Errors that occur when using photo-identification to identify individual black rhinos

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Abstract

Photo-identification of individuals has been successfully applied in sea mammals for over a decade but errors of judgement do occur. Photo-identification can also be used to identify or verify the identity of black rhinos (*Diceros bicornis*) from appropriate features, including the sex, age, horn size and shape, and ear markings. By developing and applying a series of tests, judgement errors that occur when reviewing identification photographs are determined and are reported. Results show that individual black rhinos can often be accurately identified from suitable photographs but even for the best of the judges, using photographs to identify individual rhinos is not completely reliable. There are four key factors which improved the accuracy and consistency of identification: the amount of identification information available, the quality of the photograph, the distinctness of the rhino and the aptitude of the judge for reviewing photographs. The distinctness of identification features is more important than the quality of the photographs. People vary widely in their ability to judge identification photographs irrespective of their experience of working with rhinos. Where photographs are to be used to verify the identity of a rhino, the verifier must have shown the aptitude to undertake such analysis and/or should be practiced in the skill. Recommendations are made to reduce the impact of judgement errors when using photo-identification with black rhinos.

Additional key words: photographs; identification; black rhino

Résumé

La photo-identification des individus est appliquée avec succès chez les mammifères marins depuis plus d'une décennie mais des erreurs de jugement peuvent se produire. La photo-identification peut aussi être utilisée pour identifier ou vérifier l'identité des rhinocéros noirs (Diceros bicornis) en utilisant des traits appropriés tels que le sexe, l'âge, la taille et la forme de la corne et les marquages des oreilles. En développant et en appliquant une série de tests, on peut déterminer et rapporter des erreurs de jugement qui se produisent lorsqu'on examine les photographies d'identification. Les résultats montrent que les rhinocéros noirs individuels peuvent souvent être identifiés correctement sur des photographies convenables, mais, même pour les meilleurs juges, utiliser des photographies pour identifier des rhinocéros individuels n'est pas complètement fiable. Il y a quatre facteurs clés qui ont amélioré l'exactitude et la consistance de l'identification: la quantité d'informations d'identification disponible, la qualité de la photographie, les caractéristiques distinctives du rhinocéros et l'aptitude du juge à examiner les photographies. La clarté des traits d'identification est plus importante que la qualité des photographies. Les gens diffèrent largement dans leur capacité de juger les photographies d'identification indépendamment de leur expérience de travail avec les rhinocéros. Là où les photographies seront utilisées pour vérifier l'identité d'un rhinocéros, le vérificateur doit avoir montré l'aptitude d'entreprendre une telle analyse et/ou il devrait avoir pratiqué la compétence. Les recommandations sont faites pour réduire l'impact des erreurs de jugement quand on utilise la photo-identification avec les rhinocéros noirs.

Introduction

When photographs are used to assist in the identification of individual black rhinos, the potential causes of error (misidentification) need to be addressed. The supposition is that a person will be able to regularly and accurately identify individuals from the photographs, a subject which psychologists have studied since the 1950s (Zhao et al. 2000). The basic problem is that 3D objects have to be recognised from 2D images.

The results of research on human face recognition using photographs suggest that some areas of the face provide more information about a person's identity than other areas which has led to the view that face recognition is dependent on the arrangement of the features with respect to each other (their configuration), as much as the features themselves (Bruce and Young 1986). This suggests that photographs which do not contain all the important features or which obscure important areas of the face could lead to misidentification. In many situations, contextual knowledge is also applied e.g. the surroundings play an important role in recognising faces in relation to where they are supposed to be located (Zhao et al. 2000). However with rhinos, context can also lead to misidentification (Patton 2007) as an observer 'expects' to find a certain rhino in a certain place and the standardised AfRSG identification training course (Adcock and Emslie 2003) emphasises that rhinos should not be identified on the basis of location.

Some identification features on individual animals may be particularly distinct. A single distinctive feature may be sufficient to extract an accurate identity while a face with no particular distinctive features may be recognised by the whole set of features together (Zhao et al. 2000). However, Vokey and Read (1992) found that faces which are highly distinct in appearance are not necessarily highly memorable although they usually are (Zhao et al. 2000). It is therefore important to consider distinctness of identification features as well as the quality of the photographic image obtained of the feature.

