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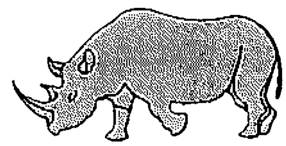
Alan Birkett

2003

Kenya's Black Rhino

EXPEDITION BRIEFING



Principal Investigator: **Alan Birkett, Ph.D.**
Position/Title: Honorary Research Fellow
Affiliation: Manchester Metropolitan University

Dear Prospective Team Member,

I am delighted that you have shown an interest in joining one of the teams going out to Kenya to study black rhinos. Sweetwaters Black Rhino Reserve was created in 1989 on land that was originally part of the Ol Pejeta cattle ranch located on the Laikipia Plateau not far from Mt Kenya. The Reserve and the Ranch are now owned by a multinational company, Lonrho, which was originally run by a 'larger than life' character who was reputed to have won the ranch in a gambling game from a Saudi Arabian arms dealer! Although I can't guarantee that you will meet any individuals as exciting as these, inevitably you will have more memorable experiences and meet more unusual characters than anywhere else you have been to previously! Expect to have to push your vehicle out of the mud or help to change a tire in the dark to the background sounds of hyenas calling. You will get so close to big game that all you can hear is your heart beating. You will meet people you will never forget. The scenery is spectacular, the climate excellent and the wildlife fascinating.

When I first went to Sweetwaters in 1995 I had just retired from a career working as a project manager with a multinational chemical company. I completed an external PhD at about the same time and was asked by the Manchester Metropolitan University whether I was interested in setting up a Research Centre for them in Kenya. When I arrived I couldn't believe how beautiful the scenery was and how much wildlife existed in such a relatively small game reserve. Since then I have become convinced that we must try to save places like Sweetwaters, which are the last surviving pieces of East Africa as it existed in the past. The Black Rhino is a flagship species and if we save the rhino we also save the other species that share the reserve. All rhino species are fascinating but the black rhino, in particular, has a unique character. They are secretive, very selective in what they eat, short sighted and belligerent - and they are all individuals. The trackers you work with know the animals and will enjoy sitting round the fire at night talking about themselves, the animals and the incidents that make life in Kenya so rich.

The Reserve has been stocked with rhino from other reserves, but all the other animals were either originally on the land or have come in since it was enclosed. The Reserve is ideally suited to the breeding of black rhino and the Kenya Wildlife Service had estimated that numbers of black rhino could increase to a maximum of 70 without damage to the environment. However, this estimate was based on very limited data and a major aim of the work you will be doing is to improve the accuracy of this estimate.

In order to protect the rhino from poachers, the land is enclosed by a high quality, patrolled, 40 km long electric fence. This has served its purpose in that only one rhino has been poached since the establishment of the Reserve. Protection of the rhino is seen, for the foreseeable future, as the only way that the Kenyan black rhino can be preserved. However, enclosing the land raises a number of problems for the reserve managers. Rhinos at Sweetwaters feed largely on the whistling thorn, a type of acacia tree that thrives on the black cotton soil of this part of Laikipia, but this is also the primary food of the reticulated giraffe and is also eaten by elephant and impala. The elephant and giraffe populations were enclosed when the Reserve was created and, although occasional breakouts by elephants occur, by 2001 the populations had increased to over 100 elephants and nearly 200 giraffe. Rhino numbers had increased to 32. However, the Reserve area is only 90 km^2 and, at these densities, damage to the whistling thorn was occurring to such an extent that the Kenya Wildlife Service, based on our data, decided to move half the elephants to another Reserve east of Mt Kenya.

Giraffe browse the tops of the acacia and slow down its rate of growth, in some cases to such an extent that a tree would take up to 60 years to exceed the height of a bull giraffe. In areas free from giraffe browsing the tree would reach this height in only 13 years. Elephants break off the main stems of whistling thorn and eat the bark. In dry conditions they switch from their preferred grass diet to trees and eat the bark, leaves and branches. Rhino also feed on the thorn trees and at high elephant, rhino and giraffe densities few trees ever reach maturity. At high browse intensities the mean tree height drops and other animals damage the smaller trees and eat the saplings. Eventually trees would disappear and open plains or areas dominated by dense bushes would be formed. These habitats are less suitable for rhino, so the overall effect would be that the Reserve's capacity for rhino would be greatly reduced and its whole character changed.

In order to quantify these and other effects of enclosure, long term studies are needed in which the present composition of the habitat, the tree growth rates, the animal distribution and the impact of the animals on the trees are measured accurately, so that future trends can be predicted. Based on this knowledge, management decisions on stocking levels can be taken. Following the removal of half the elephants in 2001 we now have to measure the effect of that change and see whether the reduction in tree damage agrees with our predictions.

The problem in any scientifically based management approach is that we need a lot of data collected over a long time as well as computer based systems to analyse the data and make predictions. The only way this data can be collected is by sending trained teams into the bush to take measurements at regular intervals. The data that you collect will be input to computers at the Research Centre and you should be able to see the relevance of it immediately. The feeling you get of being out in the bush and experiencing the sights and sounds of Africa will be unforgettable. You will have to walk long distances and get bitten by the ants that protect the whistling thorn. But you will be comforted by the thought that you are contributing to the conservation of one of the most fascinating of Africa's mammals and helping to preserve a habitat that is the home to hundreds of other species.

