FIELD REPORT

Project title: Saving Sweetwater's Rhinos

(*Saving Olpejeta black rhinos: Olpejeta's black rhino habitat monitoring programme*)
Date Field Report completed: 15th January, 2009

Period covered by this report: January 2008 to January 2009

Completed by Geoffrey M. Wahungu

Dear all

As I write this end of year report for the period ending October 2008, I cannot but reflect with pride the fact that 2008 was a trying year for the project but that the volunteers achieved phenomenal results. First, Kenya experienced post-election violence in the early period of the year that resulted in cancelling several teams. All of the work reported here was achieved by just three teams. In 2008, the three groups of volunteers sampled 4326 individual *Acacia drepanolobium* trees, 3460 seedlings, walked 526 kilometres counting game and determining elephant dung distribution, and recorded 218 individual sightings of black rhino. The remaining quarter of the samples were collected by the research team consisting of the PI and two field assistants. All the objectives for 2008 were fulfilled and this report is a summary of the analysed data collected by volunteers.

The data you collected, you will be pleased to learn, produced very interesting results as follows: within this period, there was an unprecedented doubling of elephant damage to Acacia trees as more elephants moved into the conservancy, away from the drought in the north through the opened corridors. The effect of rhino damage on Acacia reduced within the reporting period even as rhino numbers in the reserve increased. Rhinos continued to occupy areas of the conservancy that were least used by elephants - indicating habitat segregation. Giraffe damage to Acacia reduced,and in 2008 we recorded for the first time that trees are flowering in the old reserve section with the number of flowering trees increasing five-fold. The effect of fire on Acacia was such that damage was more severe on the adult trees and also while seedling densities increased after fires, seedling recruitment into trees was hampered by a resultant increase in the densities and diversities of seedling predators.

You are aware that the reserve was expanded in 2005. We analysed data to see the effect of the expansion on *A. drepanolobium*. Results show that the payoff for the expansion of the conservancy is being realised since last year, with Acacias flowering in substantial numbers for the first time since this monitoring programme began in 1999. However, the creation of migration corridors linking the conservancy and the northen areas has resulted in seasonal immigration of elephants that has resulted in hightened damage to Acacias.

We also determined that the controlled burning programme at Olpejeta is detrimental to the health of the main rhino browse, *Acacia drepanolobium* as it kills adult trees and decelerates seedling recruitment. In December 2008, we developed a zonation map showing seven areas that will need management intervention through exclosures to stem the damage to *Acacia drepanolobium* and allow the habitat to recover. Justification for this was based on our nine years of monitoring work, including the data you collected and by determination of accepatable damage thresholds. In January 2008, we presented our findings on effects of fire and elephant damage to Olpejeta Conservancy management. Consequently the controlled burning programme was put on hold and a new taskforce where we are represented was formed to be in charge of the programme. We have also been incorporated into the Olpejeta Conservancy Research Advisory Committee.

Sadly for all of you, Morani, the resident black rhino that you studied and came to love passed on in November after the close of the field season. In his exclosure is Marx, the subabult white rhino that you may also remember. We will not therefore be able to study the foraging and feeding behaviour of a black rhino; at least not in the near future. Once again, myself and the entire crew of Olpejeta, James, Vincent, Lucy, Paul, Catherine, Dickson, Anthony and Daniel thank you for your contribution and ask you to keep in touch and visit us again soon. Thanks for your contribution to saving the black rhino and its habitat.

Geoffrey Wahungu (PhD)

Reporting on research objectives

Introduction

Within the last three years, Olpejeta Conservancy (OPC, formerly Sweet waters Game Reserve) has expanded in size from 9000ha Sweet Waters Game Reserve to a 71900 acre Conservancy. The black rhino population has been increased from 51 to 78 by bringing in 27 more rhinos. The northern reach of the conservancy was also opened to the outside through the creation of three migration corridors. For the last nine years Earthwatch habitat monitoring has provided baseline data on the effect of confinement of Black Rhinos, elephants and giraffe on the *Acacia drepanolobuim* woodlands. In the last year we have expanded our objectives in accordance with management needs by incorporating several new objectives. These include: monitoring of key browse plant species (*A. drepanolobium* and now *A. xanthophloea*), examining the effect of prescribed burning on woody vegetation, browse availability for black rhino and examining the interaction of rhinos and elephants at habitat levels. Most importantly, we analysed data to determine whether expansion of the reserve has reduced the pressure on *Acacia drepanolobium*.

Between 2007 and 2008, Volunteers sampled 6338 individual *Acacia drepanolobium* trees, 5433 seedlings, walked 720 kilometres counting game and determining elephant dung distribution, and recorded 218 individual sightings of black rhino.

Results

Within the period of monitoring there was an unprecedented doubling of elephant damage to Acacia trees as more elephants moved into the conservancy through the opened corridors and away from the drought in the north. Conversly the effect of rhino damage on Acacia reduced within the reporting period, even as rhino numbers in the reserve increased. Rhinos continued to occupy areas of the conservancy that were least used by elephants indicating habitat segregation. Giraffe damage to Acacia reduced, and we recorded that trees are flowering in the old reserve section for the first time since the programme began in 1999.

The effect of fire on Acacia was such that damage to the adult trees was severe. While seedling densities increased after fires, seedling recruitment into trees was hampered by a resultant increase in the densities and diversities of seedling predators.