Rangers identifying rhinos would usually see the individual animals as they move about their habitat and not motionless as captured in a photograph. Knight and Johnston (1997) found that famous human faces were easier to recognise when seen in moving sequences than in still photographs. It is possible therefore, that those used to seeing movement could misidentify individuals they know well when reviewing photographs. This may impact on the choice of person to be an identification verifier.

Photo-identification is now a standard research method in studies of whales and dolphins (Hammond et al. 1990). Researchers have found that as the quality of a photograph decreases, the information in the natural markings becomes obscured and it becomes increasingly difficult to recognise the represented individual. As less distinctive individuals are more difficult to recognise than more distinctive ones, poor quality photographs will exacerbate this problem (Hammond et al. 1990).

Problems were encountered while examining photographs of bowhead whales (*Balaena mysticetus*) (Rugh et al. 1992). Inexperienced judges obtained 60% correct classification while experienced judges (used to the photographs and changes in markings over time) obtained 85%. The main difference was the relative success in subjective comparisons – judging if a mark was larger or smaller than standard. However with humpback whales (*Megaptera novaeangliae*) most judges were able to agree when evaluating specific and overall aspects of photographic quality and individual distinctiveness and it was found that they need not be experienced in photographic identification. Nevertheless it was stated that some individuals may be less suited as judges for evaluation (Friday et al. 2000).

Types of Errors associated with Photo-Identification

Incorrect identification may involve falsely identifying two sightings of different individuals as the same – a false positive – or two sightings of the same individual as different – a false negative error. Stevick et al. (2001) undertook the first large scale investigation of errors in individual identification by natural markings for any species. Working with humpback whales (*Megaptera noraeangliae*) they used photographs which showed the pigmentation pattern and scars on the ventral side and contours in the trailing edge of the tail flukes. Because the quality of the photograph may influence recognition of individual whales, all photographs were given a quality designation based on the clarity and contrast of the image and the angle of the fluke to the camera. An ad-

ditional rating was designated to half flukes or images showing less than 20% of the fluke area, designated as partial flukes, irrespective of other photographic quality considerations. This rating reflected the difficulty in re-identifying animals based on only part of the tail being visible. Since distinctiveness of the individual markings may also influence recognition, each nominal individual was given a distinctiveness rating based on the colour pattern, scarring and serrations of the trailing edge.

Five photographic matching errors were identified as due to half or partial fluke photographs and four errors were considered to be due to problems with the photographic angle, contrast, clarity or portion of fluke visible. Error rates increased steadily with decreasing image quality. When identification was made by an experienced individual the probability of errors was substantially reduced.

The aim of this study was to examine the types of problem and error found in the photo-identification of black rhinos.

Materials and Methods

Photographs were selected from the dataset produced in 2002 and 2003 for individual identification of black rhinos at Sweetwaters Game Reserve, Kenya. Photographs of adults and older sub-adults were used, as young sub-adults and calves have limited and under- developed identification features. Three types of identification photographs for each rhino were chosen – face view, left profile and right profile. There were 12 individuals for which all three types of identification photograph were available i.e. 36 pictures.

A second set of identification pictures was also made where a similar but not the same identification photograph was available. This was possible for 7 of the 12 individuals, giving an additional 21 pictures.

Table 1. Judges used for pairs and matching tests

Type of judge	Pairs test	Matching test
Researcher and rangers experienced in rhino i/d	6	7
Monitoring rangers	5	5
PhD & MSc students and volunteers inexperienced in rhino i/d	11	12

Prints were made at a standard 2.5" height in greyscale on HP premium quality paper on a portable Hewlett Packard hp deskjet 450 printer.

All 57 individual pictures were cut out and pasted separately on to 15cm x 10cm card. Each card was identified by a number written on the reverse which corresponded to a particular rhino. All photographs were subjectively graded independently by three assessors (experienced in reviewing rhino photographs) for their clarity of exhibiting features used for black rhino identification using a rating scale 1-5 with 1 = poor, 2 = fair, 3 = average, 4 = good and 5 = excellent.

Depending on the type of test used as described later, either a single face or left or right profile view photo was shown, or a pair of face and one of the profile view photos was shown, or all three photographs of face and left profile and right profile views were shown.

