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DIPLOME D'ETUDES SUPERIEURES SPECIALISEES

PRODUCTIONS ANIMALES EN REGIONS CHAUDES

LE DEVELOPPEMENT DES FERMES DE FAUNE SAUVAGE AU ZIMBABWE

par

Raphaël ZWIJNENBERG

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INTRODUCTION

Le Zimbabwe le seul pays au monde avec l'Afrique-du-Sud à gérer l'exploitation de sa faune sauvage.

Grâce à une législation particulière et au développement des structures d'élevage, l'exploitation de la faune sauvage est devenue possible.

Maintenant le Zimbabwe essaye de tirer au maximum parti de cette ressource par des divers systèmes comme:

1) les safaris de chasse
2) les safaris photo
3) l'exploitation de la viande de faune
4) la vente des trophées etc.

Nous verrons le contexte géographique et humain propre au Zimbabwe. Puis nous étudierons l'aménagement des fermes de faune sauvage, leur production, leurs systèmes de capture, leur bilan économique ainsi que la pathologie.

Enfin nous terminerons sur l'organisation des fermiers dans le pays et leurs perspectives d'avenir.

1) GENERALITES SUR LE PAYS

1.1) SITUATION GEOGRAPHIQUE

Le Zimbabwe se situe entre 16 et 22° de latitude sud, avec un climat qui se modifie selon l'altitude.

On peut diviser le pays en 4 zones;

1. le "lowveld" qui se situe dans la vallée du Zambèze et le sud du pays (Matabeleland) à 600 mètres d'altitude, avec une moyenne de précipitation de 350 mm.
2. les "midlands" qui se situent entre les deux grandes villes du pays, Harare (la capitale) et Bulawayo, à 1000 mètres d'altitude, avec une moyenne de précipitation de 450 mm.
3. le "highveld" qui se situe entre Harare et la vallée du Zambèze à 1400 mètres d'altitude, avec une moyenne de précipitation de 650 mm.
4. les "eastern highlands" qui se situent dans l'est du pays, près de la frontière avec le Mozambique, avec un climat très modéré (frais et humide)

1.2) VEGETATION

On peut constater que la végétation change considérablement selon les altitudes.

Sur le "highveld" on trouve surtout des arbres comme le Brachestaesia, avec relativement peu d'arbustes.

Dans le "lowveld" les principaux arbres sont les baobabs et les mopanes et on y trouve beaucoup d'arbustes.

Les "midlands" sont caracterisés par une végétation mixte

1.3) LES DIFFERENTES POPULATIONS

1.3.a) La population traditionnelle on peut diviser en 3 tribus

Les MASHONAS se retrouvent surtout dans le "highveld", les "midlands", et les "eastern highlands".

Les MATABELES se concentrent autour de Bulawayo et dans le "lowveld".

Les TONGAS habitent la vallée du Zambèze et autour du lac Kariba.

Les Matabeles ont leur origines dans la tribu des Zoulous (une grande tribu de guerriers qui se trouve actuellement en Afrique du Sud).

Ils sont partis au nord quand les Zoulous se divisèrent au début du 19ième siècle.

Traditionellement il y avait beaucoup de guerres entre les Shonas et les Ndebeles, et les Shonas ont été repoussés au nord du pays.

Actuellement on dit que les blancs, à leur arrivée (1890), ont protégé les Shonas auparavant massacrés par les Ndebeles. Depuis et jusqu'aux temps modernes les deux peuples ne s'entendent pas .

1.3.b) Le Zimbabwe a depuis sa colonisation en 1860 connu une population d'origine européenne qui était maximale en 1978 avec 250000 personnes, actuellement il y a environ 100000 européens d'origine dans le pays, un nombre qui est assez stable.

1.3.c) Depuis le début du 20ième siècle, la population indienne a augmenté au Zimbabwe, comme dans beaucoup de pays colonisés par des anglais (comme le Kenya et l'Afrique du Sud);

1.3.d) Bien sûr existe toujours une population de métis qui néanmoins reste relativement limitée au Zimbabwe.

1.4) SITUATION POLITIQUE

Depuis la colonisation en 1860 le gouvernement anglais a tout fait pour encourager les anglais à s'établir en Rhodésie du Nord (actuellement la Zambie) et en Rhodésie du Sud (actuellement le Zimbabwe). Après l'indépendance de la Zambie en 1963, les blancs du Zimbabwe ont déclaré leur pays indépendant (unilatéralement), et la Rhodésie était seulement reconnue par l'Afrique du Sud.

La politique était dirigée vers un système capitaliste, avec de grandes fermes commerciales dirigées par des blancs.

Entre autre à cause dela pression étrangère, la Rhodésie est devenue de plus en plus autonome avec une industrie très diversifiée.

Après une guerre d'environ 8 ans, le pays a enfin trouvé l'indépendance en 1980.

Depuis 1980, beaucoup de blancs sont partis en Angleterre, en Australie, au Canada, et en Afrique du Sud.

Avec eux, beaucoup de connaissances sur la production moderne et des techniques avancées ont également disparu.

En 1980, un gouvernement se forma en majorité de représentants des tribus (Mashonas et Matabeles).

Comme ils ne s'entendaient pas traditionellement, le pays a connu beaucoup de problèmes de sécurité interne jusqu'en 1986.

Actuellement on a formé un état avec un parti politique, régi par des principes socialistes.

Néanmois le président, Robert Mugabe, stimule les grands fermiers-commerciaux pour servir de tremplin à l'économie du pays, car leur production (par exemple de tabac et de viande de boeuf) demeure vitale.

La division des terres est actuellement:

16300 ha pour les zones communales
16600 ha pour les zones commerciales
200 ha pour les zones urbaines
5900 ha pour les parcs nationaux
39000 ha = l'ensemble du pays

2) DES FERMES DE FAUNE SAUVAGE

2.1) HISTOIRE DES FERMES DE FAUNE SAUVAGE

Historiquement le Zimbabwe a produit de la viande de boeuf, et surtout après l'éradication de la mouche tsé-tsé, le bétail a crû de façon importante.
La faune sauvage qui était là traditionellement était considérée comme concurrente du bétail et, de plus, était suspectée de transmettre beaucoup de maladies contagieuses comme la peste bovine et la fièvre aphteuse.
Dans les années '50, presque toute la faune sauvage a été tuée pendant la lutte contre _Glossina morsitans_.
Plus tard, en 1967, on s'est limité aux hôtes préférés de _Glossina morsitans_ comme les suidae, l'éléphant, le buffle, le koudou et les guibs.
Dans les deux situations la lutte fut un succès, ce qui montre que beaucoup d'espèces pourront être sauvées dans une telle lutte.
Bien qu'il y eût un début pour l'établissement des fermes de faune sauvage dans les années '60, beaucoup de ces idées ont été perdues durant la guerre des années '70.
Par la suite, pendant les années '70 le parlement de la Rhodésie a accepté le "parcs and wildlife act" ce qui veut dire que chaque animal sauvage qui se trouve sur un terrain,

peut être exploité par le propriétaire à l'exception des animaux protégés. (voir annexe 1)

Après la guerre, le premier but était l'augmentation de la production de viande de boeuf, pour l'exportation sur le marché de la CEE et pour satisfaire les besoins propres. (Cette exportation a été réalisée en 1986, et maintenant le Zimbabwe est en mesure d'atteindre les quotas exportables vers l'Europe, ce qui permet un afflux dans le pays de devises).

Mais l'année 1983 a connu des périodes sèches de longue durée et les fermiers ont beaucoup souffert.

Les fermiers ayant commencé modérément l'exploitation de faune sauvage ont aussi souffert, mais ce n'est rien en comparaison de leur collègues.

A partir de 1983/84, on organise de plus en plus de safaris au Zimbabwe, avec en conséquence une valorisation de la faune sauvage.

Tout d'un coup une antilope n'est plus une bête négligable (un impala en 1982 ne valait pas plus que 15 francs français) mais au contraire peut devenir un animal de prix.

Depuis les fermiers ont arrêté de tuer la faune sauvage et, de plus en plus, ont commencé à exploiter leur faune.

2.2) SITUAION ACTUELLE DES FERMES DE FAUNE SAUVAGE

Il est impossible de donner des chiffres exacts sur le nombre de fermiers qui exploitent leur faune et sur leur comptabilité, car cela se montre très différent de l'un à l'autre.

Pourtant on peut constater que le nombre de fermiers de faune sauvage et l'intérêt général augmente tous les jours.

3) DIFFERENTES FORMES DE FERMES DE FAUNE SAUVAGE

Dans un pays comme le Zimbabwe, avec un climat qui connait des periodes de sécheresse, les fermiers sont intéressés à diversifier leur production.
Ainsi ils sont de moins en moins affectés par les années de sécheresse et par des fluctuations de prix sur les marchés locaux et internationaux.
En particulier pendant la sécheresse des années 1983 et 1984, les fermiers qui avaient diversifié leur production n'ont pas eu autant de pertes que les autres.
Une méthode de diversification pour les fermiers de bétail est de commencer d'exploiter leur faune sauvage.

Les possibilités pour l'exploitation de la faune sauvage dépendent largement de la situation de la ferme dans le pays et de la grandeur.
En général les fermes qui sont situées dans le "highveld" sont plus petites que celles qui, sont situées dans le "lowveld".
Le grandeur moyen des fermes dans le

"highveld" = 2300 ha

"lowveld" = 4500 ha (avec des fermes de plus de 10000 ha)

3.1) SITUATION DANS LE "HIGHVELD"

Dans le highveld, où la pluviosité annuelle est de 650 mm, les fermes sont assez petites pour une exploitation de la faune sauvage.

Ici la majorité des fermes se trouve autour de la capitale.

Ce sont des fermes avec une production mixte de:

1) bétail

2) faune sauvage

L'exploitation de la faune se traduit par l'organisation de "mini-safaris", ce qui veut dire des safaris d'un jour ou quelques jours.

Pendant ces chasses d'un ou deux jours, le fermier offre ses animaux de surplus, p.e. des mâles d'impala, des vieux mâles. On le paye pour le trophée tandis que la carcasse reste à la ferme.

On organise aussi des "safaris-photo" pour les touristes qui viennent de la capitale, et qui n'ont pas le temps de passer des jours et des jours dans le pays pour visiter des parcs nationaux.

Bien sûr les gens locaux d'Harare en profitent aussi.

Une nouvelle chose se développe rapidement: "le safari de chasse à l'arc"

Ces safaris sont faits préférablement dans de petites fermes où les distances sont raisonnables, car on cherche l'animal à pied.

En effet les animaux doivent être relativement calme parce qu'il faut les approcher à moins de 30 mètres.

La chasse à l'arc est devenue de plus en plus populaire et aux Etats-Unis on trouve déja environ 3.10^6 chasseurs à l'arc.

La saison de chasse à l'arme à feu aux Etats-Unis est précédée d'une période de 3 semaines, uniquement réservée aux chasseurs à l'arc.

Ainsi les animaux restent calmes pendant cette période.

3.2) SITUATION DANS LE "LOWVELD"

La situation dans le "lowveld est complètement différente de celle du "highveld".

Ici les fermes sont très grandes (>4000 ha) et très extensives.

Suite à son développement dans le reste du pays, l'exploitation de la faune sauvage s'y est implantée rapidement.

Enfin il faut dire que l'exploitation de la faune sauvage a pu s'étendre dans cette région du fait que l'exploitation du bétail y reste très marginale (350 mm de pluie).

On y trouve aussi des fermes qui n'exploitent que de la faune sauvage.

Bien sûr il est impossible de donner les chiffres exacts du nombre de fermiers qui exploitent la faune sauvage, car beaucoup de fermiers ont commencé récemment, et déjà l'arrêt de la chasse de la faune sauvage et le début de la vente de

carcasses peut être considéré comme un début de l'exploitation de cette faune.
En 1975, après l'acceptation du "Parks and Wildlife act" on a commencé à préserver la faune, mais surtout après la sécheresse en 1983/84 où il s'est avéré clair que les résultats financiers des fermiers qui exploitent la faune sauvage étaient vraiment supérieurs aux autres.

L'exploitation de la faune dans cette région veut dire que les fermiers organisent des chasses de 10 à 21 jours sur plusieurs espèces de faune sauvage et ils vendent des animaux aux autres fermiers débutants, ou qui n'ont pas assez d'une certaine espèce.
Quelques fermiers chassent aussi certaines espèces en grosses quantités pour vendre les carcasses en ville, car la demande en viande de brousse augmente toujours!

4) AVANTAGES ECOLOGIQUES DE L'EXPLOITATION DE LA FAUNE SAUVAGE

Une recherche a été faite à "Buffalo Range Ranche" au sud-est du Zimbabwe pour comparer les performances et conséquences écologiques de la faune sauvage, établie sur une partie de 8000 ha, avec du bétail, établi sur une partie de 12000 ha.

Il y avait dix espèces de grands herbivores dans la partie de faune sauvage, et la biomasse animale était approximativement la même pour les deux parties.

On a constaté que le % d'utilisation de la végétation herbacée pour la partie de faune sauvage était de 43% tandis que seulement 28% était utilisé par le bétail.

12 espèces d'herbes étaient utilisées à plus de 10% chez le bétail, 20 espèces chez la faune sauvage.

L'utilisation des arbustes (feuilles + branches) était de 20% chez la faune, et seulement 7-8% chez le bétail.

Le bétail restait moins sur place que la faune, mais c'était à cause de la gestion des patûrages organisée par les bouviers.

Le choix de l'herbe était plus diversifié avec la faune sauvage, mais le bétail et la faune ont préféré les mêmes espèces.

La partie "bétail" était beaucoup plus couverte de fécès et l'herbe était plus haute, tandis qu'en général, sur la partie "faune sauvage", on trouvait une herbe plus jeune et moins d'érosion.(1)

La nécessité pour quelques espèces de faune sauvage comme l'éland du cap et la girafe de manger des feuilles est connue.