Conclusions/Key findings

Our results indicate that payoff for the expansion of the conservancy is being realised, with Acacias flowering in substantial numbers for the first time since 1999. However, the creation of migration corridors linking the conservancy and the northen areas has resulted in seasonal immigration of elephants that has led to hightened damage to Acacias. We also determined that the controlled burning programme at Olpejeta is detrimental to the health of the main rhino browse, *Acacia drepanolobium* as it kills adult trees and reduces seedling recruitment.

Management applications

In November 2008, we delivered a vegetation map of the entire conservancy to Olpejeta conservancy.. This was the result of work carried out since 2005. This map is now being used for management and is available to other researchers in Olpejeta.

In December 2008, we developed a zonation map showing seven areas that will need management intervention, in the form of exclosures to stem the damage to *A. drepanolobium* and allow the habitat to recover. Justification for this was based on nine years of monitoring work and the determination of accepatable damage thresholds.

In January 2008, we presented our findings on the effects of fire and elephant damage to Olpejeta Conservancy management. Consequently, the controlled burning programme was put on hold and a new taskforce, including our input, has been formed to manage the implementation of the programme. We have also been incorporated into the Olpejeta Conservancy Research Advisory Committee.

Objective 1: Determine browse availability for black rhino in the reserve

Between 1999 and 2007 we have monitored one key rhino browse species: *Acacia drepanolobium*. In the new proposal, we plan to monitor all black rhino food plants by assessing browse availability in the whole conservancy. This has become necessary as a result of an increased number of rhinos and as a way of assisting in the management of the conservancy. This will allow the amount of food available to the black rhino and thus the carrying capacity to be determined. This new objective began in January 2009.

The 2008 teams did not collect data other than on *A. Drepanolobium* but in January 2009 three plots (168 trees and seedlings) of *Acacia xanthophloea* were established and labelled for long-term monitoring by Earthwatch volunteers. There are no results for this objective yet as the monitoring for the other rhino food species will be carried out by July-October teams.

Objective 2:
Continue to measure:
(a) The rate of damage to different age classes of trees by elephants and rhinos; and

(b) The effect of giraffe browsing on tree growth and recruitment

(c)Examine seedling recruitment and dynamics of *Acacia drepanolobium* Woodlands.

Within the last year, elephants' damage to trees doubled, a phenomenon that puzzled the researchers as well as the conservancy management. Damage increased from 5.6 % to 11. 7 % (Figure 1). However, this damage involves trees that lost significant height, (a mean of 0.7 ± 0.56 m). Elephant damage did not necessarily result in tree death but most trees were reversed into lower height classes. We also determined that elephant damage thresholds are dependent on rainfall - as elephants can change diet based on food availability. We attributed increased damage to a seasonal influx of elephants into the conservancy in the dry season that were escaping from the more arid lands to the north. We are monitoring elephant movement data within this period.

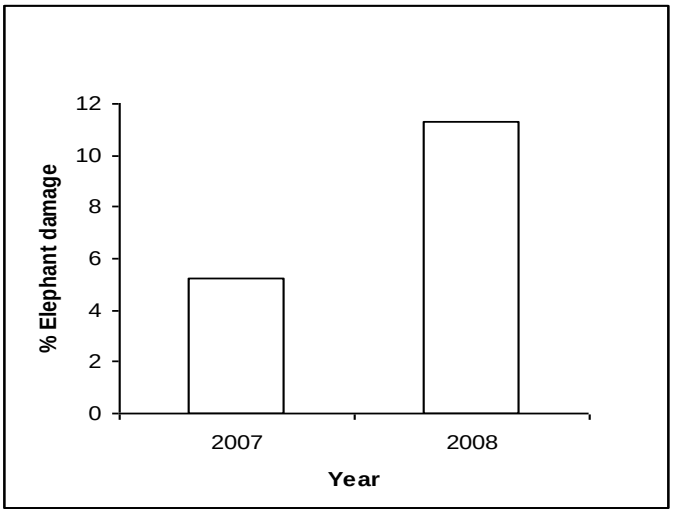


Figure 1: Elephant damage to trees between 2007 and 2008

The opening up of the fence separating the reserve and ranch to form the conservancy seems to be giving good results for *A. drepanolobium* performance, especially with regard to giraffe browsing. Giraffes mainly affect flowering and fruiting by eating terminal shoots. Data comparing the number of *Acacia drepanolobium* that were flowering annually between 2003 (Year 1) and 2008 (Year 6; Figure 2) indicate that the number of trees browsed reduced drastically: from around 500 before the fence was put down in 2005 to about 240 after, and was steadily low to 2008. Consequentlty, the trees seemed to react to reduced browsing by increasing the number of individual trees flowering annually. However, it appeared the number of trees fruiting increased three-fold from 3 to 16% between 2007 and 2008.

Reduced giraffe browsing resulted from giraffe range expansion after the creation of the conservancy. The resultant increase in fruiting episodes will result in increased fruiting and consequently to higher chances for increased seedbank and enhanced seedling recruitment.