Alan Birkett

Principal Investigator

Kenya's Black Rhino

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RESEARCH PROPOSAL

PRINCIPAL INVESTIGATOR: **Alan Birkett, Ph.D.**

POSITION / TITLE: Honorary Research Fellow

AFFILIATION: Manchester Metropolitan University

PROJECT TITLE: **Kenya's Black Rhino**

RESEARCH SITE: Sweetwaters Black Rhino Reserve, Nanyuki, Kenya

TEAM SIZE: Minimum: 8 Maximimum: 10

Abstract of Proposal

Kenya has the largest population of the black rhinoceros subspecies *Diceros bicornis michaeli* in the world. This population, currently between 400 and 500 animals, represents about 15% of the total black rhinos in Africa and has increased over the last ten years at roughly 5% per annum. It is split into about 15 small populations, the largest being just over 50. The Kenya Wildlife Service (KWS) manages all these as a meta-population (a number of populations of a species considered collectively as one big 'herd'). Nearly all these rhinos are in protected areas. One quarter are in private sanctuaries, such as Sweetwaters, and the rest are in National Parks, such as Nairobi, or KWS Parks, such as Nakuru.

The Sweetwaters sanctuary was created in 1989. Rhinos were introduced from other sanctuaries from 1989 to 1993 but, as a result of poor breeding, fighting and accidents, there was initially a 6% per year decline in numbers. However, since the beginning of 1994 the population has increased at an annual rate of over 10% to reach the current figure of 32.

In September 2000 I attended a workshop convened by the KWS in Naivasha to draw up a new 5-year Conservation Strategy and Management Plan for Black Rhino in Kenya. The Workshop brought together the managers of all the Kenyan sanctuaries, researchers from Kenya, South Africa and Zimbabwe and key members of the KWS and NGOs that support rhino conservation. At the conclusion of the Workshop the overall goal of the 5-year plan was stated to be:

"Black rhino numbers will increase by at least 5% per annum to reach a confirmed total of 500 by 2005, 650 by 2010 and 1000 by 2020 using conservation management approaches that are biologically, socially, economically and politically sustainable".

The figure of 5% increase per year is thought to be modest since some populations, such as Sweetwaters, are increasing at rates of 10% or more per annum. A key part of this plan is to establish a rhino research forum that will co-ordinate research on the habitat requirements and

dynamics of black rhino. Specifically, managers are asking researchers to establish why some populations are breeding at much higher rates than others and at what point high numbers of rhinos or competing species will damage habitats and lead to lower breeding rates. This is precisely the aim of the Earthwatch Project at Sweetwaters and the habitat monitoring methods developed there are seen by the KWS as a model to be followed at other sanctuaries.

The data collected by Earthwatch volunteers over the last three years have shown quite clearly that the high density of elephants, rhinos and giraffes is damaging the Sweetwaters habitat. The situation has been made worse by the drought that lasted from 1999 to 2001. A key finding is that elephant damage increases exponentially as rainfall decreases, probably because they switch diet from grass to browse. Although the increased damage has not so far led to a reduction in rhino breeding rate, the current conditions are unsustainable and the Reserve Management has accepted our recommendations that two actions be taken. In the short term, the elephant population must be halved. The KWS agreed to carry this out and in mid 2001 translocated over 50 elephants to another game reserve in Kenya. We need to monitor the effect of the reduction in elephant density on the Reserve habitat.

The second action will take more time to achieve. There is a trend in the Laikipia region of Kenya for the owners of large ranches to move from cattle ranching to a mixed regime of ranching and tourism. We have recommended that management at Sweetwaters expand the black rhino sanctuary into the Ranch. This would mean running game and cattle on the same land and would need careful management to avoid damage to the habitat. Reduced income from cattle would be balanced by an increase in visitors to what would then be one of the largest black rhino reserves in Kenya. The expansion would reduce the browse impact of giraffes, allowing trees to grow more rapidly and assist in regeneration of the habitat. However, it will require careful management of cattle and elephant numbers to make sure that competition for grass does not result in an increase in tree damage by elephants. In order to assist them in this venture we need to collect data on the habitat in the Ranch and predict the consequences of the change. This will require the current tree model to be expanded to incorporate changes in grass biomass so that the impact of cattle can be modeled. The interaction between elephants, giraffes, rhinos and cattle and other herbivores on trees and grassland will be the focus for the next two years' research.

A further aim of the project is to continue to develop the use of hand-held computers for the collection of field data. This project has pioneered the use of PalmPilot hand held computers (Pascoe et. al. 1998) for which Canterbury University in England has developed the software.

RESEARCH PLAN

1. THE PROJECT

The number of black rhinoceros in Kenya has fallen from an estimated figure of 20,000 in 1970 to less than 500 now. There are about 150 black rhinos in Zoos, mainly in North America and Europe. The total world population is approximately 2,500, having been 65,000 in 1970 (Anon 1993). In Kenya, the surviving rhinos are concentrated in a number of sanctuaries in which they are protected from poaching - the major threat to their continuing existence. Inevitably, however, this means that individual populations are small, usually less than 100, and confined to relatively small geographical areas. Nevertheless, rhino populations in these sanctuaries are increasing. Hopefully, in a more affluent and enlightened future, these breeding populations will be used to reintroduce rhino to their former areas, hence their critical importance.

Sweetwaters Game Reserve is an enclosed 9,000 ha reserve within the 46,000 ha Ol Pejeta cattle ranch, owned and operated by Lonrho and located on the Laikipia plateau to the west of Mt. Kenya. The Reserve was created in 1988 as a sanctuary for black rhino translocated from other sites in Kenya. The vegetation is a mosaic of grassland, *Acacia* woodland, *Euclea* scrub woodland and riverine woodland. The Reserve already contained a large number of carnivore and herbivore species before the rhino were introduced. It has a mean annual rainfall of more than 800mm and normally has a bimodal rainfall pattern giving long growth periods. However, in the last two years rainfall has been the lowest ever recorded and this has generated invaluable data about the impact of drought on a savannah ecosystem.