A cross-section of people, which included the three assessors, was selected as judges (see table 1) but all had at least a minimum knowledge of black rhino identification features. They were graded 1-3, with 1 = very experienced with black rhinos, 2 = moderately experienced with black rhinos, 3 = limited experience with black rhinos

There were three levels on which an identification judgement was made. Firstly there was the individual animal and how distinct it was within a population. Secondly, there was the photograph and if it was of sufficient quality for accurate identification. Thirdly, there was the amount of information available on which to make the judgement e.g. whether there were one, two or three different views available. Three tests were developed which would provide information for each of the three levels.

Three tests were developed to determine identification errors.

Name Test

The Name Test was devised to examine the importance of the quality of the photograph, the distinctness of the identification features and the aptitude of a judge to observe differences in identification features. The test was run with four judges – the author, the Head of Security, the Head of Rhino Patrols and a senior ranger – who were given identification photographs of the 12 rhinos (excluding duplicates for the seven rhinos) in the following order and asked to give a name to the individual rhino:

1-face 2-left profile 3-right profile 4-ace and left profile together 5-face and right profile together 6-left and right profiles together 7-all three types together

The order of the face photos was randomised and the test carried out using all face photos before then moving on to testing on all left profiles (presented in random order) and so on in the sequence shown above.

In order to standardise the quality assessment for the number (one, two or three) of types of photograph used for the identification, a quality rating was calculated by dividing the total quality score given by the three judges by the total available quality i.e. by 15 for one photograph, by 30 for two and 45 for three.

The identification features are such that some rhinos are more distinct than others. Each of the 12 individuals were placed subjectively into one of three distinctness categories with 1 = least distinct, (i/d features could be missed) 2 = moderately distinct (i/d features could be misinterpreted) and 3 = most distinct (i/d features clear) resulting, by chance, with four animals in each group.

Matching Test

A second test was devised to examine the ability of a range of judges with different levels of knowledge of rhinos to correctly match an identification photograph of an individual rhino with a similar photograph of the same rhino from within a set of identification photographs. The set of 12 photographs of the same identification type was laid on a table in front of each of 17 judges. Each judge was individually handed one of seven identification photographs and asked to select which one of the 12 photographs was of the same individual. The judges were informed that there was definitely one that corresponded to the one in hand and were allowed to move the 12 photographs in any way they liked.

This was repeated for each identification view in the following order: 1-face view 2- left profile 3-right profile 4-all three types together.

Pairs Test

This test was devised to examine the ability of a range of judges with different levels of knowledge of rhinos to correctly decide if two similar identification photographs were of the same individual or different individuals. A pair of photographs of the same type was given separately to 22 judges who were asked to record on a simple slip of paper a tick if they thought the photographs were of the same individual or a cross if they thought they were different individuals. The pairs test was repeated on five separate occasions with three of the judges to determine how consistent their judgements of the photographs were. For the Pairs Test, each pair was rated from 1 (most difficult) to 5 (easiest) in terms of the quality of one or both photographs and therefore the difficulty of obtaining a correct result.

Table 2. The number of correct identifications of individual rhinos from photographs

Distinctness*	1 (n=4)	2(n=4)	3(n=4)	(n=12)
View				
Face	2/16	4/16	10/16	16/48
right profile	2/16	6/16	6/16	14/48
left profile	4/16	5/16	5/16	14/48
face & right profile	1/16	5/16	10/16	16/48
face & left profile	5/16	5/16	10/16	20/48
right & left profiles	3/16	7/16	7/16	17/48
all views	4/16	6/16	12/16	22/48
Total	21/112	38/112	60/112	119/336
median	3	5	10	
	n=112	n=112	n=112	n=336

*1 = least distinct, 2 = moderately distinct and 3 = most distinct

Results

The quality of the photographs, the distinctness of the rhino's identification features and the ability of a judge to determine differences between individuals were all found to be important factors in correctly identifying rhinos from photographs.