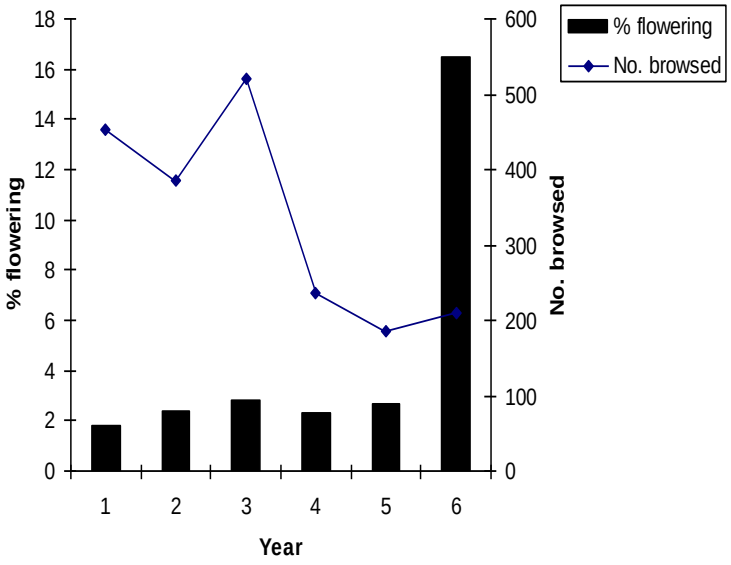


Figure 2: The relationship between the annual number of trees browsed by giraffe and the number of trees in flower, between 2003 (Yr 1) and 2008 (Yr 6)

The effect of rhino on the Acacias was lower than the previous reporting period even with an increase in the number of rhinos from 51 to 78. Rhino damage affected maninly seedlings under 0.8m, with 45% recording damage. 10% of seedlings above 1 m were reversed to below 0.5 m as a result of rhino browsing. No mortalities were however recorded due to rhino browsing.

Objective 3: Examine the effect of controlled burning on *Acacia drepanolobium*

In 2008, we were able to liaise with the research and monitoring division in order to get a burning schedule and history since 2003. We have determined the effect of fire on *Acacia drepanolobium* in the burnt plots and are therefore able to determine the effect fire has on Acacia survival and recruitment. We shall continue to determine the effect that burning has as a management tool.

Fire

In 2008, we determined the effect of fire (controlled burns) between 2004 and 2007 on all *Acacia drepanolobuim* mortality for those plots that fall within the burnt areas. As a result, 11 plots were analysed for fire damage. We have analysed the effect of fire on eight plots (5, 12, 14, 21, 23, 24, 29 and 30), containing 528-tagged trees. We compared mean growth rates between 2000 and when the fire happened and from the fire incidence to 2007. We controlled for the mortality by elephants and rhinos but not for drought as fire was an additive mortality to drought.

Seedlings

Fire was a significant form of mortality for adult tress whereas it does not significantly affect seedling mortality (ANOVA, D.f = 1; $P < 0.05$ – Figure 3). Whereas fire kills adult trees, high densities of seedlings were found in burnt areas. However, these seedlings were all cropped to ground level by herbivores. Figure 3 below shows seedling dynamics of plot 5 that was burned in 2005. Burning seems to result in heightened resprouting and appearance of many seedlings (Figure 3). However, burning opened up and exposed seedlings to predation as burn sites are attractive to grazers. In all the eight burnt plots, mean heights significantly reduced after burning from a mean of 27.33 cm ± 15.12 to 11. 38 cm ± 12.45 ($\chi^2 = 6.73$; D.f = 1; P = 0.009; Figure 4).

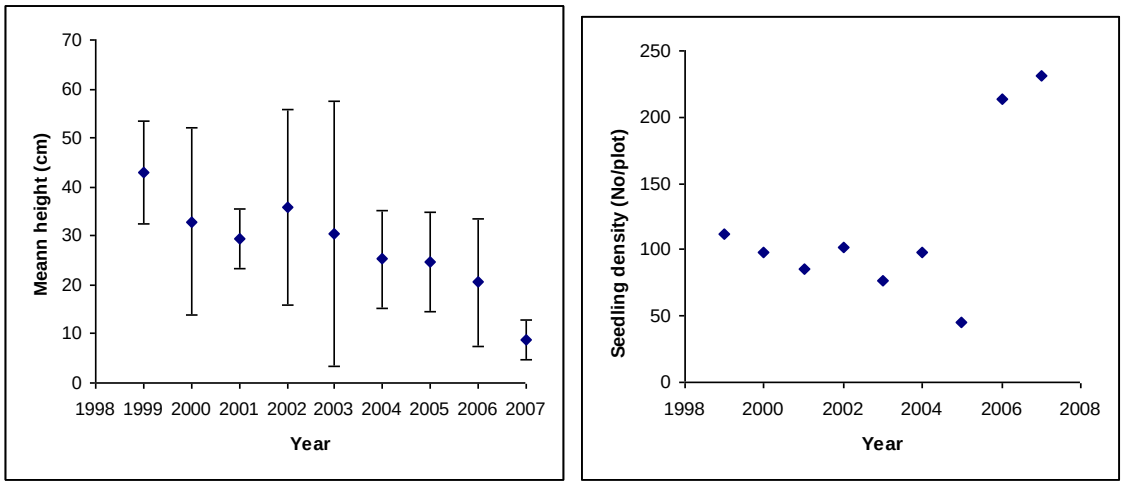


Figure 3: Trend in mean heights and in seedling density between 1999 and 2007 for plot 5 burnt in 2005

