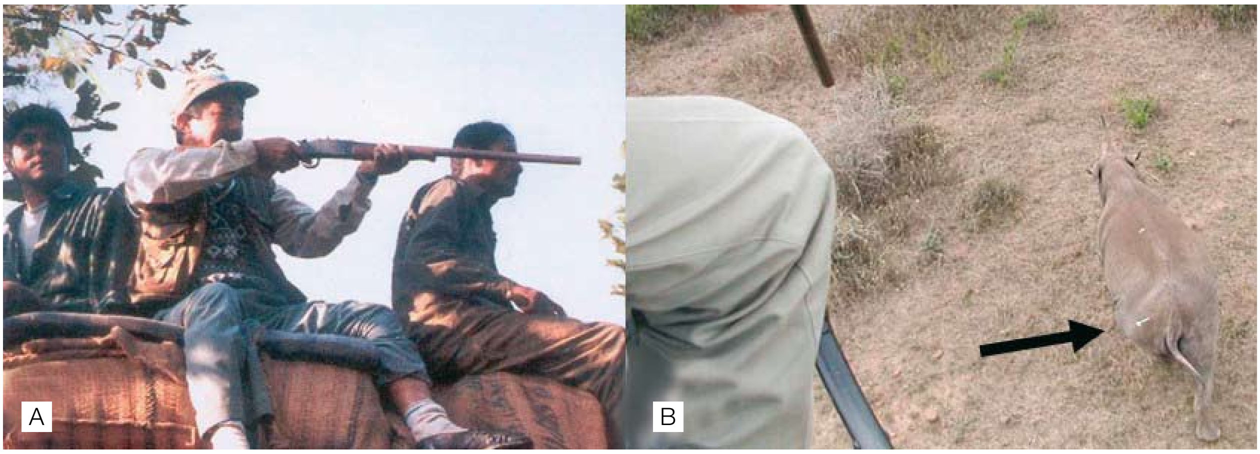

Figure 20. Common darting platforms: (A) darting a greater one-horned rhino from the back of a koonkie elephant (Photo credit: NTNC); (B) darting a black rhino from a helicopter. Note the immobilizing dart in the rump (Photo credit: Paul Havemann – EKZNW). Rhinos in Africa have also sometimes been darted from vehicle or on foot.

- In Nepal 15+ elephants are used to drive a selected rhino slowly to an easily accessible area before it is surrounded by elephants and darted (see Figure 21).
- Once down, the rhino is loaded onto a sled and towed by tractor to where a transport lorry is waiting. The sled is designed to be towed into the crate before the animal is revived. The sled is then withdrawn (Figure 22) from the partially closed crate with the animal walking off the sled before the crate is loaded onto the lorry. It might be possible in some circumstances to attempt partial recovery and walk Asian rhino to the crate instead of use of sleds. This technique needs to be explored but with the considerable water bodies and tall grass around the greater one-horned rhino habitat this method may not be feasible.

Figure 21. Use of elephants to surround greater one-horned rhino before darting. Note that this rhino has had a radio-collar fitted (Photo credit: Christy Williams WWF).

Figure 22. (A) Manouvering immobilized greater one-horned rhino onto sled. (B) Tying down immobilsed greater one-horned rhino on the sled. (C) Using a tractor to pull an immobilized greater one-horned rhino on a sled. (D) Pulling sled with greater one-horned rhino into crate. (E) Sled being withdrawn from partially closed crate with greater one-horned rhino in process of walking off sled (Photo credits: A,C,D&E – NTNC and B Christy Williams WWF).

- In Asia greater one-horned rhino after capture are immediately transported to the destination and released on arrival. Provided the animals are not travelling for very long periods there is no boma training stage. This reduces costs considerably.

- However when African or Asian rhinos are to travel long distances boma training is used to reduce the stress to the animals and ensure they are calm for ease of movement into and out of and whilst in the crate. An angry or stressed rhino can cause considerable damage to itself and the crate when it becomes aggressive. This is particularly true for black rhinos. A number of cases of fractured nasal plates have been reported in animals attacking the roof or wall of the crate.

- When moving animals to a very different habitat it is probably a good idea to hold the rhinos in a boma and to introduce them to local vegetation whilst they still can also eat supplementary food. If bomas are to be used at the recipient site, the rhino should be first boma trained at source but this is not essential. If wild caught it is advisable to use long acting tranquilisers to aid the adaptation period to the boma.

- Field to field translocations are becoming a more common practice especially with shorter translocations, and are a distinct advantage for a species like white rhino which do not adapt easily to bomas and artificial feeding. With simple capture/transport/release systems, animals will not lose condition but may be more skittish and might suffer some trauma during transport. The decision on which method to apply, boma training at source, release site boma management (pre-release) or no boma holding, will need to be taken according to the local conditions and resources. All are suitable methods if appropriately applied. Where a great deal is known about the population, its health status and feeding ecology and there are similar ecological and nutritional conditions in the release site, the no boma option will be most efficient, cost effective with the lowest risk. Where there is a need to more fully evaluate the health of the animals, bomas are essential, and where the journey times and distances are long the more adapted the animals are to the crate and people the better, and habituation and exposure to captive conditions will lower the risk of injury or loss.

- The situation with the Sumatran and Javan rhino is far less clear cut with relatively few experiences to judge best practice for the capture and translocation of rhino. As has been discussed earlier Pit traps have been used successfully to catch Sumatran rhinos. For more details of this method see Sectionov (2007). Rather than be prescriptive for these species, these guidelines provide ideas for the practitioners in that region to try and perfect.

2.2 Logistical and operational considerations during capture

A number of aspects are key to a successful translocation and are listed here:

- The capture team should include some people from the release site, especially if the translocation is of an international nature.
- All permits and other documentation should be in hand before the commencement of the operation in the field.
- Generally, cows with calves less than two years of age should **not** be translocated.
- Careful consideration should be given to the selection of the rhino destined for a translocation exercise. The advantage of taking younger adults is that they have a long life ahead of them and there is a chance of achieving rapid breeding sooner. However, sub-adults may not be suitable candidates due to a combination of stress sensitivity and increased risk of being killed by established rhinos. This is especially the case with sub-adult black rhinos (3.5–7 years old). Generally smaller animals are more suited to long distance translocations. However taking some older animals that have already bred in the donor population is also good and one doesn't want to negatively affect the age structure of the donor population by selectively only taking young animals.

Figure 23. Accurately aging immobilised rhino in the field using tooth wear and eruption patterns. Animals found to be very old can be released. Accurately knowing the ages of individual rhino also assists with future monitoring and management of a population (Photo credit: Markus Hofmeyr).

- Those undertaking the capture must be able to age rhino as there have been cases where animals that were too young were translocated and subsequently died[16]. Apart from horn sizes and shapes and body size, rhinos can be accurately aged if tooth wear series references photos are available for an area. (Figure 23).
- The timing of the capture operation should be set to coincide with the desired timing of the release. It is recommended that one works backwards from when one wants to release the rhinos to identify optimum capture time.
- The simultaneous darting of many animals should be avoided so as not to spread the personnel resources too thinly on the ground and to shorten the time each rhino remains asleep.
- Drivers should be notified well in advance of the upcoming trip so that they are packed and vehicles ready to avoid delays after the loading of rhino.

16 Training material on ageing is available for black rhinos from the AfRSG (Adcock & Emslie 2003 – Module 6 Ageing white and black rhino) and also documented in Morkel & Kennedy Benson (2007).

- Copies of the maps of the reserve indicating the road network, river courses, gate ways, area names and infrastructure distribution should be issued to each team before the capture process. If possible all vehicles should have a VHF radio set or at least a mobile unit or handset and where applicable an alternative is a mobile phone system.

- All teams should be briefed beforehand by the team leader, emergency procedures set and contingency plans determined (such as a breakdown in communication).

- Capture of rhino in adverse terrain, i.e., near cliffs and deep water bodies, should be avoided.

- When catching African rhino a strong but light rhino cotton leg rope, cane knife/slasher and blindfold and cotton wool/tailor-made ear plugs (see Figure 30-B) for blocking ears should be carried by the follow-up team. Streamers can be attached to ear plugs to remind capture teams to remove them. These also make it easier to remove plugs (see back cover - top photo).

- Teams should carry a complete box of the required drugs.

- Identification transponder implants should be tested and fitted to the captured animals in each horn and shoulder. These can be injected subdermally into the shoulder. To fit them to horns, a portable drill must first make a small diameter hole (Figure 24) just large enough to take a transponder. After inserting the transponder into horns the holes are then filled.

- Animals should be ear-notched making sure a unique unused ear-notch for the recipient reserve is used, and using the local national or organisational notch numbering system. (Figure 25).

Figure 24. Injecting a transponder into the shoulder of an immobilized rhino in Kenya (Photo credit: Rajan Amin ZSL/KWS).

Figure 25. A and C1: Cutting ear-notches in immobilised rhino to plan (usually using an agreed national numbering system) in order the facilitate routine ground-based monitoring by C, making it easier for staff to individually identify them. The ear-notches can also be collected to provide samples for genetic analysis. (C2) Recording ear-notches (Photo credits A: Rajan Amin ZSL/KWS B: Paul Havemann & C: WWF/EKZNW BREP).

- Rhinos should be radio horned (or collared) if it they are to be released straight into field from capture.

- African rhino should have their horns tipped to blunt them. This reduces the chance of horns getting stuck in cracks in bomas and crates and breaking off (Figure 26), and reduces post-release fighting mortality risk. If the rhino has lived only in the reserve before being moved, the horn tip sample should be kept and labelled for possible later use in the AfRSG Horn Fingerprinting project.