Ce tableau montré le régime alimentaire d'un éland:

proteine	16,0%(min.)	Ca	1,6%(max)
mat. grasse	2,5%(min)	P	6,7%(min)
fibre	8,0%(max)	Vit. A	10000 i.u./kg

Uniquement si l'herbe est verte et jeune, l'éland du cap mangera <70% de l'herbe.(2)

Quand plusieurs espèces cohabitent sur une même surface, on peut observer l' utilisation optimale de la végétation p.e. les koudous mangeront les herbes, les élands du cap mangent les branches de la base de l'arbre, la girafe les branches du sommet de l'arbre et les steenboks mangeront les branches intermédiaires.(3)

4.1) L'ELAND DU CAP

On a trouvé que chez les fermiers de bétail l'éland pourrait être une introduction très intéressante, car les élands se nourrissent de feuilles et de bourgeons, sauf quand l'herbe est jeune et verte.

La seule condition sous laquelle une vaste quantité d'herbe est mangée, est sa jeunesse.

L'habitat naturel de l'éland du cap est dans le "lowveld" et les "midlands".

Sur environ 45% des fermes, une population naturelle de cette espèce existe.

Dans cette région, la nécessité d'avoir une espèce qui mange les feuilles s'impose; ainsi on pourrait aboutir à un équilibre avec la présence du bétail, qui ne mange presque que de l'herbe.

Les espèces d'arbres préférées par les élands sont:

1) Colophospermum mopane
2) Combretum apiculatum
3) Grewia subspathulata
4) Enclea clivinorum (4)

5) AMENAGEMENT D'UNE FERME DE FAUNE SAUVAGE

Selon les instructions de M. Travers, propriétaire d'"Imire Game Parc" , il faut prendre les mesures suivantes quand on veut démarrer une ferme de faune sauvage:

1) Installer une clôture spécialement conçue pour la faune sauvage

2) Créer des points d'eau permanents

3) Faire du "management", ce qui veut dire : mettre des blocs de sel et éventuellement supplémenter en proteines pour certaines espèces.

4) Avoir les animaux adéquats et les acclimater dans un "boma".

5) Planter/semer des légumineuses.

6) Brûler pendant la saison sèche, selon un système de rotation de quatre ans.

7) Contrôle des parasites: normalement les parasites internes ne sont pas un problème, mais ce sont des tiques qui peuvent causer des troubles.

8) Eventuellement, l'élevage des espèces en voie de disparition.

9) Attirer des touristes pour: 1) des safaris-photo
2) la chasse contrôlée pour des trophées

10) Le "culling" pour la viande et les peaux.

11) La vente des animaux aux autres fermiers.

n.b. culling = chasse organisée à grande échelle pour une espèce d'animal donnée, pour viande, peaux, ivoire etc.

5.1) LE BOMA

Le boma est un enclos construit en bois de telle façon que les animaux ne puissent rien voir de l'extérieur.

Un boma est essentiel à l'arrivée des animaux sur une ferme, afin qu'ils puissent se remettre du stress de la capture et du transport.

La grandeur d'un boma moyen est de 70m X70m avec une hauteur de clôture d'environ 4m.

La clôture est en bois et est couverte de foin pour que les animaux ne puissent pas regarder à travers.

Les coins du boma doivent être arrondis, pour que les animaux ne s'écrasent pas dans les angles, poussés par la peur.

Le boma devrait avoir deux ouvertures; une grande ouverture d'environ 3m, par laquelle les animaux peuvent sortir du boma, et une ouverture avec une rampe pour le camion qui peut ainsi charger et décharger ses animaux.

Il est prudent de mettre le boma près de la présence humaine, pour que les animaux puissent s'accoutumer aux sons des hommes.

Il est absolument nécessaire de mettre de la nourriture et de l'eau dans le boma suffisamment pour 4 jours **avant** que les animaux n'arrivent sur place, et il est absolument défendu de les déranger pendant les premiers quatre jours. (même quand il y a un animal mort dans le boma).

Après quatre jours on enlève tous les jours un peu de foin de manière à ce qu'après 15 jours le foin ait disparu.

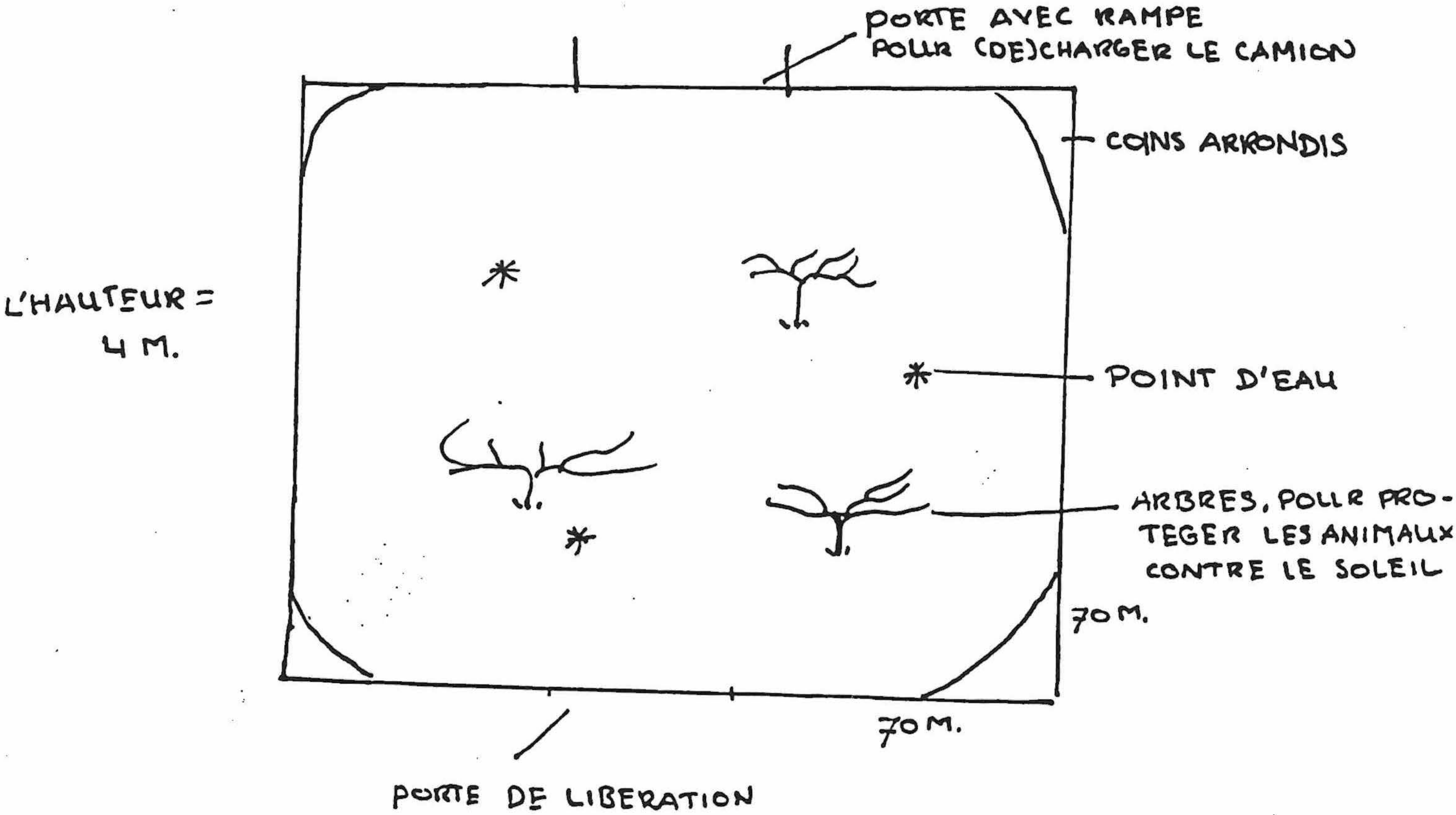
On donne la nourriture (des granulés, des branches et de l'herbe) après le 4ième jour.

Les deux premières semaines on jette la nourriture par-dessus, après quinze jours on ouvre doucement les portes et on l'amène ainsi à l'intérieur de l'enclos.

Le temps que les animaux doivent rester dans un boma dépend largement de l'espèce, leur anxiété etc.

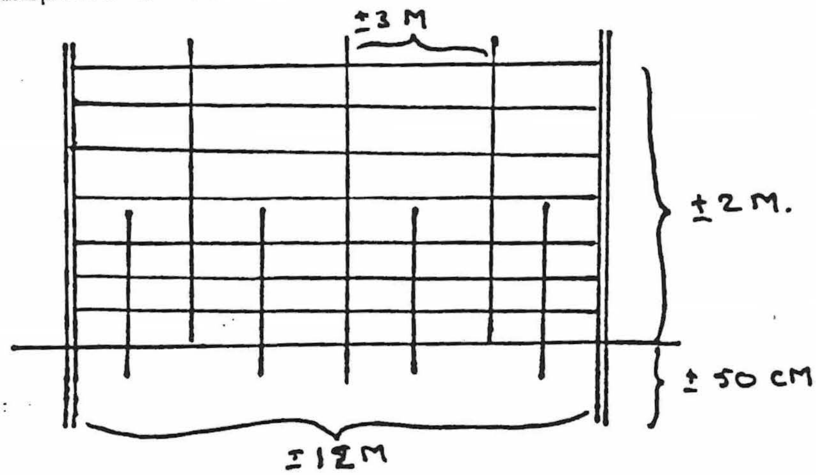
Quand on les relâche il faut le faire juste avant le coucher du soleil, pour qu'ils n'entreprennent pas de grands voyages après leur libération.

Le temps dans le boma varie de 3 à 5 semaines et est très important pour les animaux, parce que pendant ce temps ils peuvent s'habituer à manger des granulés ce qui peut être essentiel pour la survie pendant la saison sèche!



5.2) LA CLOTURE DE FAUNE SAUVAGE

Un aspect essentiel pour un fermier qui pense à l'exploitation de la faune sauvage sur sa ferme, est la mise en place d'une clôture de faune sauvage.
En plus c'est le plus grand investissement qu'il doit faire pour mettre en place une ferme de faune.
L'aspect d'une clôture:



Cette clôture est dessinée selon une recommandation des parcs nationaux au Zimbabwe, et ne donne qu'une idée.
Les fermiers peuvent dépenser autant d'argent qu'ils veulent selon leurs moyens financiers et matériels.
Normalement on essaye d'utiliser autant que possible les matériaux présent sur place, et il est même conseillé d'utiliser comme piquets les arbres qui sont là, sur place.
Une clôture de faune n'es pas pour but d'être une barrière définitive pour les animaux, les animaux pourront toujours trouver un trou pour s'échapper.
Elle fonctionne plutôt comme barrière visible pour les animaux, pour déterminer leur territoire et leur donner un sentiment de sécurité à l'intérieur.

Chaque km il faudrait incorporer une porte dans la clôture pour réintroduire les animaux échappés.

5.3) LES POINTS D'EAU

Ainsi que pour le bétail, pour la faune sauvage les points d'eau ont une grande importance.
Juste après la saison des pluies on voit beaucoup de mares naturelles qui se sont formées et on voit à peine les animaux car ils sont tous dipersés.
Pendant cette saison les animaux couvrent toute la surface de la ferme et même au dehors.
Mais quand les mares naturelles s'assèchent on voit la grande importance des points d'eau permanents, car ils fontionnent comme moyen d'attirer les animaux.
Ils attirent les animaux d'une telle façon que même les animaux hors de la ferme viendront à la ferme et éventuellement s'y installeront.

Mais ce n'est pas important seulement pour les animaux du dehors, c'est également pendant la saison sèche qu'on organise les chasses.
Et justement pendant la saison de chasse il est très convenable d'avoir le maximum d'animaux sur son terrain.
Il est important de construire les points d'eau de manière très solide, avec des pompes couvertes par des blocs de béton, car autrement les éléphants (quand ils sont présents) pourront tout détruire, jour après jour, mois après mois.

Les points d'eau doivent alors être contrôlés quelques fois par semaine, et aussi être nettoyés quand nécessaire, car les algues y poussent volontiers.
L'investissement ici est constitué par les pompes d'eau, et la maintenance.

5.4) LA SUPPLEMENTATION

SEL

Non seulement les points d'eau, mais aussi les blocs de sel attirent les animaux d'une ferme.
Le problème avec les blocs est qu'il est très dur de les avoir, car il y a un manque de sel au Zimbabwe.
Un grand avantage des blocs de sel pourrait être une supplémentation de certains éléments (p.e. Se, K etc.).

LES GRANULES

Il est très important d'apprendre aux animaux quand ils sont encore dans le boma à manger des granulés.
Une fois qu'ils sont au dehors du boma il est presque impossible de les attirer par des granulés.
Il faut leur donner une petite quantité de granulés toute l'année, et augmenter la quantité quand c'est nécessaire, comme p.e. pendant la saison sèche, juste avant la saison des pluies.
Ainsi on peut éviter la mort de beaucoup d'animaux pendant les années de grandes sécheresses.
Aussi est il possible de supplémenter les animaux quand il

manque quelque chose sur la ferme (p.e. [illegible] une ferme du "highveld").

5.5) L'INFRASTRUCTURE

Une bonne infrastructure est indispensable aussi bien pour le fermier et son personnel qui doivent contrôler la ferme que pour les chasseurs qui doivent avoir la possibilité de pénétrer dans tous les coins pour [illegible] les animaux.

Ceci ne veut pas dire qu'il faut avoir des autoroutes sur les fermes, mais des bonnes pistes fonctionnent très bien.
Il faut essayer de mettre partout des lignes d'électricité et de téléphone, surtout quand il y a des girafes.
Quand on les chasse, elles peuvent courir dans ces lignes et mourir de choc.

5.6) PERSONNEL

Le nombre de personnes sur une ferme de faune est très limité, et sert pourtant à :

1) contrôler la clôture
2) contrôler les points d'eau
3) le contrôle du braconnage
4) servir les chasseurs

5.7) LA FAUNE

Les espèces d'animaux qu'on peut trouver sur une ferme sont très variables, selon les préférences du propriétaire, sa femme, la faune déjà présente etc.