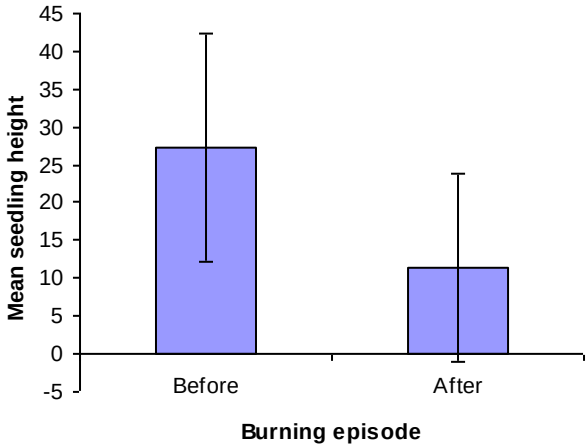


Figure 4: Changes in mean heights of seedlings before and after fire in eight plots (N= 1218 seedlings).
Un-burnt plots seedlings (N= 819) did not show significant changes in heights

For another eight selected un-burnt plots in the series (6, 11, 15, 20, 25, 26, 27 and 31) height did not show any significant change before and after randomly selected years between 2003 and 2006 (25.64 cm ± 12.17 to 26. 31 cm ± 10.16) The results are shown in Figure 5.

The results show that although burning seems to favour seedlings, through sprouting and germination, burnt areas are not capable of resulting in seedling recruitment due to heavy seedling predation and resultant decreases in heights (Figure 4a). For example, in plot 5 mean heights significantly reduced (χ^2 = 4.42; D.f = 1; P = 0.036) by about half from 32.77 cm ± 13.22 to 17. 96 cm ± 9.12 after burning, while for plot seven (no burning), heights and densities did not show significant difference (Figure 5).

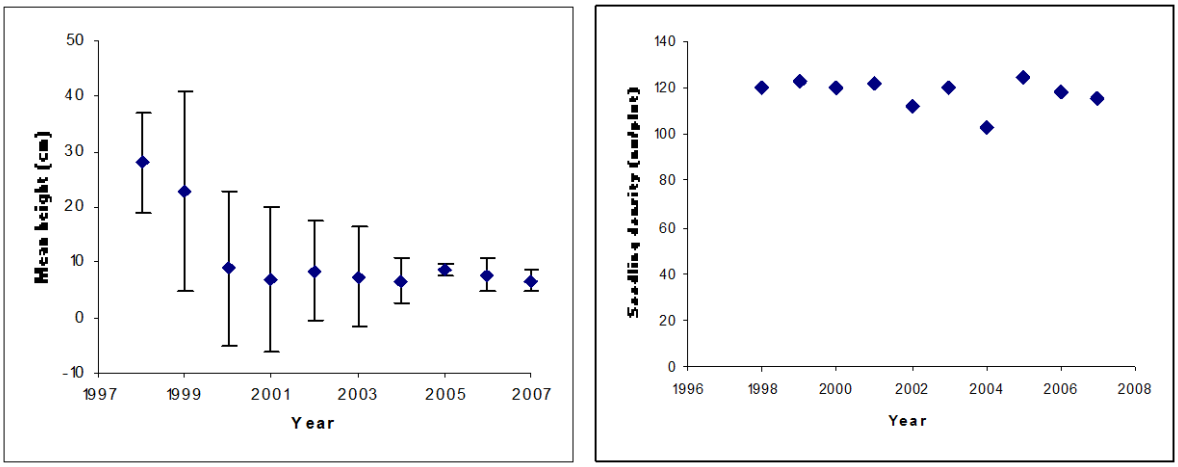


Figure 5: Trend in mean heights and in seedling density between 1998 and 2007 for plot 7 that has not experienced burning

Trees

There was a significant effect between mean growth rates before and after fire (F= 245.24; Df = 1; P= 0.0001). Mean growth rates before fire were significantly higher (2.86 ± 7.44) compared to after fire (mean = -5.23 ± 10.22). Furthermore, 45% of the trees that were killed by fire were reported to be sprouting at the bottom, even though highly significant reduction in height resulted (paired sample t-tests on trees before and after; P < 0.05). Fire therefore reverses growth rather than entirely killing the trees.

The following figure (Figure 6) shows comparisons in mean growths between 2000 and the time of burning and between the times of burning to 2007 for the eight plots. In all cases, fire affected growth and resulted in reduction in mean heights; in some instances (Height classes 1, 2, 4 and 5 meters), where significant mortalities resulted, mean growths are negative. Individual burnt plots showed the same trend over the years as shown in plots 5 and 12 below in Figure 7.