Figure 26. (A) Horn-tipping an immobilised black rhino in Kenya prior to translocation. Note the use of a padded hood to protect the eyes while immobilised. (B) Using a metal file to round off a horn on a boma-trained black rhino prior to translocation (Photo credits A: Rajan Amin ZSL/KWS and B: Markus Hofmeyr).

- For more information on the logistics pertaining to greater one-horned rhino capture see Williams (2008).

2.3 Veterinary considerations during capture

- There are significant differences in the general behaviour and physiological states of the different species of rhino. These differences will influence factors such as drug dosage rates, drug tolerances and drug combinations, and veterinary considerations are therefore specific to the particular species being translocated and local conditions. Final decisions on these matters must lie with the responsible veterinarian for the operation. The drugs used are schedule 1 (international narcotics regulation), therefore can only be used by an appropriately licensed professional. There are many important health and safety issues associated with the use of these drugs and more generally with the procedures during the capture and transportation of rhino, and these must be considered and addressed in protocols.

- The considerations below generally apply to all species of rhino but the veterinary team must ensure that they are familiar with idiosyncrasies of the particular species being dealt with.

- The number of rhino to be immobilized at any one time will be determined by the number of trained staff, vehicles and transport crates at the capture site as well as capacity to follow darted animals and not lose them (likely to require aerial support in Africa).

- In the case of a cow-calf combination the mother should be darted first.

- The immobilization should be done during a cool time of the day (always below 25ºC) by the use of a remote injection system (dart) and the appropriate chemical anaesthetic agent.

- The method of delivery of the agent will vary according to the situation on the ground. In Asia darting of rhinos will usually involve an elephant as a darting platform, which, with other elephants is also used to herd the rhino to a suitable capture site, to monitor the rhino once it is darted and to guide the recovery team to the immobilized animal. In Africa, rhinos should be darted from a helicopter but if funds are limited and or in emergencies rhinos can be darted from vehicle or on foot.

- The type of dart and projector (rifle) used is decided according to the preference of the experienced marksman involved and the options will not be listed here[17]. Darting should always be undertaken by an experienced wildlife vet or qualified rhino capture officer.

- The (reversible) chemical immobilizing agents of choice for African and Asian rhinos are one of, or a combination of the opioid derivatives, etorphine hydrochloride (M99), A30:80, fentanyl, carfentanil, thiofentanil and butorphanol tartrate at a dose according to the body size and condition of the rhino. Etorphine has by far been the most frequently used narcotic with good results. The immobilizing agent should be mixed with an appropriate short acting sedative or tranquilizer depending on the specific circumstances e.g. azaperone, xyalazine, meditomidine, detomidine, medozilam, valium, The addition of hyalase is useful to shorten induction times. See Kock, Meltzer and Burroughs (Eds) 2007 and Hofmeyer (2008) for more details of drug combinations used for African rhinos and Flamand & Ghaire (2008) for greater one-horned rhinos. Practitioners in the field are also constantly seeking to refine and improve drug use and the AfRSG has organised a section on the Rhino Resource Center Website where practitioners can share recommendations, experiences, and lessons learned.

- At no time should an operation be performed without the appropriately qualified personnel, safety drugs or emergency medical equipment.

- Long acting tranquilisers are best administered after immobilization and prior to loading and transportation and can include alone or in combination, clopixol acuphase and trilafon.

- White Rhino are relatively easily captured with the correct drugs and equipment. The drug of choice is M99 (etorphine) and azaperone but the rhino show marked physiological side effects from the opioid drug M99. Alternative drug combinations are being investigated. Results from the use of the drug butorphanol (mild opioid) with M99 by SANParks to immobilize white rhino in 2007/08 holds the promise for good anesthesia with reduced negative physiological side effects. and possibly also a significantly reduced risk of white rhinos going on hunger-strike in bomas and having to be released (M. Hofmeyr, pers. comm.). White rhino are loaded after partial reversal with small doses of M50-50 (diprenorphine) and in the past nalorphine[18]. Full reversal in the crate is given with M50-50 and white rhino can be successfully walked using this drug. This drug is an antagonist/agonist and in white rhino particularly the agonistic effects are marked, which help keep them calm in the crate. For a more complete antagonism of the narcotic in this species, naloxone can be used or naltrexone. Additional tranquilization during transport can be achieved by administering azaperone and cloxipol acuphase. At release after transport it is important to administer naltrexone IM to avoid renarcotisation (frequently seen in this species).

- Staggered releases of white rhino are possible.

- Field capture to field release (in South Africa termed “Veld to Veld”) translocations is the preferred method for white rhino translocations (especially for cows with calves). Field capture to bomas is the preferred method for auction animals or if ones that are to be shipped or flown long distances. In these instances the animals need to be used to noise and trained to drink and feed in a crate.

17 For discussion of this topic see Morkel & Kennedy-Benson (2007)
18 This drug is being withdrawn but alternatives are being investigated (P. Morkel Pers. Comm.).

- Black rhino are browsers and live in thick bush, making immobilization difficult. They are habitually more aggressive than white rhino and respond better to the drugs used. Higher per kilogram dosages of M99, xylazine or azaperone and cloxipol acuphase tranquilizer are used than in white rhino. They are also more responsive to the reversal drugs used for walking with only the weak partial antagonist nalorphine being used successfully. Unfortunately nalorphine has recently gone off the market and is no longer available, and new protocols for walking black rhinos are being tested including the use of nalmafene. During transit a small dose of M50-50 can be given to obtain a state of tranquilization from the partial agonism. The key to successful black rhino translocation is to protect the animal from itself and its highly aggressive nature. Release into holding facilities requires careful planning and use of the different drugs. With particularly difficult animals a very low dose of M99, with high doses of azaperone can be given before release from the crate so that a near immobilized state is achieved. This results in the animal calmly walking out of the crate into its new surroundings. Should the animal become immobilized after release, then IM administration of M50-50 adequately reverses this state. Naltrexone is only used as a (complete) reversal (preferably IM) when short procedures are done in its normal environment and when all disturbances can be removed before the animal is reversed. Introduction of black rhino into established populations is far more difficult than white rhino due to the increased incidence of aggression between individuals that do not know each other. The knowledge of the behavior and nature of this species is extremely important to ensure that they are successfully captured, immobilized, transported and then released.

- Greater one-horned rhino are generally difficult to capture because of their habitat preferences. The species lives on flood plains that are difficult to access with vehicles and the animals themselves are often not easy to find and follow due to the thick, tall grasses which they favor. However, the use of domestic elephants makes finding and darting some animals relatively simple, but the loading of the rhino and moving them out is more complicated, requiring mechanical diggers and sleds to drag the rhino to a suitable loading point. The elephants are extremely important for the prolonged follow up and herding of the rhino to a selected spot and keeping it there if possible prior to knock down. The drugs used are M99 combined with the tranquiliser acepromazine as these were the drugs most readily available in Nepal in the mid-1980s to 2002 (Flamand & Ghaire, 2008). The use of acepromazine is simply because of the available drug in the region being the combination agent “Immobilon” rather than for any drug effect and it might be preferable to use pure etorphine in combination with other drugs e.g. xylazine, meditomidine, azaperone as used with black and white rhino. The use of ketamine-meditomidine combinations in certain circumstances (captive, tame or young wild greater one-horned rhino) has proven effective for a very few translocation cases from Kaziranga to Manas NP in India (Dutta *et al.,* pers. comm.). There will need to be many more cases before its use in adult free-ranging animals can be advocated but the differences in techniques (use of elephant) which in general reduces the initial stress during the approach to capture might allow its use in more situations. The physiological effects of this combination are less significant when compared to narcotics, but this must be weighed against its effectiveness and the impact of prolonged induction or failed immobilisation. Use of sub-optimal drug dosing is not to be recommended and the cost of drugs in relation to the overall cost of an operation or value of an animal should not make this an important consideration. The current process of loading and transfer to crates involves a lot of people and equipment including mechanical diggers which significantly increases the overall manipulation period compared to the current loading techniques used for African species. One argument for maintaining this method has been the difficult terrain with many watercourses and tall grasses. The sled can be pulled by tractors across these inaccessible areas which other vehicles cannot access. The sled is drawn into the crate and after the recovery of the animal from the anaesthesia the crate is removed slowly pulling it retroactively so the animal walks forward off it before finally closing the slides and securing the crate for transport. The walking technique has been tried with captive greater one-horned rhino in the Zoological Society of London (R. Kock, pers. obs.) animal collection with considerable success with rhino literally walked along corridors and finally into a crate. Therefore it should be possible to develop this technique for use with free-ranging translocations of greater one-horned rhino.

- There is limited information on the veterinary aspects of capture of free-ranging Sumatran and none for free-ranging Javan rhino. Chemical immobilization of Sumatran rhino has been undertaken in zoological collections without complications using standard techniques applicable to other rhinoceros species and they apparently do not show any particular anomalies or sensitivities to the drugs used.

- For a more detailed discussion on the use of different drugs on African rhinos and recommended dosages by species, age class of animal and whether one is capturing, "walking", transporting, loading, offloading, type of release etc. see Rodgers (1993a..e in McKenzie (1993), Rath 1994, Kock, Meltzer & Burroughs[19] (2006), Hofmeyer[20] (2008); Morkel & Kennedy-Benson[18] (2007). For information on drug dosages and combinations for greater one-horned rhino see Flamand and Ghaire[18] (2008).