The Sweetwaters site has many potential attractions for scientific research and for tourists. It is situated on the equator and forms part of a loop, which is used by tour operators when taking visitors around Kenya. In the future, if the entire Ol Pejeta Ranch were to be included in the Reserve, it would cover an area larger than Samburu National Park with a potential to support an even larger number of rhino. These considerations coupled with its wealth of staff committed to its long-term success, means that Sweetwaters could become a primary rhino conservation and breeding area in Africa.

Sweetwaters provides a unique opportunity to study the ecology and behaviour of rhino in an enclosed savannah ecosystem. This project will look specifically at the distribution of rhino and competing species, quantify the impact of the herbivores on the ecosystem and use mathematical models and Geographical Information Systems to predict the future condition of the ecosystem under various conditions. There are at least three possible scenarios. If nothing is done, herbivore populations will increase and damage to the environment will become severe. If the elephant population is halved in the Reserve, elephant damage will fall, but tree regeneration will still be hindered by giraffe browse. If the Reserve is expanded into the Ranch, browse pressures will fall and regeneration should commence, but the optimum ratio of cattle to herbivores will have to be established. The data already collected provides the base-line for what in effect are three possible experiments. The outcome will provide a model, which is relevant to all the other rhino reserves in Kenya.

This project will be part of the research programme of the Behavioural and Environmental Biology Research Group in the Department of Biological Sciences at Manchester Metropolitan University. This group, made up of ten full-time academic staff, a number of postdoctoral research associates and, approximately, twenty research students, has a successful history of conservation research in tropical environments in Africa, South-East Asia and South America. The overall strategy of the group is to examine the effect of habitat change on species' population biology and particularly to develop behavioural ecology concepts and techniques to answer applied conservation problems. The group will provide logistical back-up when necessary as well as the academic environment for project development.

2. RESEARCH OBJECTIVES

The primary objective of the project is to predict what will happen to the ecology of this enclosed reserve and cattle ranch as populations change. Using these predictions, scientifically based management decisions on optimum stocking levels can be made, with the overall aim of maximising black rhino breeding potential. A key task is to determine the ecological carrying capacity of the reserve and ranch for black rhino.

Normally ecosystems are complex, so predictive models are difficult to develop, but at Sweetwaters there is a relatively simple ecosystem. There are open plains, a well-defined riverine environment and large areas of savannah consisting of two dominant species, *Acacia drepanolobium*, the whistling thorn tree and *Euclea divinorum*, a dense shrub or small tree. More than 70% of the trees sampled to date belong to these two species. We know already that more than 75% of the diet of rhino and giraffe is thorn tree browse, and that elephants damage both species (Edwards 1998). A mathematical model has already been developed that predicts how different levels of browse intensity and damage (Birkett in press) will affect *Acacia* tree growth. The next step is to develop a model for grass growth and use and link it to the tree model. Elephant damage has been shown to increase under drought conditions and it is believed that this is primarily due to elephants switching diet from grass to trees when the grass biomass falls to a critical level.

To meet the primary objective we need to carry out the following:

- Collect basic map and vegetation data. The GIS (Geographical Information System) map of the Reserve has been largely completed but collection of Ranch data is only partially complete.

- Determine the home ranges of individual rhino in the Reserve and in the Ranch, if expansion takes place. Compare these ranges with those measured previously (Tatman 2000). How do rhino ranges change if elephant numbers are halved? How would rhinos adjust their home ranges if they could expand into the Ranch? How would their foraging be affected by these changes? Foraging studies have been carried out already at Sweetwaters (Edwards 1998), but it is known that rhino have a very varied diet (Oloo *et al.* 1994) and more data are required.

- Measure (a) the rate of damage to different age classes of trees by elephant and rhino and (b) the effect of giraffe browsing on tree growth through these age classes. Then run the mathematical model in order to predict how the number of *Acacia* trees per hectare would change with differing levels of elephant, rhino and giraffe impacts. Do this for the Reserve and the Ranch.

- Measure the green and brown grass biomass at selected points throughout the Reserve and Ranch and then correlate biomass quantity with rainfall and herbivore grazing intensity. Carry out game counts along transects to estimate the number of herbivores present.

- Continue to observe the semi-wild rhino Morani to see how his foraging behaviour changes following his move to a new compound. Volunteers had already collected behavioural data that had shown that his diet was being restricted. The Reserve management agreed to move him to a new area early in 2002.

3. METHODS

1. Vegetation sampling will be carried out at precise GPS locations 0.5km apart. The map for the Reserve is largely complete but data collection for the Ranch has only just commenced. At each location a specific set of parameters (height, diameter, shape, etc.) will be measured for the ten nearest trees or shrubs (of any species). From these data, density maps can be calculated for any one of up to 15 species. Initially the density (trees/ha) of *Acacia drepanolobium* and *Euclea divinorum* will be calculated for each point and input to a computer-based Geographical Information System called IDRISI. Two maps will then be created - of *Acacia* and *Euclea* density - by using the module INTERPOL which calculates the value of every pixel, based on an average of the six nearest points weighted by $(\text{distance})^2$. The two density maps will be combined and the resultant image reclassified to show five different vegetation types. These will range from pure *Acacia*, through mixed habitats, to pure *Euclea*. Open plains and riverine areas will be overlaid using GPS readings collected by walking the plains or river to produce the final vegetation map. This map has been created for the Reserve but needs 'ground truthing' to validate its accuracy. In addition we can create density maps of all 15 species as well as maps of height specific browse availability, e.g. What browse is available to rhinos in different parts of the Reserve?