En général il est conseillé de demander aux vieilles personnes du coin quelles sont les espèces qui vivaient à l'origine dans ce coin, et quand elles ont disparu et pourquoi.

Ainsi on évite les problèmes de carences en nutriments, en éléments etc.

Les espèces les plus connu aux Zimbabwe sont:

1) Eléphant - Loxodonta africana
2) Buffle d'Afrique - Syncerus caffer
3) Lion - Panthera leo
4) Léopard - Panthera pardus
5) Hippotrague noir - Hippotragus niger
6) Le grand koudou - Tragelaphus strepsiceros
7) Cobe à croissant - Kobus ellipsiprymnus
8) Zèbre de burchell - Equus (Hippotigris) burchelli
9) Eland du cap - Taurotragus oryx
10) Impala - Aepiceros melampus
11) Cobe des roseaux - Redunca arundinum
12) Guib harnaché - Tragelaphus scriptus
13) Gnou à queue noir - Connochaetus (Gorgon) taurinus
14) Autruche - Struthio camelus
15) Nyala - Tragelaphus angasi

16) Oréotrague - Oreotragus oreotragus

17) Céphalophe du natal - Cephalophus natalensis

18) Steenbok - Raphicerus campestris

19) Grysbok de sharpe - Raphicerus sharpei

20) Phacochère - phacoccerus ethiopicus

21) Potamochère - Potamochoerus porcus

22) Hippopotame - Hippopotamus amphibius

23) Crocodile - Crocodilus porosus

24) Chacal à chabraque - Canis mesomelas

25) Otocyon - Otocyon megalotis

26) Caracal - Felis caracal

27) Serval, "Chat-tigre" - Felis (Leptailurus) serval

28) Civette - Viverra civetta

29) Genette commune - Genetta genetta

30) Chat sauvage d'Afrique - Felis (sylvestris) libyca

31) Girafe - Giraffa camelopardis giraffa

32) Hyène tachetée - Crocuta crocuta

33) Babouin jaune - Papio synocephalus

34) Porc-épic - Hystrix

35) Sassaby - Damaliscus lunatus

(5)

5.8) PREFERENCES PAR ESPECES

Bien sûr on ne peut pas trouver toutes les espèces n'importe où.

La distribution des espèces est limitée à cause de 2 facteurs principaux:

1) des frontières naturelles pour une espèce p.e. des montagnes, des rivières etc.

2) la présence humaine, soit parce que l'homme a chassé l'animal, soit simplement à cause de sa présence.

Pour donner des exemples: les élands du cap peuvent être trouvés partout où il y a beaucoup d'arbustes, dans le "lowveld" et dans les "midlands".

Les impalas les zèbres et les koudous peuvent se trouver partout dans le pays.

Les buffles sont limités à cause des contraintes vétérinaires qui ne permettent pas leur présence dans les zones vertes (voir partie vétérinaire/fièvre aphteuse).

Le rhinocéros noir (mangeur de feuilles), se trouve dans le "lowveld" et les "midlands", tandis que le rhinocéros blanc (mangeur d'herbe) est présent surtout sur le "highveld" et les "midlands".

Aussi une très bonne indication pour la présence d'une espèce à un endroit précis, c'est la présence des peintures de bushman.

Ainsi on peut recevoir une bonne idée sur la présence de telle et telle espèce à un endroit précis pour éviter des problèmes plus tard.

L'animal le plus difficile est le sassaby, car il ne supporte pas d'être enfermé dans un boma, et puis il est très sensible aux carences des éléments comme le Sélénium (observation personelle à "Imire farm").
Une particularité des girafes est que la présence des acacias est essentielle pour une bonne reproduction.

5.9) DENSITE

Un des problèmes des fermiers de faune sauvage est de savoir jusqu'à quelle densité on peut aller sans qu'il y ait des conséquences pour l'écosystème de la ferme en question.
D'abord il faut qu'il sache combien d'animaux il y a sur sa propriété.
Chez les petits fermiers du nord dans le "highveld" ça ne posera pas de grands problèmes, mais les fermiers des grandes fermes extensives dans le sud ne pourront jamais avoir de chiffres exacts sans une méthode plus sophistiquée.
Il y a cinq ans, on appliquait la méthode des "road strip counts", ça veut dire que l'on passait en voiture sur certaines pistes à une certaine vitesse sur le terrain d'une ferme, et on comptait tous les animaux jusqu'à une certaine distance de la voiture (p.e. 50m), et puis on avait une formule scientifique pour calculer le nombre des animaux au total sur le terrain.
Maintenant on a découvert que les animaux savent exactement où sont les pistes (ils les connaissent à cause des chasseurs) et ne viennent pas brouter auprès d'elles.

Les chiffres ainsi obtenu n'étaient pas corrigibles, et on a dû trouver une autre méthode pour compter les animaux.

Maintenant on compte les animaux avec un avion une fois par an.

On quadrille le terrain systématiquement.

Ainsi on obtient un nombre d'animaux plus exact pour le fermier, et ainsi le fermier peut entre autre déterminer combien d'animaux il veut vendre pour la chasse ou la translocation de l'année suivante.

Pour déterminer la densité de la biomasse animale optimale le fermier zimbabwien a trois choix;

1) une formule des parc nationaux (origine inconnue), qui donne une bonne indication:

$$8684 * \text{mm pluie} - 1205{,}9 = \text{kg PV}^{0{,}75} / \text{km2}$$

buffle	= $PV^{0.75}$	=98	éland	= 79
gnou	=	=37	rhino	=405
zèbre	=	=53	sassaby	= 29
hippotrague=		=50	etc.	

Alors quand on connait la surface du terrain et le nombre d'animaux (divisé en espèces), il est très simple de calculer la charge optimale.

2) un autre essai de calculer la capacité d'un terrain a aussi été fait par le "U.S.A. Peace Corps". (voir annexe 3)

3) la pratique est de faire une bonne observation de la végétation sur le terrain, et contrôler cette végétation

contre toute dégradation.

Les fermiers savent très bien qu'une fois tous les 10 ans ils ont une année de sécheresse, et que pendant cette année de sécheresse beaucoup d'animaux mourront.

Selon les fermiers il faut contrôler la végétation et pendant les années de sécheresse il faut supplémenter avec des granulés et des autre suppléments comme du foin, et ainsi essayer de sauver le maximum d'animaux.

Ceci est une approche très pratique qui s'est avérée très bonne dans le sud du Zimbabwe.

Au nord on ne connait pas tellement les périodes de sécheresse et là les formules deviennent de plus en plus intéressantes.

5.10) CAPTURE DES ANIMAUX

Quand un fermier décide de commencer une ferme de faune sauvage, il faut qu'il achète des animaux, après avoir construit une clôture, des points d'eau et un boma.

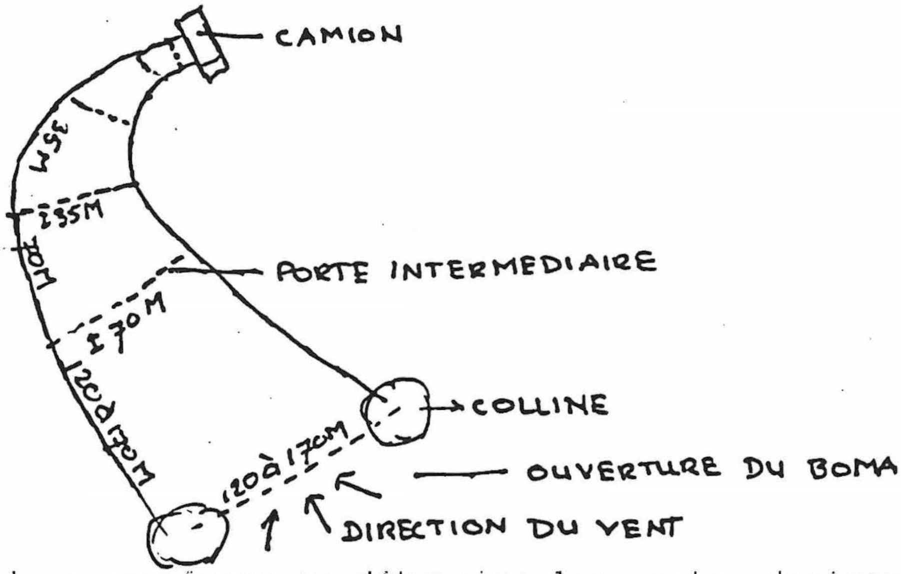
Les animaux qu'il achète proviennent soit des parcs nationaux, soit des autres fermiers de faune sauvage qui en ont de trop.

Mais ensuite il faut capturer les animaux.

Au Zimbabwe il y a en ce moment trois équipes de capture: deux équipes privées, qui sont les plus chères, et une équipe des Parcs Nationaux.

Le capture se passe aussi avec un boma, mais cette fois-ci le boma est transportable et fait de plastique beige.

Toutes les équipes ont un système de capture différent, et le système qui est décrit ici est développé par M. Mike La Grange, un Zimbabwien qui travaille (encore) pour les Parcs Nationaux.



A l'arrivée dans une ferme on détermine les vents dominants de la région, et en général au Zimbabwe pendant la saison sèche les vents dominants viennent du sud-est, et la "bouche du boma est donc aussi située sud-est pour que le vent souffle dans le boma à travers sa bouche.

Bien sûr il faut bien camoufler l'entrée du boma, p.e. entre deux petites collines, et il faut prendre soin qu'il n'y a pas une route près de l'entrée du boma.

Puis on essaye de trouver les animaux par hélicoptère, pas trop loin du boma.

Une fois qu'on les a trouvé il faut les diriger doucement vers l'ouverture du boma.

C'est très facile à écrire et à décrire mais en réalité ce n'est pas aussi simple que ça.

Les animaux peuvent sentir tout d'un coup que quelque chose ne va pás et s'enfuir, le vent peut tout d'un coup tourner et sortir de la bouche du boma etc.

Enfin une fois que les animaux sont entrés tout doucement dans la bouche du boma ils ne réalisent encore rien et on tire de l'hélicoptère une balle à blanc pour prévenir de manière qu'on ferme vite la bouche du boma avec une sorte de rideau.

A ce moment les animaux voient, sentent et entendent quelque chose et commencent à courir dans le boma.

Et ensuite la deuxième porte ferme derrière eux.

Les animaux courent toujours tout droit tandis que les portes se ferment derrière eux (chaque porte a une équipe de travailleurs qui la ferme aussi vite que possible).

Ils n'arrêtent pas de courrir parce qu'ils ne voient pas la fin du couloir qui se trouve dans le camion.

La dernière partie du couloir est faite de bois pour que les animaux ne puissent pas s'échapper quand ils paniquent au dernier moment.

Et le couloir aboutit à une rampe ce qui mène directement les animaux dans un camion.

Quand il s'agit des impalas la porte du camion reste encore fermée, car il faut d'abord tirer sur tous les mâles du troupeau, sinon ils tuent avec leurs cornes les femelles et les jeunes animaux quand ils se sentent pris au piège.

Les zèbres et les élands entrent directement dans le camion, qui, dès que les animaux sont dedans, commence à faire tourner le moteur.

Les animaux retrouvent leur calme directement quand ils voient qu'il fait sombre dans le camion, qu'ils ne peuvent pas échapper et que le moteur tourne.
A l'arrivée des derniers animaux dans le camion, les papiers sont écrits (nombre d'animaux, espèces etc.) pour les contrôles vétérinaires (voir fièvre aphteuse), et les animaux sont déjà en route à leur destination.

Il est évident qu'il n'est pas permis au chauffeur du camion de s'arrêter au bord de la route, car il doit arriver aussi vite que possible à la ferme de destination où un autre boma les attend avec de la nourriture et de l'eau fraîche au moins pour quatre jours etc.........

Chaque animal pose des problèmes différents pour la technique de capture.
Par exemple chez les impalas il faut tuer les mâles et chez les zèbres il est défendu de mêler des troupeaux différents.
On capture aussi les girafes avec un boma mais ici on enlève le toit du camion et on ne peut pas les transporter quand il fait sombre car il y a danger que les animaux ne voient pas les branches et les fils électriques durant le trajet.
Bien sûr cette méthode n'est valable qu'avec les animaux qui vivent en troupeaux.

Un petit herbivore comme l'oréotrague est capturé avec un filet placé entre deux collines.
Comme c'est un petit herbivore solitaire qui vit sur des collines, on grimpe la colline par l'autre côté et on chasse

tout ce qu'il y a dans le filet avec plus ou moins de succès.

La grandeur d'un équipe de capture est de 100 personnes, et le matériel utilisé consiste en;

4 radios — des tentes

3 camions — l'équipement pour l'entretien du matériel

3 voitures

3 fusils

1 helicoptère

environ 800m de plastique avec un hauteur de 2m etc. etc.

Ceci montre que la capture des animaux est une opération coûteuse et demande beaucoup de patience et de l'expérience.

Il est conseillé de commencer la capture avant la saison de chasse et de continuer après la saison de chasse, car les animaux pourraient être apeurés durant cette saison de chasse.

On préfère que le proprietaire soit sur place et observe la capture, car une heure de vol de l'hélico lui coûte au moins 2100ff!

L'année prochaine M. La Grange ne travaillera plus pour les Parcs Nationaux, mais pour le secteur privé, et ainsi le prix de capture augmentera considérablement.

6) STRUCTURE ECONOMIQUE D'UNE FERME DE FAUNE SAUVAGE

Pendant notre visite à "Jonsyl ranch" avec l'équipe de capture de M. La Grange au sud de Bulawayo, à West Nicolson, on a pu parler avec le propriétaire du ranch M. du Plessis et ainsi se faire une image de l'économie d'une ferme.