2.4 Rhino crates

Specially made rhino crates are invariably used to move rhinos.

- In Asia rhino crates have been traditionally made from Sal wood (for further details on their construction see Williams, 2008).

- In Africa different creates are usually used to transport rhinos from the capture site and to transport boma-trained animals. Different crates are also usually used for white and black rhino capture and smaller crates are used for calves. While all wooden crates were also used on the first captures in Africa, these are no longer used in Africa.
    - Heavier, stronger crates are often used to move wild-caught rhino from the capture site. These are usually either all metal crates or wood with angle iron reinforcing and usually have strong steel doors. (see Figures 26, 27-B&C,28-A,B&C, 29 &37-A).
    - Lighter crates are usually used to transport rhino that have been boma trained and are often wooden with angle iron reinforcing (including on the doors). Sturdy steel bars at the front of these transport crates allow the front doors to be opened to feed and water animals in the crates (Figure 27-B).
    - Specially modified crates have also been designed to be allow crates to fit on cargo airplanes.

- In Africa crates (especially those used for black rhino capture) often have rubber or zinc sheeting on the inside front and front side of the crates to prevent animals wearing and damaging the wood in transit, as shown in Figures 27-B&C.

- A Mass crate mounted onto a large flat bed trailer can be used to move up to six rhino at a time. It is a single steel crate with six compartments, each of which holds one rhino. Each compartment is approximately 3.2m long, 1.1–1.3 m wide and 2m high and has a hatch on top for ventilation and for observation (Morkel & Kennedy-Benson, 2007).

- Rubberised matting is often used for the floor of crates (Figure 27C). Even if the rhino urinates in the crate it will still have a good footing. However great care needs to be taken to ensure that the rubber matting is well fixed to the crate.

19 This text on chemical and physical restraint of wild animals covers a wide range of species but with simple and accurate information on white and black rhino chemical and physical restraint and is available from the Zimbabwe Vet Association or through the authors.

20 Accessible on the Rhino Resource Center www.rhinoresourcecenter.com and AfRSG webpage

Figure 27. (A) Wooden crate used to move greater one-horned rhino (Photo credit: NTNC (B) Collecting dung to spread around release areas prior to distributed release of black rhinos at Mun-ya-Wana in KwaZulu-Natal, South Africa, in the hope that this would reduce distances rhino travel before settling down. Experimental results were inconclusive although this may have been due to confounding due to hormonal status of control and experimental animals. It did not appear to matter which rhino's dung was used (Linklater & Swaisgood, 2005). Before dung spreading becomes a recommended practice further work is needed to conclusively demonstrate it works. Photo B also shows a rhino transport crate attached to the bomas with its doors open. Note the zinc cladding on the front side walls (Photo credit: Jacques Flammand, WWF/ EKZNW BREP) (C) Looking down on a black rhino in a crate showing rubberised front door and front side wall as well as rubberised matting. The rubber matting provides rhinos with good grip even if they have urinated in the crate. Note how the matting is securely fixed to the crate floor (Photo credit: Markus Hofmeyr).

2.5 Transport-specific considerations

- The availability of suitable transport will depend on the operation and agency concerned. Many countries have dedicated capture units with a variety of sophisticated and mechanized systems (Figure 29) for loading and transportation of animal crates, including rhino. If the translocation of rhino is to become a routine procedure it is advisable for the agency mandated with this work to consult experienced operators and get training in the construction of appropriate crates and advice on appropriate vehicles and loading systems to suit different budgets. Many rhino capture trucks have either hydraulic lifting arms or cranes to lift crates onto transport vehicles. The crane system (Figure 28-A) is preferred (Morkel & Kennedy Benson, 2007) as it is the most versatile and can lift from the side and up and over boma walls as well as being able to lift rhinos by their feet, other equipment etc. and not just crates. The Multilift system (Figure 28-B) uses a hydraulic arm to hook onto the front or back of the crate and pulls in up and onto the back of the truck. This system is very strong but has limited flexibility and for approximately 10 seconds the rhino is standing at about 45^0 in the crate (Morkel & Kennedy-Benson, 2007). The "Hannibal" hydraulic "skip" lifting system (Figure 28-C) is also a very strong system and keeps the crate horizontal during loading/ unloading, but it too has limited flexibility (Morkel & Kennedy-Benson, 2007). Alternatively crates can be winched up runners onto the back of a truck. When winching great care needs to be taken to ensure the crate does not fall off the runners (Morkel & Kennedy-Benson, 2007).
- In Asia to date, standard local trucks rather than specially modified trucks have been used to transport rhino (Figure 28-D).

Figure 28. (A) Crane arm being used to lift crate with rhino off rhino truck in KwaZulu-Natal, South Africa; (B) Namibian Multilift system lifting crate onto truck; (C) wooden create reinforced with angle iron being used to transport wild caught black rhino to bomas in Kenya being hydraulically lifted using the "Hannibal" system onto a specially designed rhino transporter; (D) release of greater one-horned rhino from a crate loaded onto standard truck in Nepal (Photo credits A: WWF/EKZNW BREP, B: Mark Jago, C: Rajan Amin ZSL/KWS and D: NTNC).

- Rhinos have been transported by ship over long distances. However large Russian Antonov Cargo Aircraft are being increasingly used to transport groups of founder rhino over long distances (Figure 30). For more information on transporting rhinos by air or sea see Rodgers (1993c) and Morkel & Kennedy-Benson (2007).

- In inaccessible or wilderness areas, where it is not possible to get rhino capture trucks near to the rhino, powerful helicopters can be used to airlift rhino to a place where they can be loaded into rhino capture crates. To reduce weight rhinos are lifted in a sling (Figure 31).

Figure 29. A number of low-cost systems have been developed and are used in some countries. The photo shows an example from Namibia, where an ordinary trailer has been modified and special crates developed to allow a black rhino and crate to be towed by a standard 4x4 vehicle. (Photo credit: Mark Jago)

Figure 30. Russian Antonov cargo aircraft landing on bush airstrip in North Luangwa N.P. to deliver a consignment of founder black rhino to re-introduce the species back into Zambia (Photo credit: Mike Knight).

Regardless of the system adopted, there are some general rules:

- Ensure the crate design fulfils at the minimum IATA standards. Adequate visual and physical access to the animal, ventilation and drainage, and non-slip flooring are key aspects.
- Ensure all equipment is tested and if necessary repaired prior to the capture and translocation.
- Each vehicle must have a full set of open closed and box spanners, and other assorted tools including heavy hammers and hacksaws. Several strong metal rods (e.g. Tarimbo *Swahili*) are essential for manoeuvring the crates efficiently.
- Ensure drivers and operators are experienced in the procedures, use of the equipment and vehicles with animal cargo.
- Ensure there is a back up structural (wood and metal) and mechanical repair team with a separate vehicle for the operation and for the journey to ensure any problems can be resolved quickly.
- Ensure the vehicle has sufficient fuel for the whole journey if this is possible, and cash or garage cards to purchase fuel to cover for longer journeys.
- Ensure there is a back up transportation vehicle in case of irreparable problems with the main vehicle.
- Ensure the vehicle used has a system of radio or telephone communication on board.

Figure 31. Series of photos showing a black rhino being airlifted in a sling out of the wilderness area in Hluhluwe-iMfolozi Park, South Africa, and being deposited outside the wilderness area where the rhino can be loaded into a standard crate. Note the use of rhino ear plugs in Photo B (Photo credits A, D, E & F: Pam Sherriffs WWF/EKXNW BREP, B & C: Jacques Flamand WWF/EKZNW BREP).

- For additional details regarding transportation of African rhino see Morkel and Benson (2007) and Rodgers (1993b & e; 1994) or discuss with relevant rhino managers in various countries.

- For further details of sled and crate design for greater one-horned rhino see Williams (2008).

2.6 Holding bomas

- There are a variety of designs for holding bomas in Africa and include the use of pit-traps in Asia (Sectionov, 2007). The style can vary and different materials can be used including wood and metal all with advantages and disadvantages. For African rhino boma design, the reader is advised to consult Morkel and Benson (2007) and Rodgers (1993f & g; 1994), or discuss with relevant rhino managers in various countries.

- In general, different boma designs are best for each species. For example, closed pole (no gap) or metal plate walls are required for black rhino whereas white rhino can be kept in more open structures with a separated pole construction with a gap. However if a white rhino finds a weakness in a boma it is likely to work on it and to try to smash its way out. Thus bomas have to be very sturdy with many or all of the poles firmly fixed or concreted in place and poles connected together with steel spacer bolts. Doors should be sliding and it should not be possible for the rhino to place its horn under the doors and damage them. Water troughs need to be designed carefully for the white rhino to ensure they can drink as their skull and lip structure prevent them accessing water in conventional trough designs. Full details are available in texts.

There are some general comments appropriate to these guidelines:

- Bomas to date have not been commonly used in Asia – field to field releases have been the main method used in India and Nepal.

- The site for bomas in Africa needs to take into account intensity of exposure to tsetse fly and trypanosomosis and the status of source populations in respect to these challenges (East Africa and Zimbabwe). Where there are susceptible animals the use of chemical targets and traps should be part of the protocol to ensure the intensity of exposure is controlled (Figure 32).

Figure 32. Tsetse fly traps around rhino bomas in Kenya in order to slowly expose translocated animals from disease free areas to trypanosomosis, by reducing densities of the carrier Tsetse fly around the bomas and release area (Photo credit: Richard Kock).