2. Individual rhino will be identified by ear cuts and horn shape. These details are held in a rhino ID Log at the Research Centre, and the armed trackers who will accompany volunteer teams are able to recognise individual rhino within seconds of first sighting. A GPS will be carried by each volunteer team and precise locations noted. GPS co-ordinates for each rhino sighting will be input to the Windows-based computer programme Excel, processed and transferred to CALHOME - a programme that calculates home ranges based, for example, on 90% minimum convex polygons. These polygons will then be imported to IDRISI and overlaid onto the vegetation map created in 1 above. IDRISI can then be used to produce information about specific home ranges - for example what percentage of each habitat type lies within each polygon. IDRISI can also be used to produce maps of distances from rivers, roads, human habitation, etc. and in each case the polygons overlaid and interrogated. Multivariate statistical analysis can then be carried out to determine differences in needs of mature males, mature females with calves, and immatures.

3. The foraging behaviour of the 'semi-wild' rhino Morani will continue to be observed in the enclosure where he is protected. This rhino had been enclosed on the same 50 ha site since 1990 but has recently moved onto an adjacent site. The data collected for the last three years has shown that Morani's compound is overbrowsed and his diet restricted. Following his move the difference in diet will be measured. This should provide data on rhino diet preferences.

4. Giraffe restrict the growth rate of trees (Pellew 1983) and rhino and elephant damage them. Giraffe, elephant and rhino browse can be differentiated easily. The height and diameter of 100 *Acacia drepanolobium* trees have been measured in two controlled areas where no giraffe, rhino or elephant can enter. The same measurements have been taken for more than 1500 trees on 30 plots in the Reserve and 400 trees on eight Plots in the Ranch. All these trees will be re-measured every six months so that growth rates and damage rates can be calculated and used in a tree growth model. Daily rainfall records have been kept since 1995 and one plot, damaged by fire in 1998 is being carefully monitored.

5. The tree growth model has been written in Excel, a Windows-based computer package that allows data to be input easily for different browse conditions. Tree damage by elephants has been the subject of study for a number of years. (Barnes 1983, Croze 1974, Laws 1970). This model is based on an original proposal (Pellew 1983) that giraffe, elephant and fire could have a significant combined impact on woodlands. The model described in this paper was rewritten subsequently and used to make predictions about the Serengeti (Dublin 1990). It was developed further to study woodland dynamics in Botswana (Ben-Shahar 1996). The model assumes as a starting point the current tree height distribution, measured by random sampling by Volunteers on the 30 tree plots. They recorded the number of trees in each of the six height classes, plus saplings less than 0.25m. The model calculates the growth and survival each year of these saplings until they reach a height of 6m. At this point the number of trees surviving is compared with the original number and the percentage increase or decrease calculated.

6. Tree growth and survival is influenced by rainfall, giraffes, elephants, rhinos, fire and natural mortality (Ben-Shahar 1996). Rainfall has a very significant effect on growth. Giraffe browsing slows the rate of growth and hence increases the number of years that the tree takes to pass through each height class. Each year elephants (and rhinos at Sweetwaters) kill some trees and reverse the growth of others. Reversal takes place when the tree main stem is snapped and hence the tree reverts to a lower height class but does not die. Damage impact varies with tree height. The current growth rate and mortality factors for each age class will be obtained from the measurements described in section 4. The model will then be used to see how tree survival varies under different conditions. The impact of rainfall, giraffe, elephant, and rhino impact on tree growth and survival can be varied. For example, the situation where there is no giraffe browsing but high levels of elephant damage, can be compared with a case where there is no elephant damage but high levels of giraffe browse. The model also includes natural mortality and can take account of different fire conditions, although fire is not a significant factor at Sweetwaters.

7. Work carried out over the last three years has shown (Birkett 2001) that when annual rainfall is less than 500 mm, tree growth almost stops and damage increases significantly. Rhino damage increases linearly with decreased rainfall but elephant damage increases exponentially. Direct observation has revealed that in the recent drought conditions, elephants switched diet from grass to *Acacia drepanolobium*. In East African grassland systems, it has been shown (Sinclair 1975) there is a period of one to four months during the dry seasons, when green grass disappears and the protein available in the grass is insufficient for herbivores to maintain body weight. In these conditions they may switch diet and hence the length of this period may be related to the amount of tree damage. The graph below shows how grass biomass changes with the seasons at Sweetwaters. There are two rainy seasons - October to December and March to May. Hence there are two periods in the year when biomass may fall below a critical value. The total length of time that the biomass is below this critical level will be determined by (a) the rainfall and (b) the herbivore grazing intensity. The grazing intensity will be increased if cattle are run alongside game.

Total grass biomass will be measured using a canopy interference (pin-frame) method recommended by the KWS (McNaughton 1976). The pin-frame will be calibrated initially by clipping grass and measuring its dry weight. Three open plots will be selected in each of the 6 main habitats. Measurements will take place on the 18 plots 5 times per year by volunteers. Research staff will carry out sampling for the rest of the year. At each point, green and brown grass biomass (kg/m^2) will be sampled. The total area covered by each habitat can be obtained from the GIS map and hence the total green and brown biomass calculated and plotted on a monthly basis. Tree damage by elephants will be plotted against the length of time that the total green biomass drops below a fixed value. This value will be determined by measuring the protein content of the grass layer and taking the critical value as the point when the crude protein falls below 4%, the minimum required to maintain body weight (Sinclair 1975).