Les chiffres suivants sont en **$ zimbabwien**

1$ zim = 3,30 ff

surface du terrain: 28000 acres = 11331 ha

prix du terrain à l'achat: $12,5/acre = $350000

DEPENSES

clôture pour 30km à $3000/km = $90000

infrastructure: les barrages et les points d'eau = $110000

DEPENSES ANUELLES:

le terrain à 10 ans:	$35000/an
la clôture à 10 ans:	$ 9000/an
l'infrastructure à 5 ans:	$22000/an
salaires des travailleurs	
l'essence, l'entretien etc.	$50000/an
	$116000/an

REVENUS ANUELS

1) la capture

les coûts de la capture:

5 jours d'hélicoptère - prix fixe = $200/jour = $1000

2 hrs/jour d'hélico

1 heure = $720 = $7200

les coûts totaux = $8200

animaux capturés:		prix de capture:	
20 zèbres à $750 =	$15000	$20/an. =	$400
10 girafes à $1000 =	$10000	$20/an. =	$200
100 impalas à $100 =	$10000	$5/an. =	$500
20 élands à $750 =	$15000	$20/an. =	$400
4 oréotragues à $250=	$ 1000	$5/an. =	$ 20
154 têtes	$51000		$1520

Une levée des "wildlife producers association" est 7,5% de $51000 = $3825

coûts de capture = $3750 + $8200 + $1520 = $13570

PROFIT = $51000 - $13570 = $37530

2) la chasse

Il y a deux types de chasse:

A) la chasse sur des antilopes, des gnous, des zèbres etc.
cette chasse dure de 7 à 10 jours et on l'apelle le "plains game hunt".
le prix de cette chasse est $350/jour

B) la chasse sur des grands cinq : le lion, le léopard, l'éléphant, le rhinocéros(défendu) et le buffle
le prix de cette chasse est $650/jour avec un minimum de 21 jours.

Chez M. du Plessis de "Jonsyl Ranch" on organise 100 jours de chasse par an : 3 chasses de 21 jours et
5 chasses de 7 jours

21 jours à $650/jour	-	$13650
1 léopard	-	$ 1500
1 éland	-	$ 800
2 koudous	-	$ 1500
3 zèbres	-	$ 2100
4 impalas	-	$ 400
total		$19950

7 jours à $350/jour	-	$ 2450
1 koudou	-	$ 750
2 zèbres	-	$ 1700
3 impalas	-	$ 300
total		$ 5200

REVENUS:

capture	-	$37530
3 * safari de 21 jours	-	$59850
5 * safari de 7 jours	-	$26000
total		$123380

revenus - coûts = $123380 - $116000 = $7380/an

dans 10 ans les revenus seront $7380 + $35000 = $42380/an

M. du Plessis a acheté sa ferme il y a deux ans et depuis la valeur de la terre de sa ferme est doublée à cause de ses investissements.

Ces chiffres ne semblent pas formidables, mais les prix des animaux montent tellement vite et aussi les prix des safaris montent continuellement que M. du Plessis est très optimiste pour le futur.

p.e. il y a 5 ans le prix d'un impala était $5, maintenant le prix de vente est $100 !

Les prix actuels en Afrique-du-Sud sont:

1 girafe	- 7000 Rand	= $4900	($500 = prix au Zimb.)
1 gnou	- 1200 Rand	= $ 840	($300)
1 hippotrague	- 6000 Rand	= $4200	($800)

Il est évident que ce décalage énorme entre les prix au Zimbabwe et d'Afrique-du-Sud ne peut pas continuer.

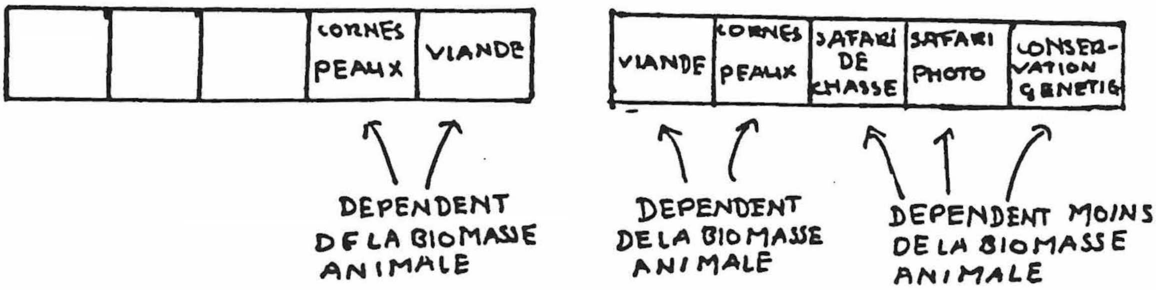
Actuellement il est défendu d'exporter des animaux de Zimbabwe en Afrique-du-Sud, mais les prix montent d'une telle façon qu'on pense atteindre des prix un peu plus équilibrés dans cinq ans.

7) SITUATION ECONOMIQUE EN GENERAL

Aussi bien que pour les captures, les Parcs Nationaux ont aussi leur propre prix pour la chasse dans certaines parties des Parcs Nationaux.

Pour une liste des prix en 1988, et une compraison des prix entre les dernières années, voyez annexe 4.

revenu de bétail | revenu de faune



- les revenus sont en relation directe avec la consommation de l'herbe

-l'essai d'augmenter les revenus met en danger l'environnement

PUIS:

-dégradation de l'environnement

- la valeur relative de la viande de boeuf descend

(6)

- les revenus sont moins dépendent de la consommation de l'herbe

- on peut augmenter les revenus sans dégradation de l'environnement

PUIS:

- peu d'effort humain (recherche etc.) a été fait pour la faune

- la demande pour de la récréation augmente

-la faune est déjà plus viable

Les fermes qui font l'intégration de la faune dans leur production ont beaucoup de succès.

Une comparaison entre les revenus obtenus dans différentes zones au Zimbabwe avec des économies plus ou moins intégrées entre faune et bétail.

100 % de bétail;

région	% du région	revenu/ha
S.O. Matabeleland	0	$1,50
Matetsi	65	$0,67
S.E. Lowveld	0	$0,92
Midlands	18	$3,78

bétail + faune;

région	% du région	rev.faune	rev.bét	rev.tot
S.O. Matabeleland	91	$1,66	$1,5	$1,16
Matetsi	10	?	$0,67	?
S.E. Lowveld	61	$0,60	$0,92	$1,52
Midlands	73	$1,72	$3,78	$5,50

100% faune;

région	% du région	revenu
S.O. Matabeleland	9	$3,78
Matetsi	25	$3,8
S.E. Lowveld	24	$2,70
Midlands	9	$2,50

(6)

Ces tableaux montrent qu'un système intégré ou un système de 100% de faune ont les meilleurs revenus.

A Chiredzi (400mm de pluie) on utilise 24% de la terre purement pour la faune.

Avec buffles les revenus sont $4,55/ha

Sans buffles les revenus sont $0,66/ha

Donc la chasse au buffle peut être très importante pour le revenu des fermiers.

Au contraire des mesures vétérinaires peuvent être très graves pour les revenus des fermiers.

A Chiredzi 75% des ranches qui ont intégré leur bétail avec la faune ont une augmentation de leurs profits de $3,72/ha à $5,72/ha, pour la vente de la chasse.

A Buffalo Ranch, près de Chiredzi on a fait entre '78 et '84 les investissements suivants:

pour le bétail - $965000

pour la faune - $36000

les revenus annuels étaient les suivants:

partie de la faune - $0,63/ha

partie du bétail - $0,18/ha

Le bétail était sur une surface de 20000 ha , la faune sur une surface de 10000 ha.

Dans les Midlands, on peut trouver "Iwaba Estate" où en 1978 tout le bétail présent fut remplacé par de la faune sauvage.

Cette ferme était l'une des plus dégradées parmi toutes les fermes environnantes; actuellement, elle possède une valeur 65% supérieure à ses voisines et la biomasse végétale s'est totalement reconstituée.

	bétail	faune
Biomasse en kg/ha	45	36
Revenu net ($/ha)	3,78	6,35
Revenu net ($/kg biomasse)	0,08	0,18

On a constaté que, dans des régions à précipitation annuelle <700 mm de pluie, l'exploitation de la faune sauvage est largement plus rentable. C'est sûrement d'autant plus vrai, qu'actuellement peu de fonds et de strutures sont consacrés à l'étude et la valorisation de la faune sauvage.

Le prix de la viande de faune sauvage à Harare est aujourd'hui: gros: $3,50/kg de carcasse

boucherie de détail: $5/kg

(la viande de boeuf coûte $7/kg au détail)

8) LE "CULLING" DES ELEPHANTS

En ce moment, on entend à travers tous les médias en Europe que l'éléphant est en voie de disparition. Mais actuellement le nombre d'éléphants au Zimbabwe, au Botswana et en Afrique-du-Sud augmente.

De ce fait, pour éviter une dégradation totale de la végétation, dans certaines régions du pays on est obligé de tuer les éléphants. Ceci se passe d'une manière rapide et aussi humaine que possible.

	Nombre d'éléphants au Zimbabwe
1900	4000
1983	50000 (dans 30% du pays)

	Population du Zimbabwe
1900	700000
1983	7000000

Depuis 1960 on a tué environ 20000 têtes d'éléphants.

Mais les jeunes dont la hauteur au garrot est entre 110 et 130 cm sont sauvés et vendus aux fermiers ou mis sur le marché international.

8.1) ECONOMIE

Coût de l'opération: $123,10 par animal

Revenu : $409.09 par animal

Le profit est donc de $287 par animal

Prix de vente des jeunes: $1200 par animal

Prix de capture : $10 par animal

(7)

9) LA C.E.E.

Les renseignements qui suivent sont le résultat d'une conversation avec D[r] Thompson, Directeur du Departement Vétérinaire du Ministère de l'Agriculture, à Harare le 30 juin 1988.

Actuellement 6 pays en Afrique ont passé un accord avec la CEE pour l'exportation de la viande de boeuf:

1) Kenya
2) Madagascar
3) Botswana
4) Swaziland
5) Afrique-du-Sud
6) Zimbabwe

Mais les conditions sanitaires au Kenya et à Madagascar ne sont pas acceptées par la CEE. Seuls les quatres derniers cités exportent de la viande dans la CEE.

Cette exportation est très importante pour ces pays car elles permettent de faire rentrer des devises.

L'Afrique-du-Sud, le Botswana et le Swaziland ont aussi passé un accord avec la CEE pour exporter la viande de faune sauvage (surtout en Allemagne).

Les conditions à remplir pour garantir ces exportations sont très strictes, comme nous allons le voir dans l'exemple suivant:

Une ferme a un surplus de 1000 Impalas

On les dirige tout doucement vers un boma, puis on les tue au fusil. Ils sont immédiatement embarqués à bord de camions présents à côté du boma:

_ le premier camion est un abattoir, l'inspection vétérinaire y est faite.

_ le second camion est un véhicule frigorifique.

A ces seules conditions, l'exportation vers la CEE est permise.

Au mois de juin 1988, le Zimbabwe demanda officiellement l'exportation de ses viandes de faune sauvage vers la CEE.

Une rencontre téléphonique avec le D[r] Watson, Directeur du Comité Vétérinaire de la CEE, le 29 septembre 1988, me confirma qu'en 1990 le Zimbabwe exporterait sa viande de faune sauvage sur le marché européen.

Quand ce marché s'ouvrira, on peut s'attendre à une hausse des prix sur le marché local. Ceci explique les forts investissements engagés actuellement par les fermiers zimbabweens.

10) PROBLEMES PATHOLOGIQUES DANS LES FERMES DE FAUNE SAUVAGE

10.1) LES TIQUES

Ces résultats sont le fruit d'une conversation avec M. M.Duncan, tecnicien vétérinaire, le 10/07/1988, à Harare.

Quand on parle avec des fermiers de faune, ce sont malgré tout les tiques qui les ennuient.

Peut-être ont ils l'habitude de faire attention aux tiques à cause du bétail, qu'on doit traiter régulièrement.

Les problèmes avec les tiques ne sont pas les maladies transmises par des tiques, mais les effets sur la peau avec infestation de larves de mouches etc. (9)

Une infestation de tiques et des carences alimentaires (p.e. pendant la saison sèche) sont les causes principales de mort des ongulés sauvages.

Surtout les élands, les hippotragues et les koudous sont très sensibles(8)

Les problèmes causés par des tiques sont:

1) le stress
2) perte sanguine
3) larves de mouches
4) infections seondaires

Des méthodes de contrôle pourront être:

1) brûler une partie du terrain

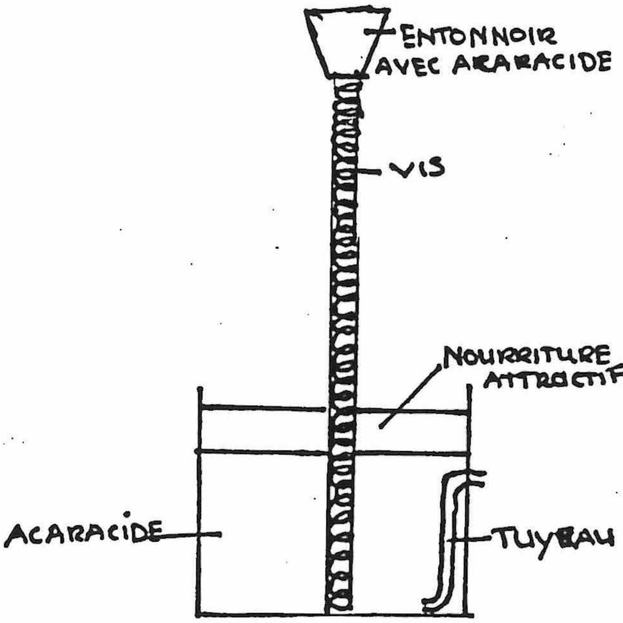
2) mettre du bétail sur le terrain, ainsi le bétail peut récolter les tiques et ensuite on peut traiter le bétail.

Mais il y a des tiques qui ne s'attachent pas tellement au bétail, mais préfèrent la faune! Et le bétail souvent ne peut pas pénétrer dans tout le terrain. (9)

Au Zimbabwe on a trouvé un appareil qui marche très bien dans la lutte contre les tiques: le "Duncan Applicator".

Cet appareil est utilisé actuellement au Zimbabwe et en Afrique-du-Sud (et bientôt ailleurs?).

le principe:



Le produit est déversé dans un entonnoir, et s'écoule ensuite le long d'une vis pour être récuperé dans un tonneau.