- There are risks from stress associated with boma management of rhino but there are advantages especially if rhinos are traveling long distances or where there are unusual health challenges or risks from exposure to unusual plants and toxins in the recipient area.

- Good design does not necessarily avoid the effects of poor boma management. Adequate and appropriate feed and clean fresh water and sufficient salt is essential to maintain condition. Pens should be kept clean and well maintained. Unscheduled noise and disturbance should be kept to a minimum but habituation can help to reduce stress overall. This can be achieved through provision of radio, music and regular staff attention to the animals.

- Traditionally, white rhinos have been confined in solid pole bomas where the animal's will to escape is overcome by its inability to break through the poles. While most wild caught white rhinos submit to their new surroundings after a few days and start eating (usually 3–7 days after confinement), about 10% of white rhinos usually embark on a hunger strike and have to be released (M. Hofmeyr, pers.comm). Black rhinos by contrast adapt much quicker to bomas and hunger striking is not a problem with this species. White rhino therefore need to be kept under constant surveillance after being put into bomas to make sure they have started eating, and to determine how much they are eating, as well as to note their temperament and condition. Where a white rhino is not eating, a boma manager has to decide whether to release the rhino before it loses too much condition, or to hold it for another day or two in the hope that it will start eating. If a hunger-striking rhino remains confined, it will eventually become weak and die, despite a plentiful supply of good-quality feed being offered. It is therefore generally accepted that white rhinos on hunger strike, or which have been consuming insufficient food, should be released 7–12 days after confinement depending on the extent to which they are eating, their condition and temperament (Reilly, 2005; J. Flamand & M. Hofmeyr, pers. comm.). Such animals should be released as close to where they were caught as possible. Cows and calves are most likely to go on hunger strike (M. Hofmeyr, pers comm.), and for this reason these animals should be taken from veld to veld. If a rhino capture centre in a major donor population has access to a nearby fenced enclosure of about a hectare with natural grass, hunger-striking white rhinos can be placed there and are likely to start eating in such enclosures (e.g. as has been done in Kruger NP, South Africa). The incidence of hunger-striking can be reduced for sub-adult white rhino by initially introducing them to larger bomas (Figure 33-D) containing one or more experienced subadult white rhino that are used to feeding in bomas. Following the use of a new drug combination of etorphine and butorphanol by SANParks in 2007–2008, only about 2% of white rhino held in boma in SANPark (compared to the more usual 10%) went on hunger strike and had to be released. Thus the use of this drug combination, which also reduces negative physiological side effects in white rhino, may also significantly reduce the incidence of hunger-striking in this species (M. Hofmeyr, pers. comm.).

Figure 33: Photos of EKZNW's Centenary Game Capture Centre in Hluhluwe-iMfolozi Park. (A) View of outside of rhino bomas showing transport crates attached to boma pens. Note roof to keep rhinos dry and to give shade from the sun. (B) View from an observation gangway at EKZNW's Centenary Game Capture Centre. Adjoining wooden transport crates reinforced with angle iron are on the right. (C) Two black rhinos in adjacent pens at EKZNW's Centenary Game Capture Centre. Note fresh cut browse which is provided twice daily in addition to lucerne and cubes. Horn transmitters have already been fitted to these animals. (D) Larger white rhino boma connected to smaller inside pens. The incidence of hunger-striking in wild-caught subadult (but not adult) white rhino can be reduced by initially introducing subadult white rhino into a larger boma containing one or more experienced white rhino subadults that are used to feeding in the boma. (Photo credits: Richard Emslie).

- Where one is only moving a small number of white rhino in a year. a 1 ha see-through electrified "Bonnox" boma (Reilly, 2005) may be used to try to minimise the chance of hunger-striking (Figure 34). This gives white rhinos the chance to initially eat real grass in the bomas in a visually less-threatening environment before they can move on to eating cut grass (Reilly, 2005). This method of bomaing white rhinos is still in its infancy and has not been tried with adult territorial bulls, and it would also be unsuitable if many animals are to be translocated from an area each year. Although it has not been put through sufficient testing to become a recommended practice, it would appear to have considerable advantages over conventional rhino bomaing in terms of both cost and reduced white rhino hunger striking risk.

Figure 34. White rhinos in "Bonnox" bomas at Mkhaya GR, Swaziland. The rhinos have eaten all the natural grass in the boma and have learned to feed on cut grass on a raised conveyor belt to reduce the risk of sand colic (Photo credit: Richard Emslie).

2.7 Release specific considerations

- The release is an important part in the whole process and should be equally carefully planned.

- If possible, distributed narcotised releases of black rhino (as are now routinely being undertaken by SANParks and Ezemvelo-KZN-Wildlife) should be undertaken rather than releasing all animals from bomas or a single point.

- The suitability of field to field release will be most appropriate for short <15 hour journeys, and where the recipient site is ideal (i.e. no risk of trypanosomosis requiring gradual exposure in a boma before release). In the case of the latter consideration may be given to releasing animals into a temporary fenced holding area but this needs careful design because on release animals often hit these fences and sometimes break out. The fences should be highly visible and electrified if possible.

- When transport times are greater than about 15 hours pre-release bomas are usually used. These ensure the actual release is controlled and ensure the animals are fully recovered and healed from any injury acquired during capture and transport. Having the option to boma rhino reduces the overall risks. The location of the release boma used to be critical to minimise post-release fighting for some species (e.g. black rhino) but with the increasing use of distributed releases this is no longer a key factor.

Figure 35. Release bomas used for black rhino reintroductions into North Luangwa National Park, Zambia (Photo credit: Markus Hofmeyr).

- The basic principle of releases is that one should seek to ensure that animals settle into optimal social and feeding routine as soon as possible with the least amount of stress and disturbance.

  There are some general rules:

- Bomas or release sites should be located near water, but not so near that there is risk of accidental drowning e.g. near a steep river bank or cliff.

- There should be good vegetation close to the release site.

- Rhinos should not be released too near cliffs or harsh terrain.

- Media/publicity circus should be avoided where possible during release and there should be minimal disturbance at release site. This may not be achievable in Asia where crowds of onlookers may gather (Williams, 2008).

- For multiple releases, rhinos generally should not be released from the same place.

- Mobile bomas can be considered to ensure new releases are not all in the same area.

- If there are concerns about trypanosomosis then field to boma and gradual exposure to parasite through the use of tsetse traps would be recommended best practice (Figure 32).

- Where it is not possible to re-introduce all black rhino founders at roughly the same time consider staged releases of rhino into different fenced off areas with eventual removal of fences as has been done successfully by SANParks and Swaziland Big Game Parks, and is being done in North Luangwa.

- If releasing all animals at similar time then bomas are useful as can then release all animals from boma to field in shortest possible time.
- Rhinos (and black rhinos in particular) should not be released where there are known established animals, particularly aggressive bulls.
- The horn of rhinos should be tipped or rounded off (Figure 26) and the animals fitted with radio transmitters and transponders (Figures 38 & 24) prior to release if not already done so at capture. If more than one rhino are moved than it may be preferable to fit transmitters at time of capture.
- Rhinos should be ear-notched using a recognized numbering system (Figure 25) prior to release (preferably at initial capture if not already notched). Photos should be taken or drawings made of notches. Ear-notch samples can be kept and sent for genetic analysis if required.
- In any translocation there is a slim chance of animals dying, and even if the capture team does exactly the right thing at every turn in the operation the media may pick up on any problems in their quest for sensational news. If media presence is unavoidable, Williams (2008) recommends team members do not disagree amongst themselves in front of the media, as perfectly logical discussions can be inflated into sensational arguments. Williams further recommends that a team for handling media should be set up. The handlers should be given clear briefings by the operation leader/capture team leader, and the media need to be told that they will given instructions so as to minimise the disturbance their activities might cause during the operation. It is recommended that the media have the same access and privileges as that of observers and visitors, but not the same access as that of the capture team members (Williams, 2008). It is important to identify spokespersons from the Forest Department/Government to address the media and he/she can be primed in advance with a list of possible questions and answers in order to be prepared for difficult or controversial questions. It also important to prepare press packs with the help of NGOs, to give a background on the operation as well as to ensure that all donors funding the operations get proper credit (Williams, 2008).
- While access to captures and releases in Africa tends to be strictly controlled, in Asia it is necessary to have a plan to control both the media and crowds of onlookers that may gather to watch capture and translocation operations (Williams, 2008). In Asia, a capture operation cannot be kept secret and word will spread immediately. More likely than not, huge crowds will gather as soon as a rhino has been caught, possibly even when the capture operation is ongoing. These crowds (including that of visitor/observers and media) have to be contained for their own safety, that of the capture team and of the rhinos (Williams, 2008). Local authorities should develop crowd-control plans that isolate the capture team, rhinos and koonkie elephants as much as possible. In addition, once the rhinos are woken inside the crates, they will sense what is happening and may become stressed if too many people crowd around them during the loading and transportation process. Hence a team of police personnel to handle the security is likely to be essential (Willams, 2008).

2.8 Equipment checklist for capture

2.8.1 Veterinary

- Appropriate dart rifle, charges and darts
- Narcotic immobilising agent and antagonists (including emergency human reversal agent naloxone and instructions), sedatives and their antagonists, tranquilisers, respiratory stimulants (doxapram), antibacterials including antibiotics, eye ointments, Normal Saline packs. Sufficient clean water.
- Wound treatment pack and surgical instruments including for ear-notching.