8. Temporary (1m x 1m) exclosures have been located in each of the 6 habitats. They will be moved every month, so that the stimulating effect of grazing on grass growth can be included (McNaughton 1979). Volunteers will measure biomass in these 6 exclosures five times per year and research staff will sample them for the rest of the year. The positive increments in biomass will measure the ungrazed Grass Production. The difference in biomass between the temporary exclosure and the open grazed areas (measured in 7) will be used to estimate grazing intensity (McNaughton 1979).

9. Volunteers will also carry out game counts along pre-defined transects. These data will be used to calculate herbivore densities (using the DISTANCE computer programme) for each habitat. Grazing intensity (measured in section 8) will be plotted against herbivore density. For any combination of rainfall and herbivore densities it should then be possible to predict the biomass graph and hence the time that the green biomass is below the critical value. The graph plotted in 7 will then show the percentage tree damage by elephants and the tree model will predict the combined effect of elephants, giraffes and rhinos on the *Acacia* trees.

10. There are many examples of habitat change resulting from the impact of elephant alone (Laws 1970) but this work will look at the impact of several animal species on an enclosed ecosystem. By combining the output from the tree and grass models with GIS generated vegetation maps it will provide insights into the complex interactions between grazers and browsers. The percentage reduction or increase in *Acacia* density, calculated by the model, will be applied to the IDRISI vegetation map to predict the change in area covered by each vegetation class. The effect on rhino breeding potential will then be assessed. For example a 60% reduction in acacia density across the whole reserve may lead to reduced areas of pure *Acacia* and increased areas of pure *Euclea* but, more significantly, would reduce the mixed areas favoured by rhino with calves (Tatman, 2000).

4. APPLICATION OF RESULTS

a) In the first year of the Earthwatch project (Birkett 1999) height-specific browse impact data were recorded for 1075 trees of the dominant species, the whistling thorn, *Acacia drepanolobium*. Rhinos and elephants browsed 18% of these trees in one year, including 5% that were killed or removed. The remaining trees were subjected to high levels of giraffe browse and low rainfall and grew by only 7.5 cm in a year. A mathematical model was constructed that predicted how the number of trees/ha would change with time under different browsing impacts. The model compared recruitment rate with removal rate and estimated that the number of trees/ha would fall by 2% per year under the browsing impact of black rhino (0.27 per km^2), elephant (1.1 per km^2) and giraffe (1.9 per km^2). In seven years, if the rhino and elephant populations continued to increase at the current rates, tree density would be falling by 5% per year and nearly one-third of the trees would have been removed. These results were discussed with the Reserve managers. It was agreed that these conditions were unsustainable and various options were then considered. These included halving the elephant or giraffe populations or expanding the Reserve into the Ranch.

b) The second year (Birkett 2000) was characterised by drought in Kenya. Rainfall at Sweetwaters was the lowest on record and this affected vegetation growth and hence the distribution and browse patterns of the herbivores. Grass and tree growth virtually stopped. Elephants switched their diet from grass to trees and moved into areas normally occupied by rhinos. The overall rate at which trees were being removed increased from 2% to 5.8% per year. Some elephants, mainly adult females, died but black rhinos and giraffes, being browsers, are surviving well.

c) In the third year (Birkett 2001), the mean height of trees in the reserve actually decreased. In the 5 months since they were last measured more than 13% of the trees were damaged, including 5.4% that had been killed or removed. The drought killed some trees, but the most significant effect was that damage by elephants increased significantly as they supplemented their grass diet by browsing increasingly on *Acacia drepanolobium*, the whistling thorn tree. In July 2001 the Kenya Wildlife Service translocated half the elephants to another game park. A paper is now in preparation that summarises the data collected up to the end of 2001. In the 3 years of the study there was a reduction of twenty per cent in the sample population of *Acacia drepanolobium* trees. The trees were monitored from 1998 to 2001 when rainfall was significantly below average for the region. Fourteen per cent of the trees were killed and five per cent were reduced to the seedling class. Recruitment from the seedling class was only 0.2% and there was no increase in the number of mature trees taller than six metres. Elephant killed nearly 6% of the trees, drought 5% and rhino 3%. Elephant and rhino damaged a further 14%. Tree height distribution was significantly changed. Mean growth of the undamaged trees and seedlings was only 14cm in the Reserve in three years, compared with 46 cm in a control area free from giraffe browse.

d) In September 2000 I was asked to make a presentation to the Kenya Rhino Stakeholders Workshop held at the Kenya Wildlife Service Training Institute at Naivasha. The Workshop was convened by the KWS to draw up a new 5-year Conservation Strategy and Management Plan for Black Rhino in Kenya, and brought together the managers of all the Kenyan sanctuaries, researchers from Kenya, South Africa and Zimbabwe and key members of the KWS and NGOs that support rhino conservation. In the presentation I described the research being carried out at the Sweetwaters Rhino Reserve and used the data collected by Earthwatch Volunteers in 1999 and 2000 to illustrate the problems of managing a black rhino sanctuary. The presentation was well received by the experts attending and the monitoring techniques used are to become the model to be followed on other black rhino reserves in Kenya. The use of hand-held computers to collect field data was of considerable interest to other researchers and managers.