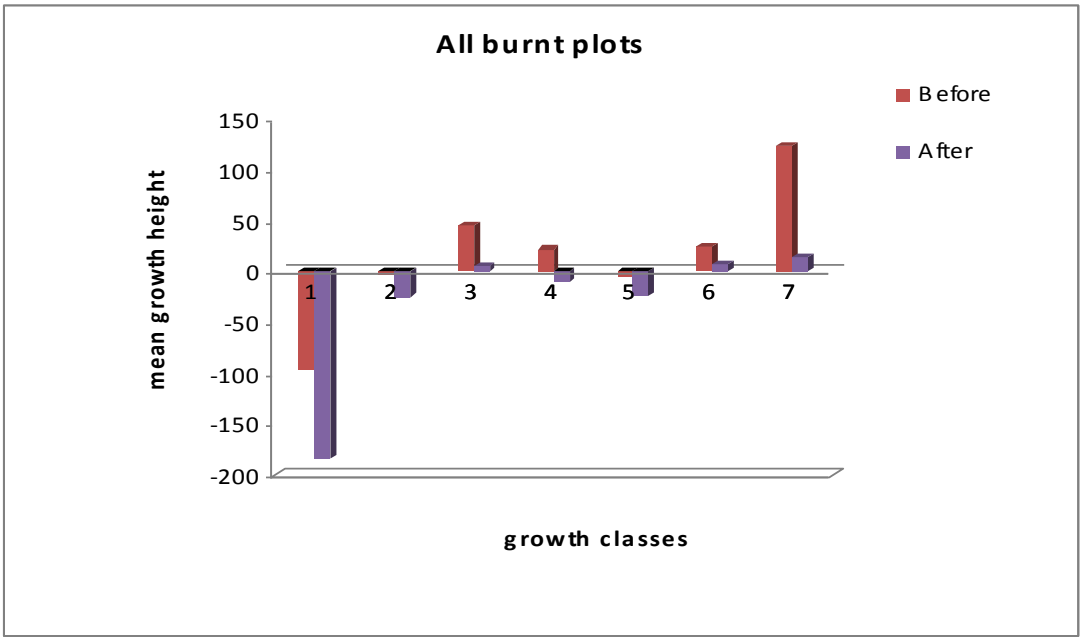


Figure 6: Effect of fire on growth of *Acacia drepanolobium* trees. In terms of reduction in height, old trees (> 7m) and seedling class (< 1 m) are most affected.

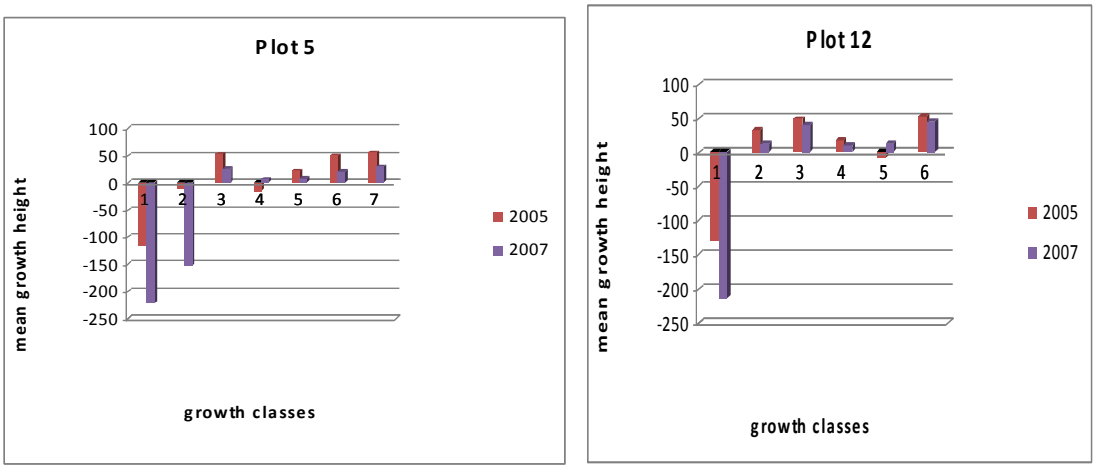


Figure 7: Effect of fire on growth of *Acacia drepanolobium* trees is selected plots.

Acacia ant interactions

We monitored burnt plots that had been colonized by crematogastor ants before the fire episode to determine the effect of fire on crematogastor ants. The results are being analysed as a master's thesis. However, preliminary results show that the plots had no ants at all in the year proceeding the burn. However, all plots have been re-colonised by ants within 3 years of burning. Trees that were not affected by fire but from which ants migrated as a result of fire may be without effective anti-predator deterrent for the period between the fire and when the ants recolonise.

Management action for *Acacia drepanolobium*

A. drepanolobium damage by elephant, fire, and drought, the three most important factors causing mortality, has been monitored for nine years between 1998 and 2008. At the end of 2008, we examined our data on damage across the old reserve and together with Olpejeta management set up acceptable damage thresholds of 10%. All plots falling in areas experiencing damage above this threshold were targeted for exclusion to protect the Acacias. Consequenlty, seven different exclusion zones were established (Figure 8) where electric fences will be erected to allow the habitat to recover. These zones have been earmarked for exclusion between 2009 and 2010.

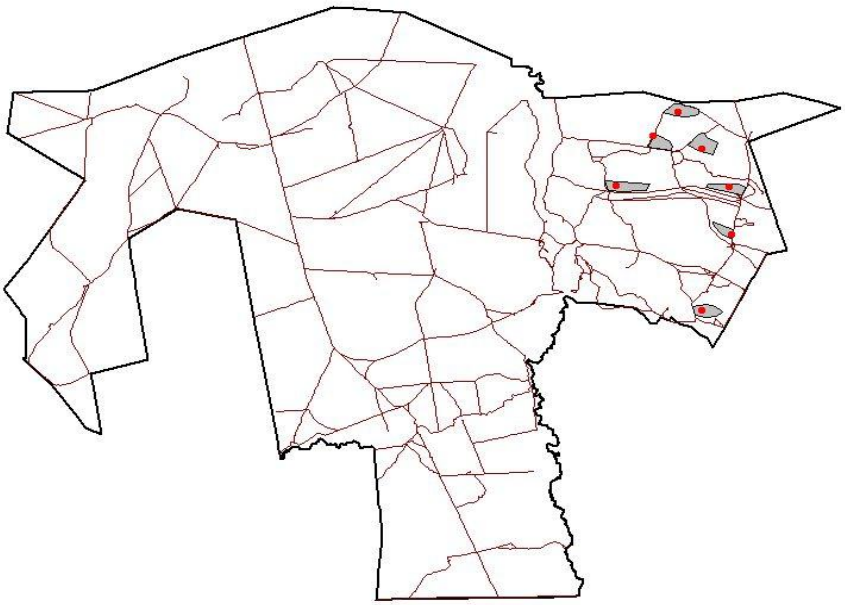


Figure 8: The proposed exclusion zones to allow regeneration of *Acacia drepanolobium* in areas above the threshold damage levels