- Cotton wool and blind folds.
- Pole syringes and blow pipes.
- Blood-sampling kit.
- Needles and syringes.
- Physiological monitoring equipment (stethoscope, pulse oximeter, PCV field centrifuge).
- Record sheets and pens.
- Radios including ground to air.
- Large containers with sufficient water to cool rhinos if necessary (Figure 36).
- Ultrasonography equipment (where available for identifying rhino in late stages of pregnancy).
- Laminated tooth-wear and other ageing charts, if available.

Figure 36. Container of water being used to cool an immobilised rhino. The rhino has been tied to the sled with belts using a quick-tighten ratchet system. Note the small helicopter in the background used as the darting platform (Photo credit: Markus Hofmeyr).

2.8.2 Capture and transport equipment

- Two or more > 2 cm diameter soft cotton rope of >10 meters.
- Electrical cattle prod with fresh batteries.
- Crate
- Repair kit for crate
- Winches and metal bars.
- Load system (hydraulic or other).
- Tie down ropes, straps, clamps or chains and tools to ensure rapid release of U-bolts and knots.
- Canvas eye covers and ear plugs (which can be fitted with streamers).
- Water hose and adapters.

- Two-way radios, including ground to air.
- Transport truck
- 4x4 heavy duty support vehicle with bright orange painted bonnet to increase visibility from the air (Africa).

2.8.3 Air support

- Small manoeuvrable helicopter (Africa) with safety harnesses – the recent incident of a wildlife vet falling out of a helicopter while darting reinforces that the use of harnesses should be mandatory.
- High wing support single prop light aircraft with ground to air communications (Africa).
- Rhino slings if being used with heavy lifting helicopter or for lifting rhino by their feet (Africa).

2.8.4 Ground support

- Elephants (for greater one-horned rhino) with two-way radios (short range walkie-talkies are sufficient).
- Horses and protective gear if being used to help follow darted rhino in Africa, with radio handsets.
- Rhino capture trucks and follow up vehicles including for greater one-horned rhino, a mechanical digger (JCB) with radio communications (mobile units and handsets).

2.8.5 Monitoring/Security

- Ear-notching (notching tool [see Figure 25- A & C1] or scissors/scalpel with clamps) and nail notching equipment (if nails are to be notched for short-term monitoring purposes).
- List of available notch patterns (preferably with pictures of notches - see Figure 25-A.
- Transponders and an appropriate form to record numbers of transponders inserted into which rhino or horn. These data should be captured onto a transponder database such as MicroTrak as soon as possible.
- Collars and or horn transmitters with hand and electric drills and sealing compounds (usually dental acrylic powder and liquid catalyst) together with appropriate form to record transmitter details. Spare batteries and fully charged batteries are essential. A small mobile generator is a useful back-up.
- Digital camera to photograph rhino and ear-notches, or failing that a rhino ID field monitoring form on which ear-notches applied can be recorded (see Figure 42 and 25-C2).

3 Post-release period

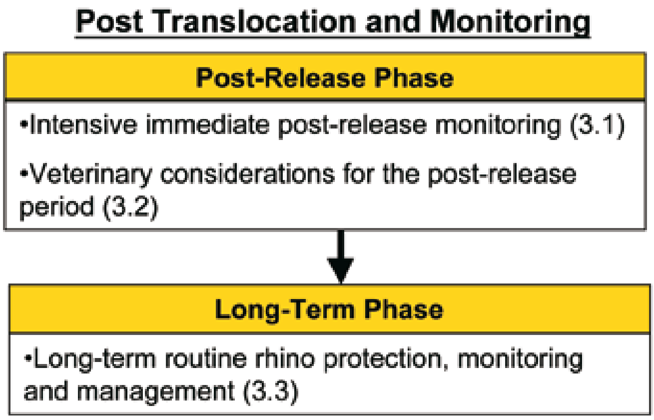

Figure 37. Flow diagram showing key components of the post-release period.

Rationale

The translocation process for rhinos can cause a significant amount of stress to the individuals concerned as rhinos are removed from their familiar environs and thrust into an unfamiliar world where the location of food and water resources are unknown, where many of the disturbances are of a novel and unknown nature and which may be perceived as threats, and where there may be increased risk of fighting/harassment from other rhinos. Major stress can also result in the rhino becoming exhausted and chase-darting, handling and transport procedures can cause myopathy which can be fatal. If a rhino's immune system is weakened during the post-release period it may also become more likely to suffer from opportunistic infections. Reintroduced populations may also experience a settling in lag period before female breeding performance reaches optimum levels. In unfenced release areas, it also becomes especially important to try to prevent long distance dispersal of rhinos after release as this greatly increases the size of the intensive protection rhino area that has to be patrolled.

Improvements in translocation and release protocols are needed to:

- minimise translocation and post-release stress,
- reduce post-release mortalities due to fighting and capture, handling and transport related myopathy,
- facilitate the settling in of translocated animals as soon as possible,
- minimise the distances rhinos travel from release sites before settling down,
- enable more females to start breeding at optimum rates as soon as possible after translocation.

Analysis and reporting of problems encountered and lessons learnt during these translocation projects, along with a description of the methods used, are essential to improving translocation and release protocols. A key component of such adaptive management is to undertake intensive post-release monitoring for a period after rhinos have been released. In this way, the effects of different drug combinations and release methods (e.g. distributed field release vs. boma release, or spreading dung around release site or not) can be measured and assessed. Introduced rhinos usually settle down and establish home ranges within 3 months of release, and therefore reason intensive post-release monitoring is usually undertaken for at least this period, and sometimes as long as a year and a half (while transmitters are still operational).

Intensive immediate post-release monitoring also allows managers to detect problems in individual rhino, allowing prompt remedial or veterinary action to be taken where appropriate.

Once animals have settled in and have established home ranges, and fitted radio-transmitters have ceased to function, routine protection, monitoring and management should continue indefinitely. Details of extended monitoring are beyond the scope of these translocation guidelines. Nevertheless, managers setting up new populations must be fully aware of and have the resources and commitment to be able to carry out the ongoing protection, monitoring and biological management of rhinos and habitats that is required for long-term success. **Without these resources and long-term commitment to continue with ongoing field conservation action, translocations should not proceed**. Putting rhinos into a new area and simply abandoning them to their fate without continuous monitoring, protection or management likely to end in an expensive and embarrassing failure.

3.1 Intensive immediate post-release monitoring

There have been instances in the past where rhinos have simply been "dumped" into a new area without sufficient follow up or monitoring. As a result nothing or little was learned to help guide and improve future translocations and the translocations have often ended in failure. It is strongly recommended that intensive post-release monitoring be undertaken immediately after release and during the settling in phase.

Due to its intensive and "research" nature, immediate post-release monitoring is usually undertaken by a researcher or specialized rhino monitor (Figure 39).

Figure 38. Series of photos showing the fitting of radio-transmitter into a rhino's front horn (A) after tipping the horn to make a flat surface a vertical shaft is being drilled to take the aerial; (B) drilling side cavity which will join up with the vertical aerial shaft; (C) finished side cavity ready for implantation of aerial and radio-battery package; (D) radio package and aerial sealed into horn using dental acrylic (Photo credits: Richard Kock).

Due to difficulties in fitting collars to white and black rhino, It is recommended that whenever possible radio-transmitters should be fitted in the horn of all translocated African rhino prior to release (Figure 38). Currently VHF systems are standard but it is likely that GPS and related satellite systems will become available in suitable packages. Transmitters are usually fitted into the larger front horns of African rhinos. This procedure involves drilling and routing out a compartment towards the base of the horn that is big enough to take the radio-transmitter and battery package (taking care the drilling does not damage the area where the horn is attached to the head). The tip of the horn is then cut off. Apart from reducing the chances of rhinos seriously injuring themselves if they fight after release, this provides a flat surface to facilitate the drilling of a thin vertical "chimney" hole from the top of the horn all the way down into the transmitter compartment towards the base of the horn. The flexible aerial (which is attached to the transmitter/battery package) is then fed in to the horn compartment and up the "chimney" hole, followed by the transmitter/battery package which is then seated into the drilled compartment. Dental acrylic is then mixed up and poured in to the compartment and down the chimney hole to seal up the horn and fix the transmitter/aerial package into the horn. Masking tape can be used to keep the acrylic in place until it sets. Equipment for placement of horn transmitters includes appropriate battery operated power drills with manual back-up augers for preparing the horn transmitter and aerial seats, and suitable dental acrylic powder and catalyst for setting the transmitter and aerial.

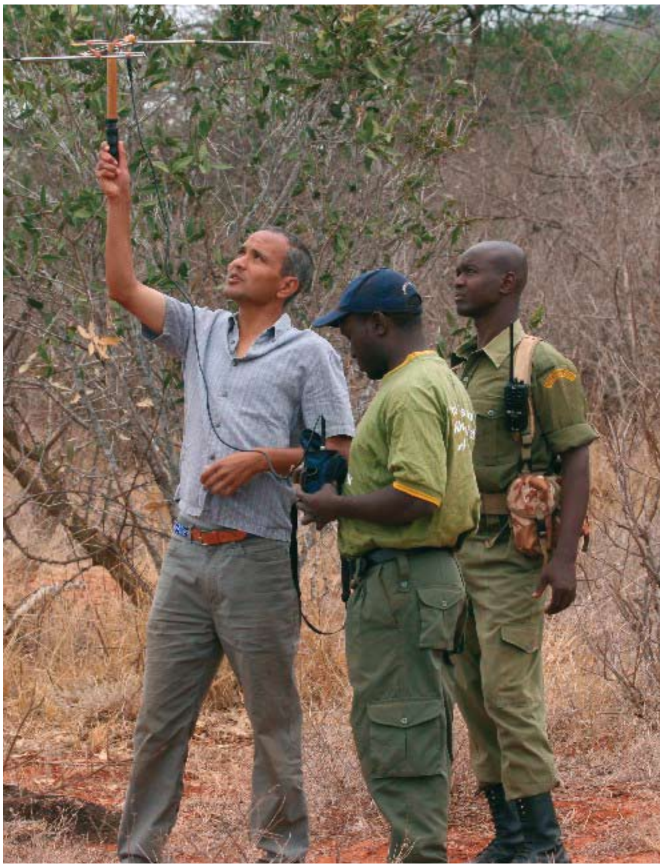

Figure 39. Using radio-tracking to monitor black rhino after release in Kenya (Photo credit: Rajan Amin ZSL/KWS).