e) Sweetwaters black rhino sanctuary is located within the Ol Pejeta cattle ranch. There is a trend in the Laikipia region of Kenya for the owners of large ranches to move from cattle ranching to a mixed regime of ranching and tourism. Ol Pejeta may well follow this trend and expand the black rhino sanctuary into the cattle ranch. This would mean running game and cattle on the same land and would need careful management to avoid damage to the habitat. This project will give management the necessary information to optimise stocking rates for cattle, giraffe and elephant whilst maximising rhino breeding rates. Similar problems will have to be solved as other ranches follow the same strategy and this data will be useful throughout the Laikipia region. In March 2001 I paid a visit to another black rhino reserve, Lewa Downs, to advise them on setting up a similar ecological monitoring system to that at Sweetwaters. A larger project, comparing six Kenyan black rhino reserves, is under discussion. This would involve Chester Zoo in England, the KWS and the Manchester Metropolitan University and would use the monitoring techniques developed by this project.

f) The database developed as part of this project will be an invaluable aid to students carrying out research on all aspects of the ecological system.

g) The results will be presented to refereed journals, as local reports to appropriate organisations and as lectures at scientific meetings

Presentations and Papers to date:

Birkett, A. (2000). The impact of giraffe, rhino and elephant on the habitat of Sweetwaters Black Rhino Reserve. Paper presented at Rhino Mayday, Royal Geographical Society, London.

Birkett A, (2000). The impact of giraffe, rhino and elephant on the habitat of Sweetwaters Black Rhino Reserve. Paper presented to the Kenya Rhino Stakeholders Workshop held at the Kenya Wildlife Service Training Institute at Naivasha, Kenya.

Birkett A, (in press). The impact of giraffe, rhino and elephant on the habitat of a Black Rhino Sanctuary in Kenya. African Journal of Ecology.

Birkett A, (2001). The results so far and the use of volunteers on Kenya's Black Rhinos project. Paper presented to the Earthwatch Open Day, Oxford, England.

Birkett A, (2002, in preparation). A 3-year Study on the Impact of Elephant, Rhino, Giraffe and Low Rainfall on the Habitat of a Black Rhino Reserve in Kenya.

5. FIELD TRAINING

Volunteers will receive a one-hour presentation on the background and aims of the project on the evening they arrive. On the following day all volunteers will receive one day training at the Research Centre:

a) In the morning they will be taken through all the activities that they will carry out. Then they will be instructed on how to use a Compass, a Global Positioning System, a hand held computer (the PalmPilot), a telescopic tree height measuring device, a laser rangefinder and a pin-frame grass biomass measuring device. They will then be briefed on how to behave safely in the bush. They will be advised on appropriate action to take in the presence of dangerous species such as lion, buffalo, rhino or elephant.

b) In the afternoon, they will go out in the bush with an armed tracker from the Research Centre. They will be shown how to move quietly through the bush, how to navigate to a tree plot, find individual trees, measure the trees using the tree height measuring device and record the data on the hand-held computer.

Subsequently they will be instructed on how to download the data to a laptop computer. They will also be trained to recognize the 15 tree/shrub species that make up the main vegetation types of the Reserve and Ranch. Leaf and flower samples are kept at the Centre and volunteers will then be taken out with a tracker and shown the most common species. They will also go into the bush to learn how to recognize birds, and tracks and signs of animals.

6. VOLUNTEER ASSIGNMENTS

1. Vegetation sampling/Validation

A team of two volunteers will go out with an armed guard to an agreed UTM co-ordinate using the GPS to navigate to the point. They will go out either on foot from the Research Centre or be driven to a suitable drop-off point before walking to the point. The volunteers will select the nearest tree/shrub to the specified co-ordinate and mark out a 30m-diameter circle around it.

After recording specific details of the ground within the circle, they will carry out a series of measurements on the central tree or shrub, recording the data on a hand held PalmPilot computer and then repeat the measurements on the nine nearest tree/shrubs to it. This operation will take approximately one hour. They will then walk to another agreed co-ordinate and repeat the process. Finally they will walk back to the Research Centre. The team will complete two sample plots in three hours. After lunch they will download the data into an Excel spreadsheet from the PalmPilot.

Some volunteers will carry out an alternative activity. A team of two volunteers will walk a specified transect (8 to 10 km) and stop every 0.5 km to record the distance and species of the ten nearest trees within 30m. This data will be downloaded in the afternoon and compared with the Vegetation Map to see how valid it is.

2. Rhino identification

A team of two volunteers will go out with a three-person armed patrol at dawn. Three patrols go out every day looking for rhino. Each patrol is responsible for finding rhino in one third of the Reserve. The probability of finding a rhino is about 30%. The volunteers will record the GPS locations of all sightings of rhino and signs, such as bedding sites. Where there is positive ID, either by sighting or by prints, the name of the rhino and its location will be recorded. The patrols will return to the Research Centre by midday. In the afternoon the volunteers will enter the GPS data into a spreadsheet for use by CALHOME to calculate rhino home ranges.

3. Rhino behaviour and feeding

A team of two volunteers will go into a 30 ha (70 acre) protected area which houses the black rhino called Morani. This fully-grown male black rhino was originally injured in a fight with another rhino and in 1989 was brought from the Nairobi orphanage to Sweetwaters, where he is protected from other rhino by the enclosure fence and from poachers by a 24-hour guard. Morani can be approached in safety and can be watched closely when feeding on acacia and in the herb layer. Volunteers will continuously record on the hand-held computer the rhino's activities and the plants that he eats. This will give valuable insights into how a rhino feeds and show volunteers what to look for when examining vegetation for rhino damage. Based on data collected in the first two years of the project, we have convinced the managers that Morani's diet is currently restricted and that they need to expand his compound and let some areas of it regenerate. We need to collect data when he moves into the new area to see how his diet changes.