Name Test Results

The more distinct the rhino, the more likely it will be correctly identified. Table 2 presents the results of four judges reviewing photographs of seven different views of four individual rhinos in each of three distinctness groups and shows that there were 119 correct identifications out of the 336 identifications possible (35.42%) of which 60 out of the 119 (50.42%) were from the rhinos independently rated as having the most distinct features. The results shown in table 2 also suggest that the likelihood of successfully making a correct identification would be similar whether a face view or a profile view was being assessed.

Rather than modelling eight levels of factor information, Table 3 presents the data in table 2 in three groups depending on the level of information available from which the judgement is made. A single view photograph (G1), be it of the face or either profile, contains less identification information than two photographs of different views (G2) which contain less information than three photographs each of a different view (G3) and the more identification information available, the more likely there will be a correct identification.

Table 3. The number of correct identifications of individual rhinos from three levels of information derived from identification photographs

Distinctness/ information	D1	n	D2	n	D3	n	ALL	Mean score	% success
G1	8	48	15	48	21	48	44	14.7	30.56
G2	9	48	17	48	27	48	53	17.7	36.81
G3	4	16	6	16	12	16	22	22.0	45.83
ALL	21		38		60		119	17.0	35.42
n		112		112		112	336		

D1 = least distinct, D2 = moderately distinct and D3 = most distinct
G1 = information from one view of an individual
G2 = information from two views of an individual
G3 = information from three views of an individual

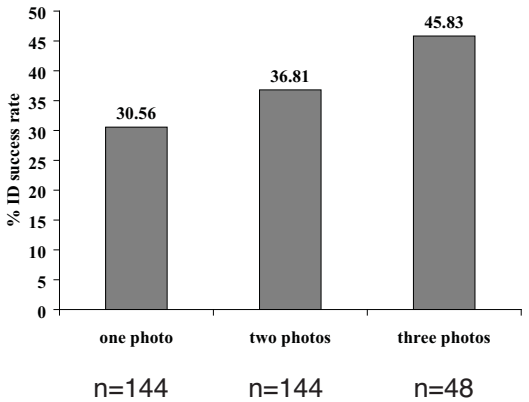

Figure 1. Success rate of obtaining a correct identification with increasing amount of information from photographs.

Table 3a. Observed and fitted probabilities of obtaining a correct identification

Distinctness/ information	D1	D2	D3
G1 P OBSERVED	0.17	0.31	0.44
P FITTED	0.15	0.29	0.48
G2 P OBSERVED	0.19	0.35	0.56
P FITTED	0.20	0.35	0.55
G3 P OBSERVED	0.25	0.38	0.75
P FITTED	0.27	0.45	0.65

It can be seen that the mean number of correct identifications, calculated by dividing the number of correct identifications by the number of views, increased with the amount of information available: i.e. it is lower (14.7) when only a single photograph is available giving a rate of getting a successful identification of 30.56%; increases (17.7) when two photographs are available with a success rate of 36.81%; and is highest (22.0) with a success rate of 45.83% where all three photographs were viewed (fig. 1).

Together, increasing distinctness and increasing the level of information significantly increased the probability of getting a correct identification (X^2 = 34.74, df = 4, P = <<0.001).

When modelled using logistic regression, as shown in Table 3a, the observed and fitted probabilities are similar. It can be seen that a probability in column D3 is about three times greater than a probability in column D1 while a probability in row G3 is only about half times as great as a probability in row G1. This shows that getting a correct identification was mostly due to increasing the level of distinctness and while there was a beneficial effect from increasing the level of information (i.e. the more photographs the better the accuracy of identifications), it was not as significant (marked).

It would be expected that the better the quality of the photograph in bringing out the identification features, the more likely there will be a correct identification. Although the dataset is limited, the results presented in Figure 2 show that there appears to be an increasing trend to obtaining correct identifications with increasing photographic quality. More data would be needed to confirm this.

All four judges who took part in the Name Test were experienced in the identification of the Sweetwaters rhinos but differed in their aptitude to make judgements from photographs, with the poorest judge only getting 12% correct identifications while the best achieved 68% as is shown in Table 4.