In Asia, where rhino horns are much smaller, collars need to be used, but need to be elastic and checked periodically to prevent strangulation.

Radio transmitters and receivers should always be tested to make sure that they are in good working condition before fitting, and also prior to releasing the rhinos to check and record the correct frequency and identification signal for the particular rhino.

Necessary post-release monitoring equipment (receivers, transmitters, batteries, collars etc.) must be procured well in advance of the translocations in case of supply/importation/ customs delays. Staff may also need to be trained in their use. There have been instances in the past of rhinos being fitted with radio transmitters and then not adequately followed up after release.

Sufficient budgets and manpower must be made available to undertake necessary post-release monitoring to make best use of fitted radio transmitters including cost for aircraft survey hours if rhinos are being released into a larger unfenced area.

Except in very large populations (> 500 rhinos) or in very large areas (>3,000 km^2) the best way to monitor numbers and population performance of black, white and probably also greater one-horned rhino populations over the long term is by using individual identification methods. **To facilitate such monitoring and to enable data to be collected by more people, translocated rhinos should always be ear-notched using a recognised notch-numbering system** (with each notched rhino in a population having a unique combination of notches so it is individually identifiable). **If translocated rhinos have not been ear-notched it makes both post-release and especially long-term monitoring significantly harder.** This is because it is possible to derive accurate and unbiased population estimates and obtain many useful indices of population performance (e.g. inter-calving intervals of individual females) if a significant fraction of (but not necessarily all) rhino are individually recognisable by all observers using obvious and easy to record features such as ear-notches (Emslie, Amin & Davey 2006). Monitoring of greater one-horned rhinos in newly established populations in particular could be greatly facilitated by ear-notching, as this would allow the animals to be easily identifiable even when tall grass or bush hides the rest of the body. In addition, the level of skill and training required to be able to accurately identify and monitor ear-notched individuals is much less than when identifying animals from more subtle harder to record patterns, such as body folds or scars.

While rhinos should be regularly monitored (every day) during the initial post-release phase (3 months to 1 year), it is recommended that every effort be made to minimise human disturbance to the animals during this settling in phase. This can be achieved by primarily monitoring during this period using locations obtained through radio-tracking triangulation, rather than risking disturbing the animals using standard visual monitoring. During this higher stress settling in period great care should be taken not to disturb the rhinos (Figure 40) while obtaining visual observations. For black rhinos an important added benefit of using a low disturbance monitoring approach during the initial post-release stress and settling in period, is that the animals become habituated and less concerned about humans in the long-term, greatly facilitating future monitoring and ecotourism (S. Morgan, pers. comm.).

Figure 40. (A) Ground-based monitoring of black rhino in Kenya and (B) South Africa (Photo credits A: Rajan Amin ZSL/ KWS B: WWF EKZNW BREP).

A recognised supplier of transmitters with a proven track record for reliability should always be used, even if their equipment is more expensive. Cheaper transmitters may not provide value for money, as they may be more prone to malfunction or may have a shorter lifespan.

Should radio-tracking reveal that a rhino has not moved since its last location, this should be immediately investigated on the ground. For example, in North Luangwa National Park, Zambia post-release radio-tracking revealed that a recently introduced black rhino had not moved position. Immediate ground follow-up found the rhino had fallen into a narrow dry drainage line and had got stuck. Thanks to this early warning, it was possible to free the rhino before it was too late (Hugo & Elsabe van der Westhuizen, pers comm.).

In addition to fitting radio-transmitters it is recommended that any rhinos moved are routinely fitted with small and relatively inexpensive transponders. Transponders are routinely fitted to horns and injected into the shoulder of all immobilised rhinos in some areas. If a transpondered rhino is poached in the next few years and the horns are recovered later, it then becomes possible to determine which rhino the recovered horn came from. In addition, if the animal dies many years later and its ears are eaten by predators (removing identifying ear-notches) it will still be possible to identify the individual rhino that has died through its shoulder transponder. By matching up shoulder and horn transponders it also becomes easy to link a specific carcass to a recovered horn or horns. When using transponders it is important that countries standardise and only use one or two recognised makes (e.g. Trovan or Destron) as different makes use different transponder readers. Proper record keeping is essential, otherwise one can end up finding a horn with a transponder but not being able to track down where it came from (this has happened!), or only being able to ascertain that the rhino concerned came from reserve X or was sold at auction Y, but without being able to identify the individual rhino concerned. A software package Micro-Trak is being developed and will be made available to help manage transponder data[21].

Ideally, post-release monitoring personnel need to be identified and trained in rhino monitoring before the translocation operation is undertaken. In Africa, the AfRSG's formalised rhino ID monitoring training course for instructors and field rangers (Figure 41) can be used and will help ensure that monitoring data are standardised (e.g. using standardised ageing or condition classes) to facilitate comparison between populations and over time. It is hoped to make AfRSG ID course modules available to be downloaded from the AfRSG webpage or Rhino Resource Center. A similar course has been developed for the greater one-horned rhino and is being formalised as an AsRSG training course, and will be available from the AsRSG. Using such a training programme can greatly accelerate the process of acquiring high standards of observational and data-collection skills. A significant advantage of this approach is that security staff can be trained to undertake the monitoring where they are located,

21 For more information contact Rod Potter of Ezemvelo-KZN-Wildlife (or SADC RESG or AfRSG).

thus saving time and money and minimizing daily operational impact on the field teams. In addition, with continuous teaching of the modules it is possible to maintain consistency as well as deal with inevitable staff turnover. A trained Officer in Charge should oversee the monitoring programme as well as quality check all sightings records.

Figure 41. AfRSG Training of Trainers Course for ID-based monitoring of Black and White Rhino in use in Kenya (A, C & D). Trained accredited instructors use posters to train field rangers. (B) Trainees guide booklet (Swahli Version). (E) Swahili version of poster from the course showing how monitoring information collected by field rangers is used to make biological management decisions, reinforcing the need for data quality. A similar ID training course is being developed by the AsRSG for greater one-horned rhino (Photo/Figure credits: Rajan Amin C &D, Keryn Adcock & Richard Emslie A,B&E).

Rhino field recording booklets based on the AfRSG and AsRSG courses can be produced at little cost and are used by a number of conservation agencies. A supply of these booklets needs to be sourced in advance of the release. It is also useful for monitors (Figure 42) to be provided with small laminated field pocket cards to assist them with ageing rhinos using recommended standardised age classes (Adcock & Emslie, 2003).

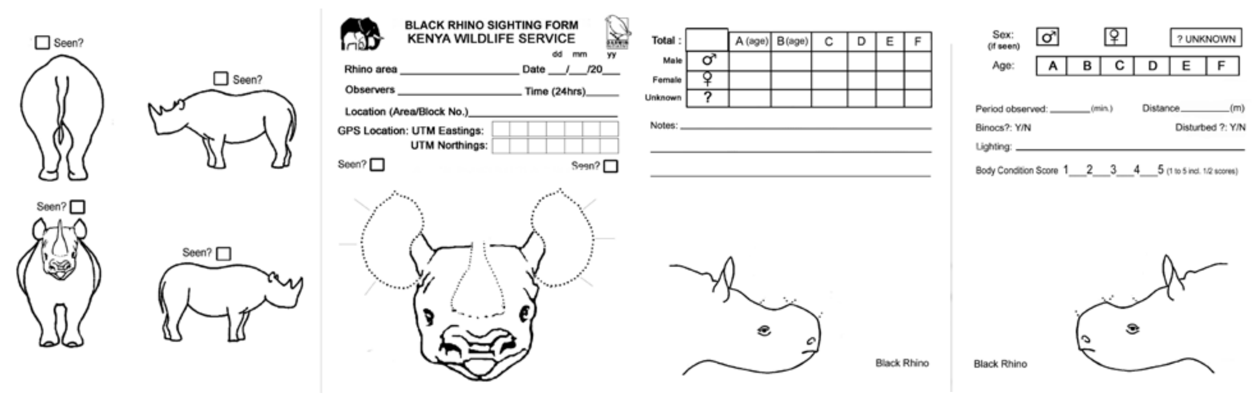

Figure 42. Example of standardized rhino sighting form (front) (back)

Whenever possible, before the introduction of black, white or greater one-horned rhinos, personnel who will be carrying out the monitoring should also visit an area with rhinos to get experience of locating animals, approaching them safely, observing them while undetected, and leaving them safely without causing undue disturbance.

Elephants used in approaching and monitoring Indian rhino must be trained and should not fear the rhinos. An experienced mahout and a well-trained elephant are needed for this purpose.

In the case of more elusive forest-dwelling Javan and Sumatran rhinos, staff should have field training in spoor identification and search effort and spoor recording techniques which can be used as part of long-term monitoring.