On dispose d'une nourriture solide au sommet de ce tonneau que les animaux viennent lécher (la nourriture contient des aliments sucrés comme de la mélasse), par la même occasion ils se frottent à la vis et s'enduisent le nez avec l'acaracide.

Quand il a plu, beaucoup l'eau rentre dans le tonneau, mais comme l'acaracide est sur une base huileuse, l'huile flotte sur l'eau.

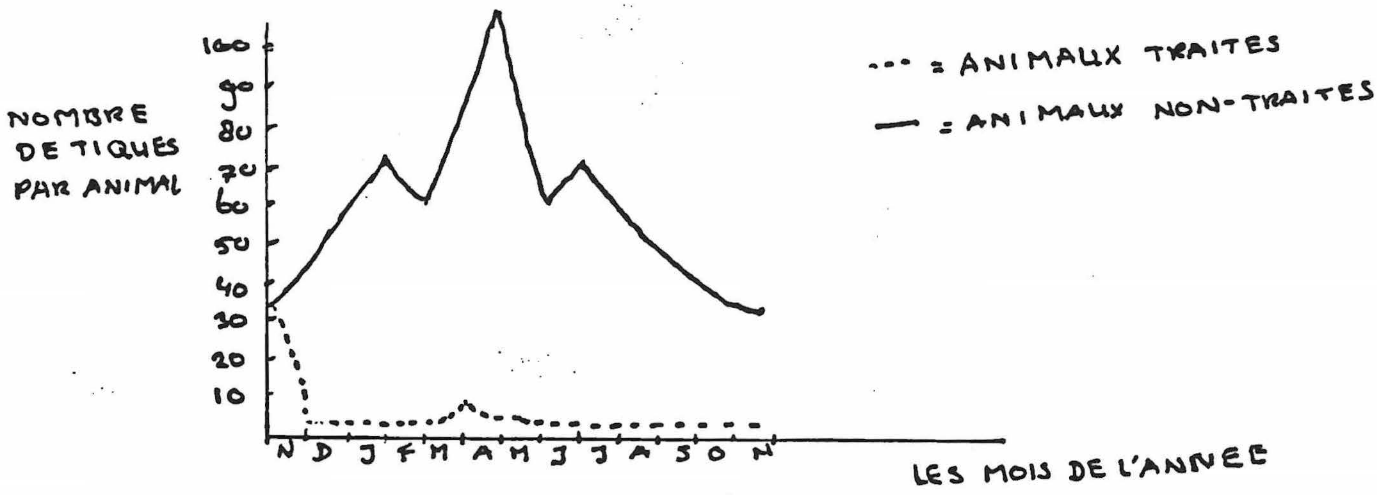
Et quand le tonneau est rempli, l'eau peut sortir par un petit tuyau.

L'acaracide utilisé est du Flumétrin 1%.

Cette lutte contre les tiques est intéressante dans les petites fermes de faune sauvage autour de Harare, tandis que dans le sud où les fermes sont très grandes et extensives, les tiques ne posent pas de problèmes.

En plus il n'est conseillé d'utiliser le "Duncan Applicator" que pendant la saison des pluies, quand le nombre de tiques est très élevé, ainsi on essaie de maintenir une résistance naturelle.

essai avec le "Duncan Applicator" à "Imbwa Farm", un peu au sud d'Harare:

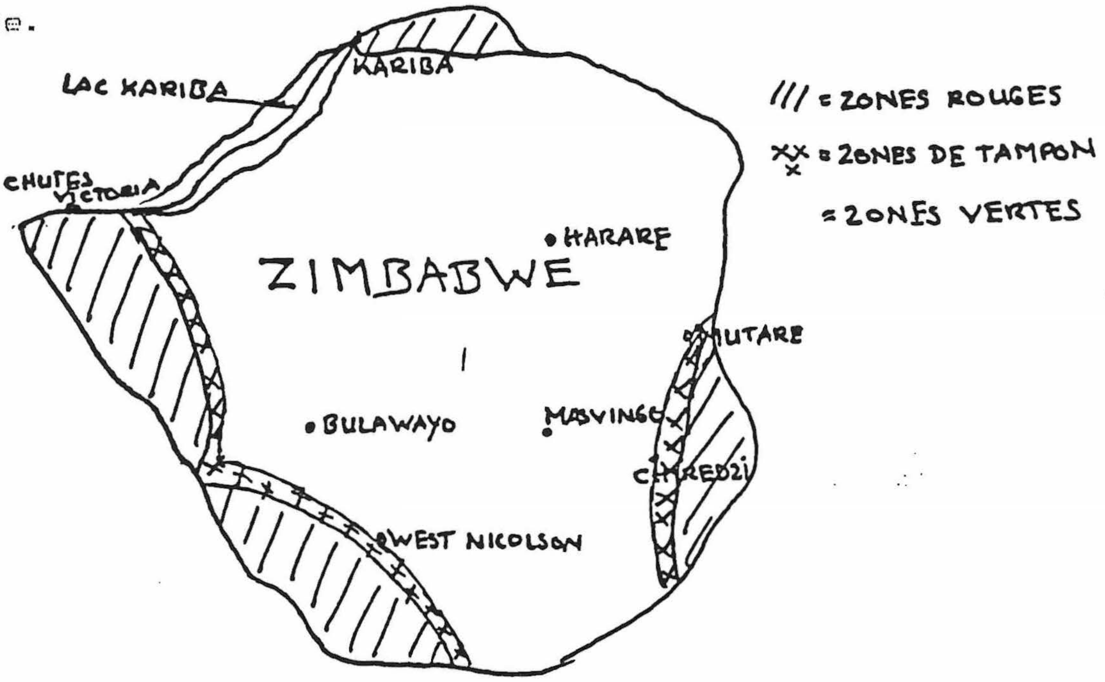


(9)

La tique qui est resonsable pour la majorité des problèmes est Rhipicephalus appendiculatus ("brown ear tique").
Mais quand on traite trop les tiques il y a le risque que les animaux n'aient aucune résistance.
Ceci était le cas avec un troupeau d'élands près de Masvingo.
On avait vendu quelques animaux à un fermier qui ne traite pas contre les tiques, et ce fermier voyait que les élands de Masvingo souffraient énormément, de tiques.
Il les a traité avec de l'ail, et toutes les tiques ont disparu.
Ensuite il les traitait quand c'était vraiment nécessaire, et après 18 mois, les élands avaient une résistance suffisante.
Le désavantage était que l'ail est assez cher au Zimbabwe!
(selon une conversation avec M Travers, propriétaire de "Imire Game Parc", près de Harare)

10.2) LA FIEVRE APHTEUSE

La situation au Zimbabwe concernant la fièvre aphteuse est très importante pour le pays actuellement.
La CEE veut être absolument sûre que toute la viande de boeuf qui est importée du Zimbabwe vient des régions dans le pays qui sont libres du virus.
Pour réaliser ça le Zimbabwe a crés des zones dans le pays: des zones vertes, des zones jaunes et des zones rouges.
Les zones vertes sont absolument libres du virus, les zones jaunes sont des zones de tampon et les zones rouges sont des zones de danger.
Seule la viande qui vient des zones vertes peut être exportée en Europe.



Tout transport des ongulés entre les zones est strictement interdit et on trouve partout des inspecteurs qui contrôlent le passage des animaux.
L'animal qui est très important dans la lutte contre la

fièvre aphteuse est le buffle.
On a trouvé que les trois types du virus de la fièvre aphteuse (SAT 1,2,3) peuvent être trouvés chez le buffle, et le buffle est le seul animalqui peut porter les trois types du virus en même temps et pour toute sa vie.
On a découvert qu'en effet 60% des buffles portent le virus vivant.

D'autres animaux comme l'hippotrague, le koudou et l'impala peuvent porter un des trois types du virus et seulement pendant deux mois, et ainsi ne forment pas un tel danger pour le bétail.
L'éland, le gnou, le potamochère et le phacochère ne peuvent pas du tout porter le virus.
Bien sûr tous les buffles sont dans les zones rouges, et il y a une obligation de déclarer quand on a trouvé des buffles dans les autres régions.
Les Parcs Nationaux viendront alors les tuer.
Comme il n'y a pas de migration de faune au Zimbabwe les zones rouges et les zones de tampon ne posent pas de problèmes.Mais comme il est constaté dans le paragraphe sur l'économie de l'exploitation de faune la perte des buffle est très dommageable pour un fermier qui exploite la faune, car avec le buffle et le léopard il peut offrir la chasse des grand 5.
Pour aider les fermiers on est en train d'élever des buffles qui sont indemnes du virus.
Il paraît que quand on attrappe des jeunes de moins de quatre

mois, ils allaitent encore leur mère et ils sont encore protégés par des immunoglobulines qu'ils ont reçu par le colostrum.

Ainsi ils ne sont ni infectés, ni porteurs du virus.

Quand on a attrapé ces veaux, on les élève à la main pour les relâcher plus tard dans de zones indemnes de fièvre aphteuse.

En ce moment il y a deux troupeaux de buffles indemnes à la fièvre aphteuse dans le pays: à Nyamaneche (une ferme d'expérience des Parcs Nationaux, 150km au nord d'Harare), et près de Masvingo.

Il est malgré tout assez délicat pour le Zimbabwe d'avoir un troupeau de buffles dans ses zones vertes, car c'est strictement interdit selon les règles de la CEE.

Dr. Tompson , le directeur des services vétérinaires au Zimbabwe m'a assuré que les pays comme l'Allemagne, l'Angleterre et les Pays-Bas savent que ces troupeaux existent, mais un pays comme l'Italie ne pourrait jamais accepter qu'un pays africain comme le Zimbabwe puisse éradiquer la fièvre aphteuse de ses territoires tandis que c'est encore un grand problème en Italie.

Actuellement il est possible d'acheter sur le marché local de la viande qui sort des zones rouges.

10.3) LE CORYZA GANGRENEUX DES BOVINS

C'est une maladie qui peut être très importante pour les fermiers qui ont du bétail et des gnous sur la même terrain.

Surtout quand les gnous donnent naissance aux jeunes ils sont très infectieux pour les vaches, et ils restent infectieux pour trois mois.

Alors les fermiers qui ont leur bétail et faune ensembles vont certainement essayer de séparer le bétail des gnous pendant ce temps, et les mettre dans des paddocks différents.

10.4) TRYPANOSOMIASE

Aujourd'hui la zone infestée de mouches tsé-tsé est la vallée du Zambèze au nord du lac Kariba.

Pendant les années '50 la lutte contre la mouche tsé-tsé était très importante.

Pendant ce temps on a tué pratiquement toute la faune dans le pays pour diminuer le nombre de mouches. (G. morsitans)

Pendant les années '60 on a tué que les guibs, les buffles et les koudous, et cette fois-ci on a eu beaucoup de succès, ce qui veut dire qu'on peut très bien séparer les animaux sensibles et non-sensibles.

Mais la G. morsitans peut être très dangereuse parce qu'elle peut transmettre T. rhodesiense. (10)

En tout cas G. morsitans disparait quand la pression humaine dépasse 40 personnes par km.

Dans la vallée du Zambèze où il y a encore des mouches tsé-tsé, on peut trouver un grand parc national: "Mana Pools".

Toutes les voitures qui sortent de cette région (et aussi celles qui viennent de la Zambie) sont inspectées avec des sprays insecticides et des filets pour tuer les dernières mouches.

10.5) LES HELMINTHES

Les animaux sauvages peuvent être très gravement infestés par des helminthes, mais on voit rarement des symptômes. Les helminthes peuvent surtout être un problème sur des petites fermes/parcs autour d'Harare.
Dans le parc "Mukibizi Woodlands" à Harare on a fait un contrôle parasitologique toutes les semaines pour une recherche de l'université.
Ces contrôles ont montré que:
1) les zèbres, les gnous et les impalas peuvent être infectés par des strongylides pendant la saison des pluies et juste après.
2) Les hippotragues peuvent être infestés par des amphistomes et de la coccidiose également pendant et juste après la saison des pluies.
D'autres recherches dans des petits parcs autour d'Harare étaient toutes négatives.

Il est connu que les éléphants dans les parcs et aussi dans la nature sont presque toujours infesté avec des strongylides.

Parfois on peut trouver des shistosomes dans le sang de la faune sauvage quand ils ont été en contact avec du bétail. (<u>Shistosoma bovis</u>)

11) LES SOUS-PRODUITS

11.1 LA VIANDE

Il n'existe pas d'organisation responsable de la distribution de la viande au Zimbabwe. Le prix de l'animal vivant devient tellement élevé qu'il est beaucoup plus attractif désormais de vendre l'animal sur pied ou de le laisser chasser plutôt que de les tuer pour la boucherie.

Quand un surplus est tué, la viande est vendue au boucher, que l'animal soit abattu par le fermier ou par un chasseur, (en dehors des cas de consommation personnelle). Parfois on l'utilise dans l'élevage des crocodiles.

Le boucher peut soit:

- vendre la viande fraîche ($5/kg)
- faire sécher puis vendre la viande ainsi conditionnée (elle est alors appelée "biltong")

Voici seulement quelques mois que l'on peut se procurer de la viande de faune sauvage à Harare, en fait depuis que le ministre Joshua Nkomo se soit étonné de son absence dans la capitale.

11.2) TROPHEES, CUIR ET PEAUX

La plupart du temps, les animaux sont chassés par des allemands ou des americains, comptant bien rammener chez eux les trophées. La préparation de ces trophées peut se faire, suivant la volonté du chasseur, soit au Zimbabwe, soit ailleurs. Mais le plus souvent cette opération se réalise au Zimbabwe.

Les cornes sont séchées au soleil, puis traitées dans des bains de sel et par l'huile. Des ongles de buffles on fait par exemple des cendriers. Les pattes d'éléphant sont transformées en poubelles!

Le facteur limitant devient le prix du sel qui a énormément monté ces dernières années (de $7 pour un sac de 50kg en 1982 à $25 en 1987).