Objective 4: *Acacia xanthophloea* damage and regeneration monitoring

We have discussed the monitoring requirements the Olpejeta Research and monitoring department and we are now going to incorporate *Acacia xanthophloea* monitoring in our model. We will monitor it in exactly the same way we are doing for *A. drepanolobium* (Objective 2) but we shall use the exclusion plots in the map below as controls and take treatments in other areas. This is a new activity that began in January 2009.

Objective 5: Carry out game counts along transects to estimate the number of herbivores present. Compare herbivore densities before and after opening of "fence line" into the ranch and the migration corridors in the northern end of the ranch.

We have continued to do game censuses of animals in the whole conservancy in order to determine populations and densities of each species in the conservancy. We will also determine habitat use of these species and changes as a result of expansion of the Conservancy. We will also monitor densities to examine movements in and out of the conservancy through the three migration corridors that have been established to the north of the conservancy to allow free movement of animals.

Results:
Although data have been collected on animal numbers, no analysis has yet been carried out. Based on the recommendations of the reviewers, the methods used to analyse wildlife count data were to be reviewed. The PI and staff are now undergoing a GIS training as well as on the method of transect data analysis funded by the Rufford small grants programme. These data will be analysed, and data on animal corridor use are at an advanced level of analysis and nearly ready for publication.

Objective 6: Monitor elephant habitat use through dung counts in order to compare elephant and rhino spatial and temporal overlap in habitat use.

Between 2007 and 2008, we compared habitat use and overlap between elephants and rhinos (Figure 9) in order to determine if the two species tolerate or avoid each other.

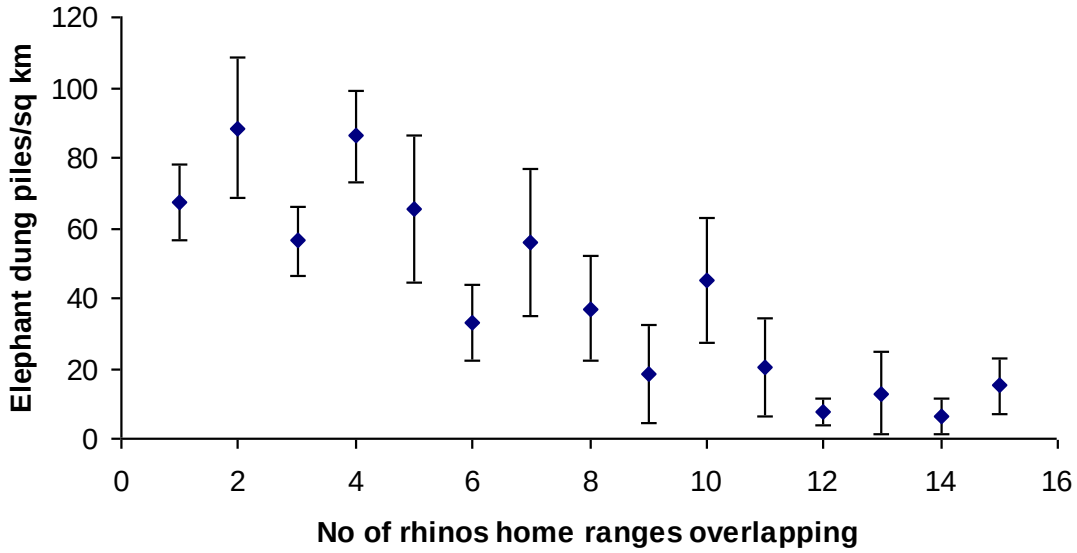


Figure 9: Relationship between blackc rhino and elephant habitat use showing avoidance.

Since it is difficult to monitor elephant movements, we have used dung density and distribution as an indicator of habitat use. We hypothesised that competition may result in spatial segregation. Data on home ranges from 51 rhinos and elephant dung density distribution across the old reserve section of the conservancy were compared using regression analysis. Data showed there was a significant inverse relationship ($R^2 = 0.778$; $P << 0.05$; Figure 8). Habitat use data indicate that areas heavily used by elephants (as indicated by dung density) are not used much by Rhinos (have fewer home ranges overlapping).

The management implications of this is that increased elephant density may lower black rhino carrying capacity by restricting rhino distribution and confining them to areas that are not frequented by elephants. The Conservancy management is now again starting to evaluate and monitor increased elephant numbers with a view to carrying out another management intervention for elephants similar to the 2001 translocation.

Objective 7: Continue to study the feeding behaviour and diet of the semi-wild rhino Morani.

Sadly, Morani the semi-wild rhino passed away in November 2008. Morani had been studied for the past eight years and we had plans to use the observational data for educational and extension services. Morani had been a subject of many school visit projects to Olpejeta. He was a flagship animal for sensitizing school children on the plight of endangered species like black rhinos. This objective has therefore been discontinued.