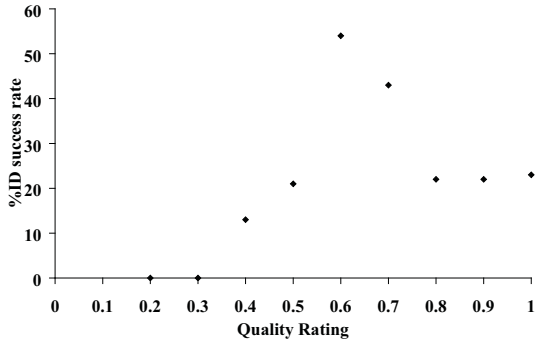

Figure 2. The relationship between correct identification and the quality of photographs.

Of the 84 pictures to identify, judge two was only able to get 10 correct while judge four got 57 correct. However, this also shows that even the best judge failed to identify 27 (32%) of the photographs correctly.

Matching Test results

The level of a judge's experience of rhinos was not found to be a factor in obtaining correct identification from photographs. Table 5 showed that, where judges are all highly experienced in field identification (category A), there was a wide variation in a judge's ability to identify individual rhinos from photographs with the correct score ranging from 14/28 (a success rate of 50%) to 23/28 (a success rate of 82%), the range (14-23) being similar to that for the least experienced judges (13-23).

Judges in the least experienced group (category C) got a higher average number of correct pairings (18.83, an average success rate of 67.25%), than those in the most experienced group (17.29, an average success rate of 61.75%)

The results show that 42% of the least experienced group of judges (category C) were in the top third of all judges (those who scored the most correct pairings) while only 29% of the most experienced group (category A) were in the top third.

Table 5a shows there was no significant difference in the average ability of judges of different experience levels to correctly identify rhinos from photos (P = 0.487).

Pairs Test Results

Out of 441 potential pairings, 154 (35%) were incorrect of which 90 (58%) were different rhinos rated the same and 64 (42%) were the same rhinos rated as different. The difference between the two proportions is significant (P = 0.003, z = 2.96) suggesting that judges, when viewing two photographs, are more likely to incorrectly rate two rhinos as being the same when they were not rather than incorrectly rating two rhinos as different when they were the same .

The highest number of correct pairings, 17 out of 21 possible, was made by 3 of the 21 judges whilst the least correct pairings, 12 out of 21 possible was made by 5 of the judges. A test of two proportions showed that the best judges made significantly less errors (19% of cases) compared to 43% for the worst judges (P = 0.002, z = -3.16).

Table 4. Judging ability from Name Test

View	Judge 1	Judge 2	Judge 3	Judge 4
Face	6	0	4	6
Right profile	2	3	2	7
Left profile	5	1	0	8
Face & right	4	1	2	9
Face & left	7	1	3	9
Right & left	5	2	1	9
All views	7	2	4	9
Total	36	10	16	57
% total correct	43%	12%	19%	68%

Table 6 demonstrates that, as previously stated, there were more false positive errors (90) than false negative errors (64) but that both the best (top 3) and worst (bottom 5) judges made a similar level of error for each type.

More errors occurred with pairs where the quality of the photographs made a judgement more difficult as shown in Figure 3 where the number of correct judgements increased with a corresponding increase in the adjudged quality of the photograph.

Where the photographs of the pairs were rated as easier to correctly identify as the same or different, the level of accuracy was repeatable with Table 7 showing how consistent judges' ratings of the pairs were. In this test, three judges rated, rightly or wrongly, those pairs which were most easy to identify (classed 5) or most difficult (classed 1) on five separate occasions.

While only a very small sample, this consistency is also shown by the trend of an increase in the number of correct identifications with the increase in adjudged quality of the photograph (Figure 4).

Table 5. Judging Ability from Matching Test

Category of Judge	A	B	C
Number of judges	7	5	12
Average correct	17.29/28	16.60/28	18.83/28
Range	14 - 23	12 - 22	13 – 23
Average % success	61.75	59.29	67.25
% in top third	29	20	42
% in bottom third	42	40	25

Table 5a. Kruskal Wallis Test on the three judging groups

Group	number	median	Average rank	Z
A	7	17.0	11.1	-0.64
B	5	18.0	10.4	-0.75
C	12	18.5	14.2	1.18
overall	24		12.5	

H = 1.44 DF = 2 P = 0.487 (adjusted for ties)

In a test of two proportions there was no significant difference (P = 0.689, z = 0.40) detected in the level of consistency in obtaining correct identifications from either a same pair or a different pair of photographs with both options achieving 60% and 62.2% correct identifications respectively.