There is no replacement for time on the ground and the development of tracking skills in routine long-term rhino monitoring – this is not a remote-sensing science for people averse to field work!

In the case of the more easily seen white, black and greater one-horned rhino, If a research student or expert rhino monitor has been contracted to do the intensive post-release monitoring, he/she could also be contracted to help train local staff, so that they can take over routine monitoring when the intensive post-release research monitoring phase ends.


BLACK RHINO INDIVIDUAL IDENTIFICATION RECORD
Reserve/Sanctuary:

NUMBER: 29 NAME: Kinald SEX: ♂
Notch Code: 29 Origin: Born in Nairobi NP Birth Date: 01\01\63
Old/New? Mother: Unknown Father: Unknown

CHARACTERISTICS:
- Has long curved horns. Easily recognised by shape of the horns.
- Differs from Adam because of age and back of horn more curved + longer.
- Obvious bump on front base and base very wide.

RHINO HISTORY:
- Rhino notched recently during captivity on 3rd May 2005

CALVES:

RANGE:
Near Kingfisher, no 30, 26 and on rare occasions in the forest area.

GROUP COMPOSITION:
Mostly solitary male

Figure 43. Black rhino identification record (part of) Master "ID" file)

Ear-notches, and details of natural features, such as ear tears, damaged tails, horn configurations, body scars and in the case of greater one-horned rhino body fold and knob patterns of each individual rhino, as well as their age, sex and body condition (using standardised systems where possible) should be recorded prior to release. Spoor size should also be measured in the boma and notches can be made in the hooves to differentiate tracks where appropriate (Morkel & Kennedy-Benson, 2007). This information, together with diagrams and/or digital photographs, should be used to set up Rhino 'ID' master files for each new population and these should be maintained (locally and centrally) and used to quality control and classify monitoring sightings in the future. In the case of difficult to see and monitor Sumatran and Javan rhino, details of spoor of translocated rhino should be recorded (possibly through taking of plaster casts) prior to release to facilitate post-release monitoring based on spoor.

Released rhinos should be extensively monitored in the immediate post-release settling in period to determine the extent of their movements / dispersal and use of habitat (water points, feeding areas, and habitat types) at different times since release and in the different seasons. This information and maps of kernel-estimated home ranges can help refine and improve best-practice release recommendations.

It may also be necessary from time to time to undertake intensive immediate post-capture monitoring in donor populations to determine how remaining animals respond to space created through rhino removals. The extent to which remaining rhinos are found to disperse into new areas and respond to removals can guide future translocation decisions.

Where there are existing rhinos, it is important to monitor how recently released rhinos interact with established rhinos. However, to minimise post-release mortalities from fighting, it is generally recommended that newly released animals are put into separate, temporary fenced areas (perhaps using a low electric fence as shown in Figure 14). This allows animals to get to know each other through the fence, which is relatively cheap and easy to build and maintain. The fence should also be low enough to allow most other animals to cross it. In time the temporary fence should be taken down allowing animals to mix with reduced mortality risks.

A rhino monitoring database/spreadsheet tool with GIS mapping capability such as Kifaru (Amin *et al.,* 2001), EKZNW's APMD or WILDb, and possibly also home-range kernel estimation software should be used to store and routinely analyse the monitoring data.

As with all rhino monitoring, data quality control procedures should be implemented to ensure that the monitoring data collected are of the best possible quality.

As discussed above the cause(s) of death of translocated rhino during post-release monitoring should be established through detailed post-mortem examinations (using standardised rhino mortality forms) and this information should be compiled and analysed on a periodic basis and modifications in protocols should be introduced if necessary to reduce losses.

Proper record keeping of the details of each translocation is important. Experience has shown it can be extremely difficult and very time consuming to determine, years later, how many rhinos of what age and sex have been moved from reserve X to reserve Y without proper records. In the heat of the action during translocation, someone needs to be responsible for collecting the basic data on the animals concerned. Having a standardised annual status reporting system for all rhino populations in a region (as has been done in SADC RMG since 1989) can help ensure translocation data are captured before it is too late. As a check, both the donor and recipient populations' annual status reports should provide matching details of any translocation.

3.2 Veterinary considerations for the post-release period

After release, a programme to monitor the health of the introduced animals should be put in place to ensure problems are identified and dealt with early on. The capture team vet(s) should closely monitor the animals for ill health as a result of the capture and transport in the short term. All animals should have basic blood sample analysis after capture and preferably after translocation. These results should be available as a baseline for any ensuing veterinary health problems that might need investigation.

Figure 44. Black rhino being examined by veterinarian after severe injury – note (arrows) scarring on the chest and neck area caused by repeated attacks from a male rhino. This was a result of intra-specific aggression in a recently re-introduced population in Ol Pejeta, Kenya. Photo credit: Richard Kock

In the immediate post-release period, rhino monitors should observe the animals (ideally without them being disturbed) for injuries, wounds or clinical symptoms of ill health or disease, such as nervous, locomotive or digestive disturbances. Translocated rhino undergo major stress and may not always show a loss of condition, but may still suffer and die. A phenomenon known as the "Exhausted Rhino Syndrome" which occurs within a relatively short period of release has been reported but the exact cause of death in most of these cases is undetermined. Exhausted Rhino Syndrome can also affect released subadults and bulls suffering harassment from established bulls in the population. Over a week or more, the distressed rhino appears to run out of readily available energy from blood glycogen, easily mobilised belly fat and other reserves, and with continued heightened energy demands (from stress and possible social harassment) this results in collapse and the animal often dies unless its state is detected rapidly and treatment given. There may be other complicating factors, such as capture myopathy, which even if low grade can result in muscle damage, restricted movement, adverse blood chemistry and toxicity and probably contributes to the Exhausted Rhino Syndrome. **For this reason, if monitors are concerned about the health and condition of any particular released rhino they should immediately call in an experienced wildlife vet to assist.**

Supplementary feeding may help build up physical condition while the animals adapt to new vegetation. Ideally, a wildlife vet experienced with rhino should be available to be called upon at relatively short notice during the initial post-release phase and the care of rhinos in bomas should be supervised by someone who is experienced.

Recording of body condition of the released animals should be undertaken by trained observers. A standardised body condition assessment system has been developed for African rhino by the AfRSG (Adcock & Emslie 2003, based on work by HO Reuter, K.Adcock, RF du Toit and C.Foggin on black rhino and ME Keep on white rhino) and a similar system is being developed by the AsRSG for greater one-horned rhino to provide quick and reliable estimates of the general nutritional status and health. Faecal analysis is also an option to monitor changes in dietary quality (protein and fibre levels) and stress levels can also be monitored through detection of faecal cortisol levels during the immediate post-release period but these are costly and sometimes difficult to interpret and levels can show considerable variation over time. These methods probably do not adequately replace sound stock management techniques and observation of rhino behavior and condition.

3.3 Long-term routine rhino protection, monitoring and management

- The welfare of an endangered species that has been captured, translocated and released into new environments should be dealt with responsibly and for the rest of the animal's life. This includes long-term continuous protection, monitoring, and biological management of rhinos and their habitats that is required for long-term success. **If the commitment and sustainable resources and funding to undertake these long-term activities are not in place, then translocation and re-establishment of rhino should not proceed**.
- Detailed descriptions of necessary long-term ongoing conservation actions in re-established populations are not within the scope of this document. These include law enforcement and protection, biological management of populations to meet demographic and genetic goals, routine rhino monitoring, annual status reporting (in some countries), building and retaining capacity for field conservation action, coordinating rhino conservation efforts, building political and community support and seeking sustainability for rhino conservation efforts.
- Interested readers wanting more information on required actions and recommended strategies for successful long-term rhino conservation are referred to the various National rhino conservation plans, strategies and policies (which have been developed for Botswana, Kenya, Indonesia, Namibia, Nepal, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe) as well as continental (IUCN African and Asian Action Plans) and regional rhino plans and guidelines (SADC Guidelines for implementing SADC rhino conservation strategies (du Toit (Ed.). 2006) and SADC Rhino Management Group Black Rhino Biological Management workshop proceedings (Emslie (Ed.). 2001). Advice can also be sought from IUCN's Asian and African Rhino Specialist Groups as well as the SADC Rhino Management Group. For African rhinos, the SADC Guidelines (du Toit, R. (Ed.). 2006) provides a useful overview of what is required for successful rhino conservation and can be downloaded from the AfRSG webpage or Rhino Resource Center.
- A deeper understanding of the factors affecting translocation success rates will only be able to be determined by pooling and analysing data from many translocations over many years (to be able to have a sufficiently large sample size for statistical analyses). This is particularly relevant with Asian rhino where relatively few operations have been undertaken and it is essential for practitioners to keep an open mind on future protocols and best practices, learning from experience. Such long-term analyses can be facilitated by requiring rhino reserves to submit standardised status reports on an annual basis (as has been done for black rhino in the SADC RMG region since 1989) and requiring information to be supplied on translocations in these reports. The long term RMG black rhino translocation dataset is currently being analysed by Linklater, Adcock and co-workers, and any practical lessons and recommendations to emerge from this work will be publicized by the SADC RMG and AfRSG in due course.