Exemple: prix de la préparation d'une tête d'hippotrague

	1982	1988
aux USA	$1200	$2000
au Zimbabwe	$750	$1500

Suite à une visite faite à la tannerie de Bromley, à 60km de Harare, j'ai pu constater qu'il était très difficile de se procurer suffisamment de sel, celui-ci venant surtout d'Afrique-du-Sud et coûtant donc cher en devises. Les produits chimiques doivent également être importés.

La tannerie de Bromley est une tannerie qui s'est spécialisée complètement dans la faune sauvage.

Ils reçoivent leur matériel:

1) des safaris

2) des chasseurs locaux

3) des fermiers qui ont tué des animaux de surplus

A Bromley on prépare pourtant des peaux à poils, mais aussi ici les prix ont augmenté.

	en 1982	en 1988	
crue	$2	$10	
préparée	$15	$55	peau d'impala
crue	$10	$15	
préparée	$40	$80	peau de koudou
crue	$175	$350	
préparée	$500	$1400	peau de zèbre

Bien sûr les chasseurs de safaris payent que les coûts de préparation.

Les produits peuvent être exportés après un permis des Parcs Nationaux et une signature des inspections vétérinaires.
Le cuir est aussi préparé au Zimbabwe, et seuls les cuirs d'éléphant et de boeuf sont intéressants.

12) RECHERCHE ACTUELLE

Actuellement il y a très peu de recherche au Zimbabwe au sujet de la faune sauvage, et certainement très peu comparé à la recherche faite par des organismes pour le bétail.

Une personne qui essaie d'en faire le plus possible est le Dr. M. Knottenbelt.

Elle fait actuellement une étude sur la mortalité sur les fermes de faune (voir annexe 5).

Un des problèmes est l'organisation des données. Quand on envoie des fécès, du sang ou des tissus à l'université, il peut s'écouler des mois avant qu'on ait la réponse.

Cela ne motive pas les fermiers à coopérer au maximum.

13) ORGANISATION

En principe tous les fermiers commerciaux sont organisés et font partie d'une association.

Pour les fermiers de faune sauvage il y a "the Game Farmers Producers Association".

Cette association fournit aux fermiers de faune l'information qu'ils demandent et est soutenu par les levées que les fermiers doivent payer, p.e. à la capture.

Les autres activités de l'association sont:

1) être une source d'information pour les fermiers intéressés
2) informer le public
3) organiser des sessions de démonstrations
4) être le centre de coordination de la capture
5) faire des statistiques

En ce moment il y a 143 membres actifs et 250 membres passifs dans l'association.

14) LE FUTUR

Le futur des fermiers de faune au Zimbabwe paraît porteur de développement.

Quand la CEE acceptera définitivement la viande de faune, et quand on continuera de poursuivre le combat actuel contre le braconnage, très peu d'obstacles pour la poursuite du développement des fermes de faune sauvage persisteront.

Mais dans un pays comme le Zimbabwe beaucoup de choses pourront se passer du jour au lendemain, et pour ça il faut suivre les développements de près.

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ANNEXES

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ANNEXE 1

ZIMBABWE

A. Overview

Zimbabwe has enacted comprehensive legislation to implement CITES. The Control of Goods (Import and Export) (Wildlife) Regulations, 1982 apply import and export controls to all the species listed in CITES Appendices I, II, and III, and in some cases extend controls beyond those of CITES for species indigenous to Zimbabwe.

The principal act in Zimbabwe for regulating the taking and domestic sale of wildlife is the Parks and Wild Life Act, 1975, as amended. This act includes provisions on the taking of indigenous plants, hunting of wild animals and regulation of fishing. Certain indigenous plants and animals listed in schedules to the act are declared to be specially protected. General regulations to the act make detailed provision for hunting restrictions, licences, required forms and fees.

A.1 List of Relevant Legislation in Force

1. Parks and Wild Life Act, 1975, as amended.
2. Parks and Wild Life (General) Regulations, 1981 (S.I.900 of 1981).
3. The Control of Goods (Import and Export) (Wild Life) Regulations, 1982 (S.I. 557 of 1982) made under the Control of Goods Act (Cap.280).
4. Trapping of Animals (Control) Act, 1973, as amended.
5. Natural Resources Act (Cap.150) and Amendments of 1981 (No.16 of 1981).

A.2 Competent Authority

The Department of National Parks and Wild Life Management, Ministry of Natural Resources and Tourism is the lead agency for species conservation at the national level.

The Natural Resources Board, established under the Natural Resources Act (Cap.150) with its countrywide system of conservation committees, is responsible for general supervision of all activities concerning natural resources, including wildlife, in Zimbabwe. It has special competence in matters of species conservation, particularly outside protected areas. Conservation committees representing grassroots conservation interests supervise conservation matters at the local level and play a major role in wildlife management and control of hunting.

A.3 International Conventions

Zimbabwe became a Party to CITES on 17 August 1981.

Zimbabwe is not a Party to the African Convention.

B. Summaries of Relevant Legislation

B.1 The Parks and Wild Life Act, 1975, as amended and consolidated in January 1982, is the principal act regulating the taking of animals and indigenous plants and the sale of wild animals or wild animal products. The act establishes a Parks and Wild Life Board to oversee national policy and programmes on the conservation and use of wild life resources and natural habitats in Zimbabwe. Provisions are included concerning the Parks and Wild Life Estate, National Parks, Botanical Reserves, Botanical Gardens, Sanctuaries, Safari Areas and Recreational Parks. All these protected areas are managed to serve conservation purposes. Taking is generally prohibited in National Parks and Botanical Reserves. In safari areas, hunting may be allowed by the Minister.

The act provides that certain animals and indigenous plants are specially protected. Schedules to the act, which the Minister may amend, list these species of wildlife. The act generally requires a permit to pick any indigenous plant on any land. The Minister is given authority to prohibit or restrict hunting and removal of animals in defined areas. The act allows the appropriate authority for the land (the land holder) considerable freedom in its use, including the hunting of wildlife (other than specially protected animals) on his land. However, the land holder may not sell a live animal or a trophy (durable portion of an animal) without first obtaining a permit.

Conservation committees responsible for overseeing use of local lands also may restrict hunting. Enforcement powers, legal proceedings and penalties are provided for. The act contains ten schedules, two of which deal with specially protected animals and indigenous plants.

B.2 The Parks and Wild Life (General) Regulations, 1981 (S.I. 900 of 1981) are the principal regulations made under the Parks and Wild Life Act, 1975, as amended. These regulations specify prohibited and restricted methods of hunting. Provisions are included on the issuance and use of various licences. The professional hunter's licence, learner professional hunter's licence and professional guide's licence are applicable only in protected areas (the Parks and Wildlife Estate). However, it is an offence for any person to purport to be a licensed operator without being so licensed. Breeder's licences and trophy dealer's licences also are covered by these regulations. Special procedures apply to possession or transfer of ivory or rhinoceros horn. Additional penalties are specified. These regulations contain ten schedules, including schedules of animals for the hunting of which specified weapons are required, and forms for registers and certificates.

B.3 The Control of Goods (Import and Export) (Wild Life) Regulations, 1982 (S.I. 557 of 1982), as amended, made under the Control of Goods Act (Cap.280), implements CITES in Zimbabwe. All species listed in CITES Appendices I, II, and III are incorporated into national law by these regulations and CITES import and export controls apply. In addition, the regulations list certain indigenous species from CITES Appendix II to which Zimbabwe applies trade control measures as if they were listed in Appendix I. Trade controls also are extended to live fish and live crustaceans not specified in CITES, and to all specially protected indigenous plants and parts thereof, unless such plants have been artificially propogated. These regulations include provisions on issuance and use of the import and export permits and certificates required. Penalties for offences against the regulations are specified.

B.4 The Trapping of Animals (Control) Act, 1973, as amended, regulates the making, possession and use of certain classes of traps for capturing animals. Legal proceedings, enforcement powers and penalties for offences are included. A 1982 Notice (S.I. 646) under this act lists the compensation to be paid to the appropriate authority for illegal trapping of specified species of wild animals and fish.

B.5 The Natural Resources Act (Cap.150), as amended in 1981 (No.16 of 1981), provides for the conservation and improvement of all natural resources of Zimbabwe, and creates a Natural Resources Board to oversee national conservation measures (sec.10). "Natural resources" are defined to include the animal, bird, and fish life of Zimbabwe, and the trees, grasses and other vegetation (sec.2). Particularly on lands not part of Zimbabwe's Parks and Wildlife Estate (the country's system of protected areas), the Natural Resources Board oversees measures concerning wildlife management and maintains close consultation with the Department of National Parks and Wildlife Management. The act also authorises the creation of local level conservation committees responsible for supervising and undertaking measures of natural resources conservation in intensive conservation areas — areas designated by the Minister (secs. 50,52,48) and covering most of the country. Local wildlife management and control of local hunting involve the direct participation of local conservation committees at the implementation stage. These committees receive direction from the Natural Resources Board and advice from the Department of National Parks and Wild Life Management.

C. Regulation of Taking of Species

C.1 Taking Generally Prohibited

The Parks and Wild Life Act, 1975, as amended and consolidated in January 1982, (hereinafter referred to as the "principal act") declares certain animals to be specially protected (sec.34). These animals are listed in the Sixth Schedule to the act. Taking of specially protected animals is prohibited except in accordance with a permit issued by the Minister (sec.36). This permit may be issued only for limited purposes: scientific research or education, falconry captive breeding, live export or restocking, wildlife management or defence of property (sec.37).

The principal act also declares certain indigenous plants to be specially protected; specially protected plants are listed in the Seventh Schedule to the act (sec.38). Taking of such plants is generally prohibited except under certain circumstances where the Minister issues a permit to the owner or occupier of land (sec. 40). Permits may be issued for such purposes as export, cultivation and propogation, scientific purposes and the collection of specimens for museums or botanical institutions (sec.41). The Parks and Wild Life (General) Regulations, 1981 (S.I. 900 of 1981) (hereinafter cited as the "principal regulations") specify the procedures for application for and use of a cultivator's permit for specially protected indigenous plants (secs. 46,47).

Several notices made pursuant to the principal act specify certain animals and indigenous plants to be protected animals and plants within the conservation committee areas of responsibility defined in the notices.

C.2 Taking Allowed With Regulation

The principal act prohibits the hunting or removal of any animal on any land except in accordance with permission from the appropriate authority for that land (sec.47). "Appropriate authority" means the land holder, whether a private individual or the state depending upon the land in question. Local conservation committees oversee

wild life hunting on most land. These committees interact with and receive management advice from the Department of National Parks and Wild Life Management. The Minister is authorised to prohibit or restrict hunting or removal of animals in any defined area for purposes of control of disease, protection of human life and property, conservation or administration (sec.48). This provision gives the government the power to take unilateral action to control or prohibit hunting if the appropriate authority abuses its rights and the abuse is not stopped by the corresponding conservation committee. Under this ministerial authority several notices have been issued identifying "non-hunting" or "restriction on hunting" areas in Zimbabwe. An exception is provided for acts in defence of life (sec.49). Reporting procedures are specified for animals killed or wounded by accident or in defence of life. Where a specially protected animal is killed or wounded under such circumstances special procedures apply (sec.51). Special procedures also apply to reporting requirements for the wounding of dangerous animals, as identified in the Ninth Schedule to the act.

The principal act prohibits any person from undertaking for reward any hunting safari in national parks and other lands under the authority of the Minister except with a professional hunter's licence, learner professional hunter's licence or professional guide's licence (sec.53). The act specifies the conditions of issuance and use of such licences (sec.54-57).

Local conservation committees may recommend hunting restrictions on any alienated land within its area for purposes of wildlife management (sec.68). On alienated land, the Minister also may restrict or specify hunting periods, after consultation with the Natural Resources Board and the conservation committee concerned (sec.66). Alienated land is defined as private land, State land held through purchase or lease or trust land held by lease.

The principal regulations specify prohibited or restricted hunting methods, particularly the use of inappropriate weapons, and include a schedule listing certain methods for various animals (sec.53). Application procedures for professional hunter's licences, learner professional hunter's licences and professional guide's licences also are provided for.

With regard to plants, the principal act prohibits the taking of any indigenous plants in Zimbabwe except with a permit issued for that purpose by the appropriate authority for the land involved (sec.45).

C.3 Taking Not Regulated

The principal act contains a schedule (Schedule Eight) listing certain problem animals. It is the responsibility of each landowner to control the populations of problem animals. Landowners are advised by local Conservation Committees and the Department of National Parks and Wild Life Management when special control measures are required.

D. Domestic Trade, Possession, and Transport

The principal act prohibits the possession, sale or other disposition of any live specially protected animal or the meat or trophy of such animal except with a permit issued by the Minister (sec.36). This permit may be issued for scientific, educational, zoological, falconry, captive breeding, export, restocking, conservation, defence of life or property, or other purposes determined appropriate by the Minister (sec.37). Except where a permit has been issued, any specially protected animal killed or found dead becomes a State trophy (sec.37A).

Similar provisions are made in respect of specially protected indigenous plants. The principal act prohibits the sale of any such plant except with a permit, by a dealer in such plants, or by a member of a recognised horticultural society selling to another member or recognised society (sec.42). The purchase of a specially protected plant is prohibited except with a permit, from a dealer or a public place, or as a member of a recognised horticultural society from another member of a recognised society (sec.42). The Minister is authorised to issue permits to cultivators of specially protected plants to sell such plants (sec.43), or a temporary permit to any person to sell under specified conditions. The principal regulations under the act contain conditions for the issuance and use of a temporary permit, including the requirement that a certificate of sale or transfer containing particulars about the permit, plant, and parties involved be delivered to the purchaser before sale (sec.49). Records of such transfers must be kept by dealers or cultivators for specially protected plants listed in a schedule to the regulations.