It was possible that judges could get better at observing the details in the photographs as they got used to the test and in what they were looking for to determine similarity or difference in features, that is, as their experience in judging increased. This was analysed by comparing the number of correct scores achieved for the first seven of the 21 pairs with that for the last seven as shown in table 8. The level of difficulty ratings for each third was 21 for the first third and 17 for the last meaning the difficulty in getting the last third correct was a little harder than for the first third, with three of the seven pairs rated as level 1 (most difficult) while there were only two in the first third.

Table 10 shows that, whatever the level of experience with rhinos, all judges improved their scores between the first and last thirds with overall the first third pairings being judged correctly in 48% of times, rising to 73% for the last third. When modelled using logistic regression, there was strong evidence of an 'order' effect which was found to be highly significant (X^2 = 19.85, df = 1, P = <0.001)

Since it has already been shown that experience with rhinos was not a factor in obtaining correct identification, the data were re-analysed to compare the performance of the best (top 3) and worst (bottom 5) judges, see table 9. While only a sample of three, the performance of the best judges, improved to 100% correct for the last seven pairs from 67% for the first seven. The worst judges also improved their performance from 40% correct to 66%.

Table 6. Types of errors arising from comparing pairs of photographs of individual rhinos

Type of error	ALL SCORES			Top 3			Bottom 5		
	incorrect	total	%	incorrect	total	%	incorrect	total	%
Different rated same	90	154	58	7	12	58	29	45	64
Same rated different	64	154	42	5	12	42	16	45	36

Discussion

Even for the best of the judges, using photographs to identify individual rhinos was not completely reliable. There were five key factors which improved the accuracy and consistency of identification: the amount of identification information available, the quality of the photograph(s), the distinctness of the rhino, the aptitude of the judge for reviewing photographs and the degree of practice the judge had in making identifications from photographs.

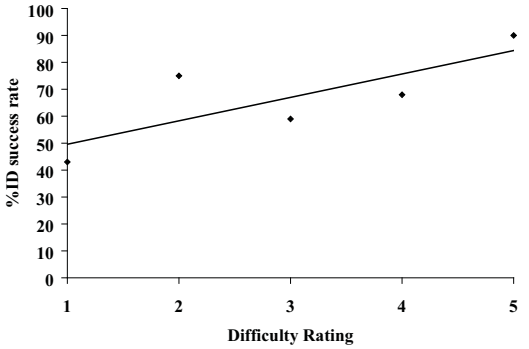

Figure 3. Effect of the degree of difficulty in correctly identifying pairs of photographs.

Table 7. Difficulty ratings for each of 21 pairs of rhino photographs were sub-divided into four ratings for judges consistently getting correct identifications

DEGREE OF CONSISTENCY			
0	1	2	3
2	3	1	5
3	3	1	4
1	2	3	4
4	2		5
	1		3
	4		4
			1
			5

Consistency scale: 0 = inconsistent 3 = very consistent
Difficulty scale: 1 = difficult to identify 5 = easiest to identify

The number of correct identifications increased with the amount of information available and the quality of the photograph. This suggests that it is important to see and/or photograph all identification features clearly to obtain an accurate identification (which cannot be successfully achieved using a poor quality picture).

Overall there was an increasing trend in obtaining correct identifications with increasing photographic quality, while half of the correct identifications were from the rhinos rated as having the most distinct features such as a unique horn structure or ear marking.

The importance of distinctness was further evidenced by the results showing that errors were more often made with pairs which were rated most difficult to match and least often with pairs rated as most easy, the degree of difficulty being related to the distinctiveness of features. Easier pairs to identify were also more consistently identified correctly by judges. Part of the difficulty was related to the obscuring of a feature by a poor quality photograph or by the habitat.

Both the judges with a high level of field experience and those with a wide variation in their experience of field identification with rhinos showed a wide variation in their ability to identify rhinos from the photographs. The best judges were those with some knowledge of rhinos having been involved in some level of rhino research as they were also used to looking at photographs in general. This illustrates that a high level of field experience is not a prerequisite for having a high level of ability to identify rhinos from photographs. The selection of a judge should be undertaken with care especially when selecting a judge to verify the identification of a rhino from a photograph.