4 Lessons learned

4.1 Summary of mistakes and lessons learned from past translocation exercises

4.1.1 Pre-release/planning phase

- Failure to translocate animals from or translocating too few animals from populations showing reduced or stable numbers and where population densities are likely to be close to or have overshot estimated medium-term carrying capacities. Decsion-makers must consider not only the possible risks of translocations (costs) but also considering the likely cost:benefit trade offs of not translocating compared to translocating different numbers of rhino. The no action equals low risk trap is one managers must conscientiously avoid (Goodman, 2001).
- Not educating owners/managers/communities/private custodians from the outset on biological management principles; for example, if breeding is successful it will be necessary sometime in the future to remove some animals to maintain rapid growth rates or to improve declining underlying performance.
- Poor progress with implementation of major multi-donor translocation programmes. There is a need to ensure that progress is made with implementation of projects or funding may be lost.
- Planning to translocate animals to sub-optimal habitat locally when there are other better potential release areas available in the country or region.
- Introducing rhinos into fenced areas where ECC has been overestimated by a non-expert.
- Not doing enough in the past to create incentives for land-owners/parks/communities to take down fences and create larger areas suitable for introduction of the recommended 20+ unrelated founders.
- Translocating and releasing of hand-reared, habituated or tame captive or semi-captive rhinos into wilderness situations often results in poor survivorship (successful rehabilitation of captive animals back to the wild can be very costly and time consuming and require expensive bomas and variable size enclosures).
- Not checking radio telemetry equipment before fitting onto a rhino.
- Not carefully considering the age and sex structure of the group of animals to be translocated.

4.1.2 Translocation phase

- Unclear chain-of-command or interference from non-operational managers.
- Moving animals that are too young (may be due to failure to age accurately).
- Circus type audience/media and disturbance at release site where animals may get stressed, travel further post release and possibly injure themselves on nearby trucks or other physical barriers.
- The use of powerful lights or flash photography upon release which can disorientate and panic rhinos resulting in injury and unnecessary stress to the animal.
- Moving and/or releasing animals in poor condition.

- Failure to properly monitor conditions in bomas and inadequate feeding.
- Not ear-notching translocated animals.
- Moving cows and calves when avoidable.
- Moving cows too close to when they are likely to give birth
- Not using experienced wildlife vets and/or qualified and experienced rhino capture teams.
- Not monitoring temperature, respiration and in particular air movement (animals can show chest and nostril movement without air moving in and out of the lung).
- Leaving animals too long in one position when immobilized, with major nerves or the trachea under pressure from debris and not placing the rhino on its brisket.
- Applying approaches developed for another species – may not work or be appropriate.
- Transporting and releasing animals in the heat with no water to cool animal down.
- Driving animals too far in the heat using a helicopter (chasing animals for an excessive period during darting must be avoided, and attempts to dart animals **must** be abandoned if they have been running under stress **> 5 minutes**).
- Not ensuring airways open and unobstructed.
- Not covering eyes and fitting ear plugs while rhinos are immobilised.
- Not documenting details of capture, release, ear-notching or transponders properly.
- Not routinely fitting transponders to immobilized rhino.
- Not horn-tipping animals prior to release.
- Not releasing white rhinos that are refusing food sufficiently quickly enough.
- Losing an animal in thick bush after it is darted.
- Always removing animals from easily accessible zones with resultant concern that suitable habitats could be depleted of rhinos, and that these habitats could change negatively for remaining rhinos.
- Over focus on the glamourous high-tech aspects of translocations and not enough care, attention and effort with less interesting aspects, such as routine boma management and post-release monitoring.
- Releasing rhino into bomas with poles treated with a creosote-based preservative
- Releasing animals into areas with established black rhino populations without any mitigating measures, such as the use of temporary fencing and access to holding pens for treating animals injured by fighting.
- Not detecting cows caught at late stages of pregnancy prior to translocation and release with resultant high mortality rates of calves born in bomas/holding facilities.
- Losing animals due to avoidable and slack boma management.

- Captive care often neglected resulting in poor condition of rhinos at release.
- Not critically evaluating the health of each rhino every day.
- Releasing rhinos from holding pens not well fed and without a good drink of water.
- Not having adequate drilling equipment at field site (mechanical back-up for battery operated systems).
- Releasing older bulls before the young animals thus not giving time for the young and the females to settle.
- Too much disturbance thus not giving the rhino a chance to settle down.
- Inadequate fencing at release site for staged releases.
- Overstocking in pre-release fenced areas.
- Poor conditions in boma from excessive rain and mud due to translocation during the wet season.
- Poor boma construction leading to damage of animal, boma and sometimes leading to escape.

4.1.3 Post-release phase

- Inadequate follow up of rhino after release. There should be intensive post-release monitoring (at least for the first month and preferably longer).
- Over-dependence on transmitters for post-release monitoring, and when these fail to work routine ground-based monitoring is not in place.
- Not providing sufficient training and equipment for the people who are going to be monitoring and providing security to the rhino.
- Failure to remove temporary fencing in release areas due to a fortress mentality, where managers may be unaware of the probable declining nutrition for females as numbers build up and highly favoured, browse-sensitive species are reduced in abundance or eliminated further lowering ECC.
- Lack of review procedures and documentation of lessons learned.

Annexe 1

Basic pre-reintroduction/translocation health screening protocols and prophylaxis

In general, reintroductions of rhino require more rigorous health risk assessment especially where there are significant distances involved or ecological separation between source and recipient populations and especially from captive populations.

After risk assessment:

Pre-translocation screening includes:

- Body scoring using the standardized AfRSG condition scoring system in Africa (Adcock & Emslie, 2003 – Module 12) and the soon to be developed AsRSG guidelines.
- Clinical evaluation and examination for stage of gestation in particular.
- Haematocrit, blood smear thick and thin and serum for banking.
- Determination of known disease history or presence or absence of known pathogens in source and recipient populations/sympatric species.
- Recording individual identification features/ear-notches/transponder numbers
- Recording endo- and ecto-parasitic load and only treating if required by international regulations or if novel to recipient site.
- Ensuring capture records have been properly filled in recording where and when the animal was caught.
- Pre-release prophylaxis should be determined by the responsible clinician on the basis of risk. This might involve vaccination for tetanus and other diseases.

Post-release screening includes:

- Evaluate body score and clinical condition regularly.
- Necropsy of any dead rhinos as soon as practical using appropriate protocols (see annexe 2).
- Ensuring release records have been properly completed, including details of when and where the animal was released, method of release and other features of the translocation (e.g. boma management).

Transboundary pre-translocation screening might require:

- All of the above.
- OIE requirements of importing country.
- AHS serology negative.
- Blood smear negative for piroplasms.
- Vaccination for anthrax.
- Treatment of endo- and ecto-parasites with avermectin group of anthelmintics.

Intercontinental pre-translocation screening might require:

- All of the above.
- Full medical history of individual and source populations and potential exposure to TB or unusual diseases, such as IHVS TSE.
- Full CBC and blood chemistry.
- Enteric pathogen culture aerobic minimum of 3.
- TB test 0.1 ml USDA PPD bovis intradermally in eyelid or ear based. Collection of tracheal or gastric lavage samples for acid fast stain and mycobacterial culture.
- Vaccination for tetanus and leptospirosis.

Annexe 2

Summary protocol for veterinary investigation and post mortem of a rhino carcass

Ensure properly trained personnel are used and appropriate precautionary measures for anthrax or other contagious contaminants. If suitably trained personnel are not available a full necropsy will not be possible but initial examination should be performed with a standard protocol.

Initial examination

Note position and posture. Examine tracks and evidence for a struggle or repeated rotation whilst lying on the ground – record agonal signs.

Examine skin surface for any ectoparasites, wounds or lesions and/or distinguishing features. If lesions are seen, describe and if infested with fly eggs or maggots remove and fix in ethanol. Record approximate size of maggot and if more than one size note this and collect representative samples.

Record body condition using standardised AfRSG AsRSG system in Africa/Asia and undertake body measurements.

Examine eyes and record condition of conjunctiva and cornea.

Examine rectum and note colour and signs of inflammation, haemorrhage or discharge.

Examine vulva for discharges, inflammation or haemorrhage.

If there is haemorrhage from the mouth, anus, eyes or vulva anthrax is a differential diagnosis and untrained personnel should not examine the carcass any further.

Sample as required. Take capilliary blood smear and serum from jugular if reasonably fresh.

Roll animal and examine top surface as before.

Post-mortem examination

Follow standard post-mortem (necropsy) procedures for any rhino that die and take comprehensive set of tissue samples (~1cm blocks) and place in buffered formal saline. Take other samples according to pathology. Ensure correct proportion of fixative to tissue and refresh when back at lab. Take particular note of epithelial layer of skin and ease of sloughing. Note degree of post mortem change from rigor mortis to various stages of tissue degeneration (describe colour, consistency). An estimate can be made of the time of death based on an estimate of the likely rate of change in the tissues post mortem and signs and stage of maggot invasion. This will vary with season (temperature and moisture) and degree of exposure of the body to sunlight.

Examine gut for content and indications of normal feeding behavior.

Examine reproductive tract for pregnancy or follicular cycling.

Record all normal data and pathology, collecting any necessary samples for diagnosis. Take photographs of normal and abnormal tissues.

Rhino are large animals and require good necropsy tools for professional examination but even without these under remote field conditions dead animals can be thoroughly examined as long as sharp knives are available. The key is to resect the rib cage at the costochondral junction which enables access to the main body organs.

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For a full list of the participants at the 2006 AfRSG Meeting Working Group that discussed the guidelines, those that contributed written text for various versions of the document or commented on drafts, and those that attended the November 2008 IUCN SSC AsRSG/WHSG Guwahati Workshop to review the guidelines for greater one-horned rhino, see the section on Contributors.

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