The principal act also contains provisions for the domestic trade of animals, indigenous plants and trophies. The act prohibits the sale of any animal, or the meat or trophy of any animal, where the animal has been hunted in contravention of the act (sec.59). An exception is made for animals which were born or hatched and have remained in captivity (sec.60). Except for trophies lawfully acquired from the State, manufacture of articles from trophies or disposal of such articles is prohibited (sec.61). Any purchaser of a live animal has the burden of verifying that the sale is valid. An exception is made where the sale is in a public shopping place or other fixed place of business (sec.62). The Minister may issue a permit to any person to sell a live animal or trophy (sec.65). Such a permit is required for the sale by a land holder of any live animal or trophy obtained from hunting on the land holder's land.

The principal regulations under the act specify the conditions for application and use of a trophy dealer's licence. This licence is required for manufacturing trophies or carrying on a trophy selling or buying business (sec.62). Each dealer is required to keep a register of transactions in trophies in the form prescribed in a schedule to the regulations. An ivory dealer or manufacturer must obtain an ivory dealer's licence or ivory manufacturer's licence as specified in the regulations (sec.63). Ivory manufacturers must keep special registers which include the accumulated ivory dust resulting from the business and must submit monthly returns on dust accumulated or sold (sec.69).

The principal regulations also require that ivory or rhinoceros horn must be produced to a specified officer for registration within fifteen days of acquisition (sec.73). Upon a determination of lawful possession, the specified officer shall register the ivory or horn, give it a distinctive mark as specified in a schedule to the regulations, and issue a certificate of ownership in the form specified in another schedule to the regulations (sec.73). The sale or transfer of unregistered ivory is prohibited, and a lawful sale or transfer requires a corresponding endorsement and

transfer of the certificate of ownership (sec.76). The sale, manufacture, processing or carving of any horn is prohibited (sec.77). The transfer of an unregistered horn is prohibited, and any legal transfer requires the corresponding transfer and endorsement of the certificate of ownership (sec.78). An exception to the requirements for registration is made for ivory or horn held by a museum, scientific or educational institution (sec.79).

The principal regulations also prohibit the possession or breeding of reptiles or amphibia for sale, or for sale of trophies therefrom, except with a breeder's licence issued and used in accordance with provisions of the regulations (sec.57-59). A registry of specified breeder activities must be kept by the breeder (sec.60).

Finally, the principal act prohibits the sale of any indigenous plant picked on any land except in accordance with a permit issued by the appropriate authority for that land (sec.46).

E. International Trade

E.1 Legislation

The Control of Goods (Import and Export) (Wild Life) Regulations, 1982 (S.I. 557 of 1982), made pursuant to the Control of Goods Act (Cap.280), is the principal legislation in Zimbabwe governing international trade in wildlife. These regulations are promulgated expressly for the purpose of implementing CITES in Zimbabwe. No person shall import into or export from Zimbabwe any wild life, trophy or controlled goods except in accordance with these regulations (sec.3). Exceptions to this general rule are made, e.g., for items acquired before the Convention became applicable (so long as the person holds a certificate to that effect), or for approved museums or scientists.

All species listed in CITES Appendices I, II, and III are listed in these regulations and CITES import and export controls apply. In addition, the regulations list certain CITES Appendix II species indigenous to Zimbabwe to which Appendix I trade controls are applied.

The regulations contain two schedules, the first declaring game-traps of metal construction, operated by springs, to be controlled goods. The Second Schedule contains five parts, Parts I through III for Appendices I, II, and III of the Convention, Part IV specifying wildlife not specified elsewhere, but trade in which is controlled, and Part V specifying wildlife which is treated as wildlife in Appendix I of the Convention for purposes of import into Zimbabwe. The trade controls are extended to the following wildlife not specified in the Convention appendices: 1) all vertebrates and invertebrates, other than fish or crustaceans, of species normally existing in a wild state in Zimbabwe, 2) live fish and live crustaceans which are not specified, and 3) all specially protected indigenous plants as defined by the Parks and Wild Life Act, 1975 and trophies of such plants, where such plants are not specified and not artificially propogated (Part IV, Second Schedule).

The regulations provide for the issuance of three kinds of documents: an open general permit, a permit and a certificate. The open general permit may be either a general import or export permit authorising the import or export of any wild life referred to in Part III (Appendix III of the Convention) or Part IV (extra trade controls) of the Second Schedule. Open general permits shall be issued by the Minister by notice in the Gazette, taking into account the obligations of the Convention (sec.4).

A permit may be issued by the Director of National Parks and Wildlife Management, or the Controller of Customs under his direction, authorising the import, export or re-export of any wild life or trophy. A permit shall not be issued for Appendix I species except where the Director or Controller is satisfied that the corresponding export or import certificate will be forthcoming from the country of export or import, and that the trade will not be detrimental to the survival of the species. In the case of imports, are involved it must be determined that the items are not to be used primarily for commercial purposes, and that no law has been contravened in obtaining the items for export. In the case of a live specimen, the Director shall be satisfied that the recipient and shipping facilities are suitable. These conditions also apply to the import of wildlife in Part V of the Second Schedule. In the case of permits issued for wild life in Part II (Appendix II of the Convention), the Director or Controller also must be satisfied that the trade is not detrimental to the species in the wild, the item was not obtained in contravention of any law, and, for a live specimen, that export shipment is in such a manner as to minimize risk of injury (sec.5).

Certificates may be issued by the Director, or Controller under his direction, authorising the import of Part I or II items taken from the marine environment not under the jurisdiction of any state, or the re-export of any wild life in Part I, II or III (Convention Appendices I, II or III) or any trophy of such wild life, where the item was previously imported into Zimbabwe under these regulations (sec.5 (1)(c)). A number of conditions are specified for issuance of a certificate. Where the item is to be imported and it is a Part I item, the Director must be satisfied that the import is not detrimental to the survival of the species and not to be used primarily for commercial purposes. In the case of a Part II item, the Director must be satisfied that the import is not detrimental to the survival of the species. In either case where a live specimen is involved, the Director must be satisfied as to certain matters relating to handling and as to the recipient conditions.

Certificates for re-export shall be issued only where the Director or Controller is satisfied, in the case of Part I items, that an import permit will be granted by the country of import and the provisions of the Convention are being complied with; live specimens must be so prepared and shipped as to minimise injury. For Part II items, the Director or Controller must be satisfied that the provisions of the Convention are being complied with, and, for live specimens, that preparation and shipment minimise risk of injury.

Whenever appropriate and feasible, the Director or Controller is authorised to mark wildlife or trophies being imported or exported in such a manner that the mark is difficult to counterfeit (sec.14).

The regulations specify information which shall appear on every permit or certificate and authorise the Director to prescribe a form to meet these specifications (sec.6). No permit or certificate shall authorise import, export or re-export for more

than one consignment of wild life or trophies. A permit is not transferable and shall be valid no more than six months unless it is revoked earlier (sec.7).

The Minister is authorised to appoint inspectors for the purposes of these regulations (sec.11). Powers of inspectors and other authorised ministerial representatives are included, as are provisions on offences and penalties.

E.2 CITES Authorities

The Zimbabwe CITES Management Authority is:

Department of National Parks and
Wild Life Management
P.O. Box 8365
Causeway
Harare, Zimbabwe

Telephone: 707624
Cable: PARKLIFE HARARE

Eight regional offices of the Management Authority have been identified as competent to grant permits. The Scientific Authority is the same as the Management Authority.

ANNEXE 2

Exemples de petites fermes/parcs autour d'Harare:

A) "Imire Game Park" à Wedza propriétaire: M. N. Travers

surface: 3080ha à 100km d'Harare

production: bétail + faune sauvage

les animaux présents:

2 éléphants	75 zèbres
10 buffles	92 gnous à queue noir
9 girafes	2 crocodiles
33 hippotragues	1 lion
20 élands du cap	des impalas
7 damaliques à front blanc	des céphalophes du natal
7 rhinocéros noirs	des steenboks
3 léopards	des oribis
45 cobes à croissant	des cobes des roseaux
31 sassabys	

La ferme est divisée en trois paddocks où sont pratiqués des rotations avec bétail et faune, mèlés sauf pendant la saison de naissance des gnous, pour éviter la transmission du coryza gangréneux des bovins.

Aujourd'hui il y a 1500 têtes de bétail contre 700 têtes de faune sauvage. (il y a 15 ans c'était 500 : 1 !)

B) "Carolina farm"   propriétaire: M. D. Tomlinson

surface: 1800ha   à 1600km d'Harare

production: bétail + faune + produits agricoles.

les animaux présents:

2 girafes	19 hippotragues
35 impalas	17 gnous à queue noire
4 damalisques à front blanc	65 cobes à croissant
15 autruches	50 grands koudous
22 élands du cap	5 guibs harnachés
9 sassabys	

Cette ferme est très intéressante car ils n'ont pas beaucoup de bétail (50 têtes), mais leur produit principal est le tabac, l'arachide et le mais.

La production du tabac est faite dans le parc, et on cultive quelques hectares de plus pour la faune!

Ils ont commencé l'exploitation de la faune il y a deux ans et cette année on chassera pour la première fois sur les élands, les koudous et les cobes.

L'année prochaine on ajoutera les gnous et les impalas.

C) "Mukibizi Woodlands" (parc national) à Harare:

Mukibizi Woodlands est un petit parc national pour les gens de la ville et surtout pour les écoles d'Harare. L'éducation des jeunes est le but principal. On y organise des safaris à pied.

Animaux présents:	2 élands
2 éléphants	13 gnous à queue noire
12 zèbres	2 cobes des roseaux
14 impalas	2 cobes à croissant
3 sassabys	7 cephalophes du Natal
1 hippotrague	7 steenboks

La gestion des pâturages recommandée au Zimbabwe est ici largement mise en pratique:

1) Couper l'herbe chaque année juste après la saison des pluies (mois de mai-juin)

2) Brûler une fois tous les quatres ans juste avant la saison des pluies (mois d'août-septembre).

En été on supplémente la ration avec du sel, en hiver avec des granulés.

ANNEXE 3

1. INTRODUCTION:

The concept of carrying capacity is central to conservation and wildlife management. Where the goal is preservation for nonconsumptive uses, the difference between the carrying capacity estimate and the actual density provides an index of the success of preservation measures and of the effort required in law enforcement. The carrying capacity estimate also provides an indication of the area's potential for tourism. Where the goal is consumptive use, the carrying capacity estimate contributes to the determination of sustainable off-take quotas and the economic potential of harvesting. Where the goal is control, the carrying capacity estimate gives an indication of the effort and cost required to reduce the population to a specified level. For these reasons, it is useful to clarify precisely what is meant by the term carrying capacity, to review the methods of estimating it, and to look at what it means in terms of off-take quotas.

2. WHAT IS CARRYING CAPACITY?

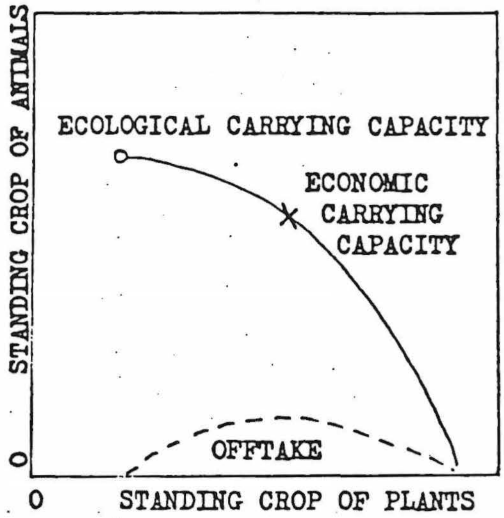
The term carrying capacity has been used in a variety of different ways by different people. As a result, there has been a good deal of confusion and argument at cross-purposes. A key step in clearing up this confusion was Graeme Caughley's (1979) paper entitled: "What is this thing called carrying capacity?" Since this appeared in a very obscure symposium, it is worth summarizing the main points here.

Caughley's paper refers specifically to large herbivores. He starts by making the point that plants and herbivores exist in interactive systems and that the two components cannot be treated in isolation. Any particular plant-herbivore system will, if left undisturbed by outside off-take or input, settle down to an equilibrium state with a particular biomass of animals and a particular biomass of plants. Caughley calls this equilibrium the "*ecological carrying capacity*." This is the point at which the rate of production of edible forage equals the rate at which the edible forage is consumed by the animals. At this point, the plant biomass will be well below what it would be if there were no animals present. The animals are not necessarily in very good condition; their death rate equals their birth rate (this is why their numbers are stable), and they may be small and bear small trophies. This equilibrium is usually what a pure preservationist means by carrying capacity. However, a livestock owner, a game rancher or a park warden may well regard the situation as "overstocked" or "overpopulated."

The ecological carrying capacity is not the only possible equilibrium between plants and animals. Other equilibria can be enforced by removal of animals, and each enforced equilibrium differs from the ecological carrying capacity equilibrium in that the standing crop of animals is lower and the standing crop of edible vegetation is higher. Suppose we start at ecological carrying capacity, then set a small hunting quota which we remove each year. The animal population will drop slightly and the edible plant biomass will increase slightly. This is a new plant-herbivore equilibrium which depends on the regular off-take of that small quota. We can now increase the quota slightly and the system will shift to a third equilibrium with fewer animals and more edible forage.

If we made a series of experiments of this kind and plotted the equilibria on a graph of standing crop of animals against standing crop of edible vegetation, the points would lie on a single curve which is called the zero isocline of vegetation. This curve defines all possible equilibria that can be enforced by sustained-yield hunting. Figure 1 shows a modelled zero isocline of vegetation and the sustained off-take needed to enforce an equilibrium at any point on the isocline.

FIGURE 1 (from Caughley 1979)



The zero isocline of vegetation marking the position of all equilibria between plants and animals enforceable by hunting. The off-take curve is the annual sustained yield necessary to enforce such equilibrium. The ecological carrying capacity point is the equilibrium in the absence of hunting whereas the economic carrying capacity point is the equilibrium enforced by a maximum sustained yield.