The improvement in the performance of judges between the first third and last third of the pairs test suggests that judging the identification of rhinos from photographs can be a skill which can be learned or at least improved on with practice. This should

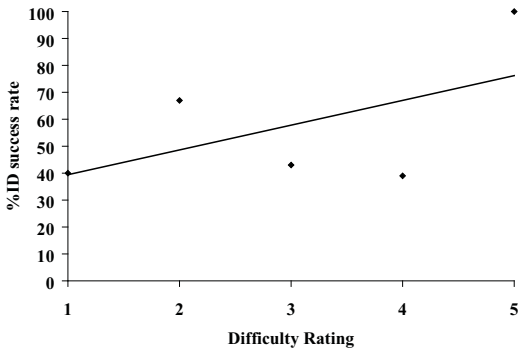

Figure 4. Number of correct pair identifications compared to their difficulty rating from the results of three judges tested five times with 21 pairs of photographs.

be borne in mind.

While errors in identification of animals with natural markings are more likely to be false negatives with the rhinos, where structural characteristics are the main source for identification, there were more false positive errors than false negatives particularly with the judges getting the most incorrect ratings.

Conclusions

Photographs can make an important contribution to identifying individual black rhinos particularly in highlighting the features which differentiate the individual from others in its population (Patton 2007). Photographs can easily and accurately record the size, shape and position of ear markings. Many monitoring programmes require horn configurations to be drawn (Adcock and Emslie 2003) which many rangers find difficult to complete accurately (Patton pers. obs.). Master identification files can be improved by including photographs. Identification forms allow for 'rogue' sighting records whereas photographs cannot be invented. However, this study showed there are limitations to the use of photography.

The results obtained show that unless judges are used who are skilled and experienced in identifying rhinos from photographs and involved in identifying animals with clear distinguishing features, there can be significant errors when using photographs to identify individual rhinos. Such errors can, in part, be reduced in practice. It is recommended that, where possible:

i) several photographs of the same rhino showing as many different identification features should be reviewed so that as much identification information is available on which to make a judgement.

ii) the quality of the photographs should be as high as possible although in practice this may be limited by the location of the rhino at the time the photographs are taken, as well as the habitat and photographic skill and equipment of the observer. If there is sufficient time, it will benefit the accuracy of identification for either the photographer to move, and/or to wait for the rhino to move, into positions where good, clear identification photographs are taken of different views of the rhino from different angles.

iii) while nothing can be done to improve the distinctness of a rhino's natural identification features, ear notching - cutting shapes in the ear of a rhino while anaesthetised - makes an individual more distinctive. It may be considered that this process is invasive, involves an important initial cost and may affect the rhino's future behaviour. It should not be viewed here on the basis of the results as a general recommendation to improve identification accuracy but rather to overcome specific problems where two similar featured rhinos are hard to distinguish. However, should a rhino be immobilised for other reasons, such as for medical treatment or for translocation, the opportunity should be taken

Table 8. The effect of order on the judges' ability to make correct decisions at different levels of experience with rhinos

Judge level	A correct	%	B correct	%	C correct	%	ALL	%
First 3rd pairs	21	50	12	34	41	53	74	48
Last 3rd pairs	30	71	26	74	56	73	112	73
No. of judges	6		5		11		22	
Total pairs in 3rd	42		35		77		154	

A = very experienced B = some experience C = no experience

Table 9. The effect of order on the best and worst judges' ability to make correct decisions

Judges	Top 3 correct	%	Bottom 5 correct	%
First 3rd pairs	14	67	14	40
Last 3rd pairs	21	100	23	66
No. of judges	3		5	
Total pairs in third	21		35	

to make it more distinctive by ear notching.

iv) before a person is chosen to make identification judgements from photographs, they should receive appropriate training and be tested to show they have an aptitude for the task. It should not be assumed that someone good at identifying individuals in the field will be equally as good at doing so from photographs.

By taking account of these recommendations, the benefit of using photographs to assist with the individual identification in a black rhino monitoring programme will be enhanced by the reduction in errors associated with photo-identification resulting in the improved accuracy of sighting records.

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