4. Tree growth and damage measurement on plots

A team of two volunteers will go to a specific plot (GPS point) where between 50 and 60 *Acacia drepanolobium* trees have been permanently marked, and re-measure their heights, diameters and damage condition. These trees have been measured regularly since 1998. There are 40 plots, two in a Control area (the Chimpanzee Sanctuary where no elephant, giraffe or rhino have access) 30 in the Reserve and eight in the Ranch. Each plot will take approximately three hours to measure and one hour to reach and return from. In the afternoon volunteers will download the data into an Excel spreadsheet, and by comparing the previous data with the collected data will calculate the annual growth rate and percentage damage for each height class.

5. Grass biomass measurements

A team of two volunteers will go to a specific sample point and carry out grass biomass measurements using a pin frame canopy contact device. The frame has ten metal pins that extend into the grass layer and volunteers record the number of green and brown grass hits per pin. The readings are taken in four directions and the mean number of hits calculated from the 40 readings for each type of biomass. The biomass (in kg/m^2) can then be calculated from a formula. Each sample point will take half an hour. There are six sample points in each of six habitats. Each volunteer pair will measure biomass at four to six points in one habitat. Data will be recorded on a PalmPilot and then down loaded into an Excel spreadsheet in the afternoon.

6. Game Counts by 8km transects

A team of two volunteers will walk a specified transect (8 to 10 km) and record the number of animals seen (specified by age and sex) within 1000m of either side of the transect line. Volunteers will record the distance by laser range finder and the angle to each sighting, so that game densities can be calculated using the Distance computer programme. The transect line will be specified as a series of Waypoints in the GPS and location recordings will be taken every 0.5 kilometres. The transect will take three hours. In the afternoon the volunteers will input the data into a spreadsheet for processing. The data will be sorted by habitat, using the recorded GPS locations and the GIS habitat map. The Distance program will then be used to calculate densities for each habitat and the figures multiplied by the habitat areas to give total game count for each species.

7. PROJECT STAFF

There will be one project leader (Principal Investigator) and one research assistant organising the project on site. There will be a Research Centre manager, two cooks and three armed guards. There is an office and Reserve Administration Centre next to the Research Centre with clerical and management staff on hand.

PRINCIPAL INVESTIGATOR

Dr Alan Birkett; 64 yrs, Ph.D. in Behavioural Ecology, BSc in Chemical Engineering with wide experience as a project manager. Has spent the last eight field seasons at Sweetwaters and in South Africa. At Sweetwaters he has supervised a total of 19 MSc students and run the Earthwatch Project since 1999. Will be on site for the whole of the field season.

RESEARCH ASSISTANT

Linus N. Gatimu
Dept. of Wildlife Management
Moi University
P. O. Box 1125,
Eldoret, Kenya.

Linus is a lecturer at Moi University and has supervised many student field trips. He is preparing to do a Ph.D. on elephant damage and is intending to do his fieldwork at Sweetwaters. He has been Research Assistant for all the Earthwatch teams in 2001 and 2002.

FIELD LOGISTICS

8. Research Area

The Sweetwaters Rhino Reserve is located within the 46,000 ha Ol Pejeta ranch and covers an area of 9,000 ha. The ranch is located 260 km north of Nairobi near Nanyuki on the Laikipia plateau between Mt Kenya and the Aberdare Mountains at an altitude of 1800 m (on the equator at longitude 36°56′ E). The mean annual rainfall at Nanyuki is 720 mm with mean annual maximum temperature of 22°C/72°F and minimum of 10°C/50°F. Normally rainfall comes in two seasons - long rains from March to May, and short rains from October to December with the first more reliable than the second (min.17 mm Jan, max.122 mm April).

The Laikipia plateau is a lava plateau (comparable to the 'Decan traps' of India), used almost entirely for cattle and sheep ranching. The plateau averages 2000 m but rises to 2500 m on the Aberdare slopes and 2250 m on the slopes of Mt. Kenya. It is flat and rolls gently only where it is cut into by rivers such as the Ewaso Narok and Ewaso Ngiro, which flow down from the Aberdare Mountains. The latter flows North through the Reserve along a line 2 km from the Western boundary and provides water all the year round, but it is supplemented by five earth dams which have been constructed in catchment areas in the South and East. The Reserve has dimensions 12 km E-W by 9 km N-S and is served by two roads - a dry weather road to Nanyuki (24 km from the Research Station via the Rongai Gate) and a wet weather road to Nanyuki (31km via the Serat gate).

Game is abundant at Sweetwaters. In 1999 the herbivore count was: Burchell's Zebra 1000, Warthog 640, Impala 452, Giraffe 200, Grant's Gazelle 194 and Eland 38. Waterbuck 400, Thomson's Gazelle 150, Beisa Oryx 60, Buffalo 450, Jackson's Hartebeest 55, Bushbuck 50 and Reedbuck 15. In 2001 there were 28 Black Rhino, more than 120 Elephant, 30 to 40 Lion, 40 Black-Backed Jackal, 45 Spotted Hyaena, 20 Hippopotamus, 420 Baboon , several groups of Bushbabies, and unknown numbers of Aardvark, Serval cat, Cheetah, Leopard, Porcupine, Mongoose, Steinbock and Vervet Monkeys. Following the drought of 1999/2000 the number of waterbuck fell by 70%, and the number of warthog, oryx and eland by half. Rhino numbers increased to 32, elephant numbers have been reduced to less than 60 and giraffe to 130. After good rains in 2002 numbers of herbivores are increasing again.