Project development

Removalor modification of original objectives

Objective seven was removed because the study subject died. Morani died in November 2008 and was diagnosed to have died from pneumonia.

New objectives

Acacia-ant interactions and the effect of fire on crematogastor ants
This is the subject of an MSc thesis but volunteers have one day of activity on it to assist in data collection. Most of the objective is however based on secondary data. We have data on plots, trees and ants before and after fire.

Logistical or scientific challenges encountered
The Conservancy has increased in size and we are now working in an area twice as large as the original area. The game count transects had been made to cover only the former reserve. We have expanded our activities to cover the whole conservancy but transects are now doubled in length. We shall have two teams of volunteers carrying out the census on one transect but coming from two different directions and meeting in the middle. That way the longer transects are completed without doubling walking distance per group.

Collecting baseline data and tagging as well as establishing *Acacia xanthophloea* plots for the new objective was handled as an Msc project. Using the advanced funding on plot establishment that we received in 2007, we have funded an Msc to determine the age structure of the trees and to tag all plots. This activity in ongoing and volunteers from 2009 are participating.

Summary of results

Volunteers sampled 6338 individual *Acacia drepanolobium* trees, 5433 seedlings, walked 720 kilometres counting game and determining elephant dung distribution, and recorded 218 individual sightings of black rhino.

Results
Within this period, there was an unprecedented doubling of elephant damage to Acacia trees as more elephants moved into the conservancy in the drought period from the north through the opened corridors. The effect of rhino damage on Acacia reduced within the reporting period even as rhino numbers in the reserve increased. Rhinos continued to occupy areas of the conservancy that were least used by elephants indicating habitat segregation. Giraffe damage to Acacia reduced and in 2008, we recorded for the first time that trees are flowering in the old reserve section with flowering trees increasing five-fold. The effect of fire on Acacia was such that damage was more severe on the adult trees and also while seedling densities increased after fires, seedling recruitment into trees was hampered by a resultant increase in the densities and diversities of seedling predators. Fire also significantly reduced flowering in Acacia with a potential to effectively reduce recruitment.

Key findings
Our results indicate that payoff for the expansion of the conservancy is being realised from last year within Acacias flowering in substantial numbers for the first time since this monitoring programme began in 1999. However, the creation of migration corridors linking the conservancy and the northen areas has resulted in seasonal immigration of elephants that have resulted in hightened damage to Acacias. We also determined that the controlled burning programme at Olpejeta is detrimental to the health of the main rhrino browse, *Acacia drepanolobium* as it kills adult trees and decelerates seedling recruitment.

Management applications
In November 2008, we delivered to Olpejeta conservancy a vegetation map of the entire conservancy, being the result of work carried out since 2005. This map is now being used for management and is available to other researchers in Olpejeta.

In December 2008, we developed a zonation map showing seven areas that will need management intervention through exclosures to stem the damage to *Acacia drepanolobium* and allow the habitat to recover. Justification for this was based on our nine years of monitoring work and by determination of accepatable damage thresholds.

In January 2008, we presented our findings on effects of fire and elephant damage to Olpejeta Conservancy management. Consequently, the controlled burning programme was put on hold and a new taskforce where we are represented was formed to be in charge of the programme. We have also been incorporated into the Olpejeta Conservancy Research Advisory Committee.

Conclusions

Our data show that:

Burning may be a useful tool in habitat management for savannahs but may be suitable for certain habitat types and not others. In Olpejeta conservancy, our results show that whereas burning is a useful tool in turning moribund grass vegetation into nutritious and reproductive forage, it is detrimental to *Acacia drepanolobium* woodlands. It results in the following impacts

(i) It reverses growth in trees by either killing off the tops thereby reducing height
(ii) It leads to reduced seedling recruitment as burnt areas attract seedling predators
(iii) It results in mortalities of adult trees thereby reducing fruiting
(iv) Fire kills crematogastor ants and thereby reduces the effectiveness of trees in deterring predation

Between 2007 and 2008 elephant damage to Acacia drepanolobium doubled because elephants from outside the conservancy came through the corridors to escape drought. Olpejeta in the south is wetter than Samburu in the north so elephants seek refuge in Olpejeta during the dry periods.

The expansion of the reserve into a conservancy has been shown to be beneficial in two ways based on our data:
(i) More trees are flowering following dispersal of giraffes and reduced browse pressure on *A. drepanolobium*.
(ii) Despite increase in number of rhinos after the February 2007 translocation, rhino damage to trees has reduced considerably.

Significance/ benefits of the research

Local (to the area of the research site)

- We have produced a conservancy vegetation map that will be used by managers and researchers (Appendix 1).

- Based on analysis of nine-years of data on the damage to *A drepanolobium*, we have guided management in selecting seven affected zones that have been earmarked for exclusion to allow tree recovery.

- We have demonstrated that expansion of the reserve has paid dividends as giraffe browsing has reduced and the number of *Acacia drepanolobium* trees flowering annually has increased dramatically with potential to improve seedling recruitment

- We have demonstrated that controlled burning is not a good management option for *Acacia drepanolobium* as fire kills adult trees and exposes seedlings to more browsers thereby interfering with recruitment

- National / Regional

Our research model at Olpejeta has been adopted by Kenya Wildlife Service. All other rhinos sanctuaries are now establishing habitat monitoring programmes.