There are 232 bird species listed on the Ol Pejeta Bird Checklist. Birds seen by the PI include: Ostrich, Jackson's Widowbird, Kori Bustard, Tawny, Long Crested and Crowned Eagles, Egyptian Vulture, Augur Buzzard, Pale Chanting Goshawk, Black-Shouldered Kite, Yellow Billed and Marabou Stork, Spoonbill, Hammerkop, Hadada and Sacred Ibis, Brown Parrot, Klaas Cuckoo, Abyssinian Scimitarbill, African Finfoot, Von der Decken's Hornbill, Crowned Crane, Little Bee Eater, Striped and Pied Kingfisher, d'Arnauds Barbet, Shrikes, Plovers, Starlings, Bronze and Hunter's Sunbirds, Weavers, Long Tailed Widowbird, and Pin Tailed Wydah.

9. TRAVEL PLANNING

Visa Information

Citizens of the U.S., U.K., Australia and Japan will require a visa for entry to Kenya. This visa may be obtained in the volunteer's home country or at the Nairobi airport for $50 US. Purchasing your visa before departure is highly recommended and may help you avoid long lines at the Nairobi airport. The most cost effective way to get a visa in the U.S. is to contact the Kenyan Embassy in Washington, D.C. at (202) 387-6101. If you are attempting to obtain a visa within 4 weeks of your expedition, a visa service is recommended. You may also download the visa application forms from the website at: http://www.kenyaembassy.com. Citizens of other countries should check with their travel agent or a visa agency for specific visa and entry requirements. A useful website for visa requirements is: http://www.embassyworld.com/Visa_Search/Visa_Search.html

Here are some Frequently Asked Questions about visas:

What kind of visa do I need?

Earthwatch volunteers who require a visa for entrance, will need a tourist visa. The Principal Investigator/researcher will have the research permit for the project.

How do I obtain a visa?

You can obtain a tourist visa by contacting the Embassy or Consulate of the country to which you are traveling. If you choose to obtain a tourist visa by directly contacting the country's embassy, please be sure to leave plenty of time, at least 6 weeks. If you have less than 6 weeks or wish to save yourself trouble, we strongly recommend using a visa agency, which can both expedite and simplify the process. The average cost of a visa is approximately $40--$60 U.S but varies country to country. A visa agency will charge an additional fee (depending on the amount of time it takes to process the application), which you can inquire about directly.

What information do I need to provide?

You will need to send your passport, an application form, 2 to 4 passport-size photos plus payment to the embassy or visa agency (if applicable) at least 6 weeks in advance of departure. Please be sure that your passport is valid for at least 6 months beyond your stay.

What do I write on the visa application form as the "purpose of my visit"?

The purpose of your visit is for vacation, holiday, tourism or travel. Foreign immigration officials do not always understand the concept of a "working vacation" or even "volunteering." Words such as "working/volunteering," "research" or a "scientific expedition" can raise questions concerning the country's foreign labor laws and/or prompt questions about official scientific research permits and credentials, etc. to which volunteers on their own will not be equipped to respond. All required research permits for the project are in place and have been approved by the proper authorities.

What do I write on the immigration form as the "purpose of my visit"?

The purpose of your visit is vacation, holiday, tourism or travel.

What should I write for the place where I will be residing?

List the address of the hotel or project accommodations where you will be staying. This is listed in the "Accommodation" and/or "Field Communications" sections of this Expedition Briefing.

Where can I find more information on visas?

Please see "Helpful Resources" below for several web site links related to the visa process.

Visa Agencies

IN THE UNITED STATES

Passport Visa express.com
1911 North Fort Myer Drive, Suite 503
Arlington, VA 22209
Tel: (888) 596-6028, (703) 351-0992
Fax: (703) 351-0995
E-mail: info@passportvisaexpress.com
Web site: http://www.passportvisaexpress.com/

Travisa
2122 P Street, NW
Washington, D.C. 20037
Tel: (800) 222-2589, (800) 421-5468
Fax: (202) 293-1112
E-mail: questions@travisa.com
Web site: http://www.travisa.com
Travisa has offices in New York, Chicago, San Francisco, and San Juan.

IN EUROPE

The Visaservice
Tel: +44 (0) 20 7833 2709
Fax: +44 (0) 20 7833 1857
Web site: http://www.visaservice.co.uk

Thames Consular Services Ltd
Tel +44 (0)20 8995 2492
Fax +44 (0)20 8742 1285
http://www.visapassport.com

Travel Agencies

The following agency is familiar with Earthwatch projects and can assist you in making travel arrangements and booking hotels:

FOR US VOLUNTEERS

Please call your Expedition Coordinator to inquire about recommended travel agents for your project.

IN EUROPE

Wexas International
London, UK
Tel: +44 (0) 20 7581 8761
Fax: +44 (0) 20 7581 7679
E-mail: southern@wexas.com
Quote code: EWE01/02

STA Travel
Oxford, UK
Tel: +44 (0) 1865 792800
Fax: +44 (0) 1865 792911
E-mail: manager.oxford@statravel.co.uk
Quote code: EWE01/02

- Third World Traveler - offers many links for useful travel information http://www.thirdworldtraveler.com/Travel/Travel_Links.html

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