- International

We have worked with volunteers from outside Kenya who have gained insight into the plight of the black rhino. The volunteers participated in data collection to aid the conservation of an endangered large mammal. We developed a network of volunteers who exchange information and disseminate the same on their experiences and this is a positive contribution to saving the rhino.

Communication of results

Printed:

Three papers are in preparation for publication addressing the following aspects of the study:

(i) corridor use by animals
(ii) effect of fire on *Acacia drepaniolobium*
(iii) habitat use and selection by black rhinos

Vegetation map of Olpejeta Conservancy (Appendix 1)

Mass media: Earthwatch work at Olpejeta is now on the Olpejeta website with links at olpeletaconservancy.org

Educational Opportunities

The project has two field assistants and two graduate students. All four are early career scientists. I am a mentor to the two field assistants and a research supervisor to the two graduate students.

One student is a naturalists at the local lodge and his participation has assisted him in improving the natural history programme at the local tented camp.

The other student is a Kenya Widlife Service Warden at Mt. Kenya National Park. He is already starting a monitoring programme on vegetation there.

Submitted PhD thesis:
Gatimu L. N (2009) Variability and detremiannts in elephant browsing, breaking and bebarking on the dynamics of Acacia xanthophloea at Olpejeta conservancy. PhD submitted to the department of Biology, University of KwaZulu Natal, Natal, South Africa. January 2009.

There are currently two ongoing Msc projects

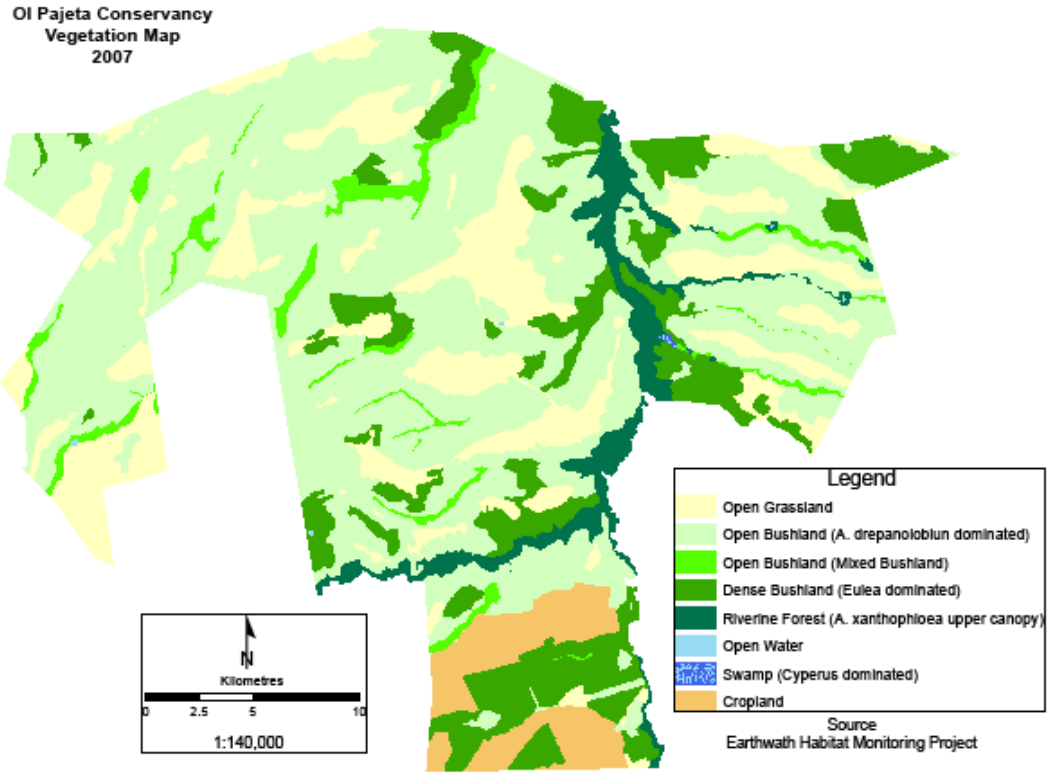
(i) **Olweny, N (2009)** Acacia-Ant interactions and effect of fire. Registered at Egerton University, Njoro, Kenya.

(ii) **Muhati, L.G (2009)** Age structure, recruitment and dynamics of *Acacia xanthophloea* at Olpejeta Conservancy. Registered at Egerton University, Njoro, Kenya.

Acknowledgements

I would like to thank Earthwatch institute for funding the work and Olpejeta Conservancy for hosting the project. All volunteers who participated in the data collection in 2008 are thanked for their effort and contribution. I also specifically thank Lucy Mureu and Paul Gacheru for field assistance during the team fielding sessions and in filling any gaps in the data that, due to time limitations, volunteers could not collect. The following people from Earthwatch helped in many ways; Anne Ogilvie, Mary Rowe and James Burton. Together with my assistants we thank the Rufford grants programme for the support in training and technical support that is ongoing.

Appendix 1


Ol Pajeta Conservancy
Vegetation Map
2007
N
Kilometres
0 2.5 5 10
1:140,000
Legend
Open Grassland
Open Bushland (A. drepanolobiun dominated)
Open Bushland (Mixed Bushland)
Dense Bushland (Eulea dominated)
Riverine Forest (A. xanthophloea upper canopy)
Open Water
Swamp (Cyperus dominated)
Cropland
Source
Earthwath Habitat Monitoring Project