The next point to notice is that in Figure 1, the off-take required to stabilize the plant-herbivore system at any particular point follows a curve which rises from zero at ecological carrying capacity, reaches a maximum, then falls back to zero as the animals are removed altogether. The maximum point on this off-take curve is the maximum sustainable yield (MSY) and it occurs at a point where the number of animals is below that of ecological carrying capacity (usually between a half and three-quarters of that level), and where the edible plant biomass is above that at ecological carrying capacity. The MSY occurs at that point on the curve at which the rate of increase of the animal population is highest, the rate of increase being determined by the number of animals multiplied by the excess of the birth over the death rate. This is the point called by Dasmann (1964), the "optimal density," and it corresponds to the point of inflection of the logistic population growth curve at which the rate of population growth per unit time begins to decrease (Mentis 1977). At the MSY point, the animals will be in good condition and have high reproductive and survival rates. Caughley calls this equilibrium point the "*economic carrying capacity*." It is a situation resembling this that most livestock owners and game ranchers mean when they talk about carrying capacity.

Neither the ecological nor the economic carrying capacity or any other equilibrium point is in any sense objectively better than any other. Which is preferred depends on the objective for the area. If the objective is preservation for aesthetic or scientific reasons, ecological carrying capacity may be preferred. However, if the objective is either to obtain a sustained yield, to maintain animals in better condition with larger trophies, or to maintain a higher biomass of vegetation, the manager must apply an off-take pressure heavy enough to supply an appropriate yield or to establish the desired plant-herbivore equilibrium. The manager may not like all the linked consequences of the off-take, such as the reduction in animal numbers or the increase in vegetation, but he will have to put up with them. In short, the zero isocline represents the class of technically sound options, but the choice of which point on the isocline is enforced depends upon the value system of the manager. It is what Bell (1983) calls an aesthetic, as opposed to a technical decision.

3. COMPLICATIONS:

Caughley's (1979) paper gives a clear and straightforward exposition of the concept of carrying capacity. However, as he himself has pointed out often enough, life is not always as simple as that. We now have to consider a series of complications:

a. Eruptions:

Firstly, as Caughley (1979) points out, animal populations can exceed ecological carrying capacity whenever they are suddenly released from a constraint such as hunting, water shortage or competition from other species that has been holding them below ecological carrying capacity. Here, the classical eruption, crash, extinction or recovery to equilibrium occurs, the sequence commonly seen following the introduction of a species to a new area (i.e., moose on Isle Royale, thar in New Zealand), or the setting up of a national park (elk in Yellowstone, nyala in Lengwe, impala in Natal). This sequence was originally described by Riney (1964).

The eruption-crash sequence is caused by the fact that the animal population is confronted by a superabundant food supply in response to which it increases rapidly and overshoots ecological carrying capacity. As Caughley (1979) puts it, the reason for the overshoot lies in the herbivores' inability to distinguish between what, in monetary terms, we describe as principal (capital) and interest. To them, all edible plant material is food and they have no inhibition against browsing or grazing in excess of the vegetation's rate of renewal. Hence, they can reduce the supply of food available to the next generation. This introduces a lag between cause and effect which sets up an oscillation, the spectacular peak and crash of the ungulate eruption. With medium sized ungulates, this usually takes 20-30 years to complete (Caughley 1981).

An equilibrium is finally achieved, however, because the plants and herbivores are pulling in opposite directions. As the plant biomass declines, the rate of plant growth per unit biomass increases, while the food intake per animal declines, reducing animal condition and natality and increasing mortality. Except in special circumstances (see below), equilibrium at ecological carrying capacity is the inevitable outcome of this negative feedback within the plant-herbivore system.

The route to the equilibrium can be smoothed out, that is, the overshoot and crash can be reduced or eliminated by reducing the rate of increase of the animal population during the eruption. This can be done by culling at a rate adjusted to allow a slow rate of increase. This allows time for the vegetation to adjust to the herbivore increase and a gentle approach to ecological carrying capacity at which point the cull will be zero (Caughley 1977, Bell 1981a). Whether the final equilibrium is the same, whether or not the overshoot and crash is eliminated by culling, seems open to question. Riney (1964) implies that following the overshoot and crash, the habitat is degraded and the carrying capacity reduced. Caughley (1977), however, suggests that the ultimate equilibrium would be the same whether or not an overshoot and crash had taken place. This is a hard pair of alternatives to test and I am not aware of any convincing evidence on either side. My guess is that the outcome would depend on whether the crash was accompanied by a significant loss of soil nutrients, in which case the following equilibrium would have more plants and fewer animals than the former (see Bell 1982, 1983 and Chapter 9). Certainly, however, most conservationists will end up with calmer nerves if the overshoot and crash is moderated by culling.

b. Oscillations:

In certain special circumstances, a stable equilibrium at ecological carrying capacity may never occur. These are the circumstances of heavy plant use and slow mutual responses between plants and herbivores that lead to prolonged oscillations or stable limit cycles. The conditions are outlined in Chapter 9 and analyzed in detail by Caughley (1976a and 1977). There is some evidence that in certain situations, elephants and woodlands may exist in this type of relationship (Caughley 1976b and see Chapter 10). The long-term oscillations involving predators, small mammals and vegetation in the subarctic zone are probably also of this type although here the story may be complicated by cycles in secondary chemical defenses in the vegetation (Krebs 1978).

In these circumstances, we are faced with another problem of terminology in terms of carrying capacity. How do we describe the carrying capacity of an oscillating system where the densities of animals may vary by one or two orders of magnitude? This is really a semantic argument. Some people prefer to say that the carrying capacity is continuously changing, others to take a mean value, and yet others to take the peak value. My own view is that the concept of carrying capacity is, at best, an idealization of the outcomes of certain types of model which, in the stable limit cycle situation, is inappropriate. However, in such systems hunting or culling may have a stabilizing influence so that an equilibrium is achieved; here a stable economic carrying capacity may be intermediate between the extremes of the oscillating animal density. This is the basis for the argument that culling may be necessary to maintain relatively high elephant densities.

c. Environmental Fluctuations:

A common situation is that densities of plants and herbivores vary continuously both within and between years in response to environmental fluctuations, particularly rainfall. In areas of high rainfall variation, usually arid areas, densities may vary greatly. Here again, it is probably strictly correct to think of ecological and economic carrying capacities varying continuously. However, in most situations, it is more practical to think of each as a series of bands of different probability. This is the approach adopted by Caughley and Walker (1983).

d. Emigration and Immigration:

Norman Owen-Smith (in press) has concluded from simulation trials that the point on the plant-animal density curve at which a system stabilizes can be influenced by animal movement into and out of an area. He suggests that if animals are prevented from dispersing, the system comes to rest at a higher density of animals and lower density of plants than if they are allowed to disperse. One may infer that if animals are forced to immigrate into an area, the system may reach still higher animal densities and lower plant densities. This is the situation envisaged as resulting from compression of elephant populations (Laws, *et al.* 1975). Such limits to dispersal and compression may erode vegetation capital and lead to a crash or oscillation. For example, Huffaker (1958) in a classic series of experiments with orange mites, showed that both the stability and the equilibrium levels of a plant-herbivore system can be modified by manipulating the ability of the animals to move between cells of a mosaic. It is necessary to add, however, that not everyone accepts the existence of the "fence effect," that is, that preventing emigration produces a higher equilibrium density of animals. Caughley and Krebs (1983) quote data from Bayliss (1980) that purport to show that fenced and unfenced populations of kangaroos stabilize at similar densities, and argue that the fence effect is only significant for species which regulate their densities by (forced) emigration; among mammals, that is, the small ones.

e. Predation:

In the same simulation trials, Owen-Smith (in press) showed that the equilibrium position is affected by predation. This is scarcely surprising since off-take by predators (or disease) is equivalent to off-take by man. Therefore, when discussing ecological carrying capacity it is necessary to define the level of predation assumed by the term. Equally, when discussing economic carrying capacity it is necessary to know at what point on the zero isocline the system is being held by predation in order to estimate the balance of off-take available before the MSY point is reached. As with human off-take, the predator-prey interaction is stable if the off-take by predators is less than the MSY. If it exceeds this value, the prey population will crash leading to extinction of prey and/or predator or to oscillations. It is worth noting explicitly that predator-prey interactions are essentially identical to plant-herbivore interactions, that is, that all intertrophic level interactions are equivalent. The equivalence is due to the fact that exploitation by a higher trophic level leads to a decline in density and an increase in unit productivity of the lower trophic level. This point has been emphasized by Bell (1971) and Caughley (1976a) who used the Lotka-Volterra predator-prey models as the basis for his analysis of plant-herbivore interactions.

f. Interactions with Other Herbivores:

Interactions between herbivore species in African ecosystems are complex, asymmetric and nonlinear (cf., Bell 1969, 1970; Bell 1982 and Chapter 9). Species may depress each other's densities by competition, increase each other's densities by facilitation or have either effect in different vegetation types, different density ranges and different time scales. Some species seem to be completely independent of each other in this respect. The details of such interactions are largely unknown and/or disputed (see Sinclair and Norton-Griffiths 1982). However, few would dispute that in order to estimate the carrying capacity of an area for one species, information on the densities of other species is required. A clear cut example is David Hopcraft's game ranch on the Athi Plains, Kenya. In the medium grass paddocks, the carrying capacity for Thomson's gazelle, a small mixed feeder of short grass plains, is very low unless grass structure is modified by livestock grazing or mowing, in which case the carrying capacity is relatively high (Hopcraft, pers. comm.) Situations of this kind imply the existence of more than one stable point (ecological carrying capacity) along the plant-herbivore isocline of the sort modelled by Walker, Ludwig, Holling and Peterman (1981). One must also recognize that, when discussing the carrying capacity of an area for a herbivore community of several species, the biomass contribution of different species may not be convertible. For example, if the total carrying capacity is estimated at say, 4,000 kg/km^2, half of this may be due to elephant; if this species is not available for some reason, it is unlikely that this component of the biomass can be replaced by some other species. It is complications of this kind that Ian Parker refers to in Chapter 18.

g. "Genetic Carrying Capacity":

The above summary of complications due to interactions between species leads on to yet another branch of the concept of carrying capacity. This has been termed "genetic carrying capacity" by Ian MacDonald (while speaking extempore at a CSIR symposium in Pretoria in 1982) and its use was implied by Brooks and MacDonald (1983). This term means the density of each species that can exist in an area that will not cause depletion of other species to levels at which they are genetically inviable, as defined, for example, by Frankel and Soule (1981). Although not usually stated so explicitly, this idea probably corresponds to what many conservationists feel when they talk about carrying capacity. The actual equilibrium point implied can be anywhere along the zero isocline, for example, the genetic carrying capacity for cats in canary cages is zero, and the decision as to what is accepted as such depends on the details of the ecological situation and a set of aesthetic decisions as to conservation priority (Bell 1983).

h. Economic Considerations:

The MSY point, or what Caughley (1979) calls economic carrying capacity, is not necessarily the most economic point at which to maintain a plant-herbivore system in terms of financial return. This point has been made by Mentis and Duke (1976), Clarke (1976), Mentis (1977) and Larkin (1977) among others. Firstly, as Clarke (1976) pointed out in purely financial terms, the most profitable strategy may be capital reduction of wildlife populations rather than a sustainable harvest, since the economic return on the financial capital derived from the animal capital is higher than the income from a sustainable harvest. In these circumstances (which are the rule rather than the exception), overhunting or overstocking is the correct *economic* strategy. Secondly, even assuming that the strategy of sustainable yield has been adopted for other reasons, the MSY point may not be the most financially rewarding state of the system. There are many socio-economic factors involved here, such as the costs of infrastructure (i.e., fencing, abattoires, etc.) and the influence of supply on prices. The most profitable strategy must be worked out in detail for each situation. Mentis (1977) suggests a means of making such calculations for African game ranches. Such approaches have led to the concept of "*optimum sustainable yield*" and "*optimum carrying capacity*" (Larkin 1977), which, as Bell (1980) has pointed out, is any point along the zero isocline that corresponds to the manager's value system.

4. CARRYING CAPACITY DEFINITIONS--CONCLUSIONS:

The concept of carrying capacity is weighted with emotional baggage in conservation circles because it is used to imply the RIGHT densities of animals for an area while any other density is the WRONG density. If the densities are WRONG, steps must be taken to get them RIGHT. If they are too high, the area is OVERPOPULATED and densities must be reduced by culling, while if they are too low, the area is UNDERSTOCKED and densities must be increased by reduced harvesting, law enforcement, translocation or range improvement (i.e., water sources). In either case, the angels of ecological calamity hover nearby on threatening wings.

However, we have concluded that carrying capacity may be defined in several ways which effectively allow any of the possible points of equilibrium between plants and animals to be identified as carrying capacity, from zero animals to the density that leads to a crash. We conclude, therefore, that the only embracing definition of carrying capacity is: "That density of animals and plants that allows the manager to get what he wants out of the system." Thus, any specific definition of carrying capacity must be expressed in relation to a particular objective, and it must be defined very precisely since there are no "natural" stability points in such interactive systems that act as foci for self-defining concepts. Thus, for any definition of carrying capacity for any one area, it is necessary to specify at least the following:

a. The species or group of species of which the carrying capacity is being defined;

b. The densities of those species that may be expected to interact with these;

c. The level of predation and disease (subsets of b);

d. The rates of immigration and emigration; and

e. The probable levels of variation due to external factors such as rainfall.

Owen-Smith (in press) defines as "*saturation density*" that density of a herbivore species at which a system stabilizes in the absence of human off-take and predation, with an enclosed population (i.e., with no immigration or emigration) with no competition or facilitation by other species; he also specifies the predicted amount of fluctuation in response to rainfall fluctuations. This definition is a tighter version of Caughley's "ecological carrying capacity" and refers primarily to the scientist's objective of determining the point of stability in an undisturbed population, that is to K in the logistic equation.

Caughley's "economic carrying capacity" refers to that herbivore density that corresponds to the maximum sustainable yield, usually between half and three-quarters of "ecological carrying capacity." As we have seen, the use of the term "economic" is perhaps unfortunate in that this point does not always refer to the most economically rewarding harvesting strategy. However, the sense is clear and the point itself is unique (within the specifications listed above) and its identification is not, in principle, beyond the bounds of human conjecture.

The concepts of "genetic" and "optimum" carrying capacity are more complex and subjective. They require complex biological and socio-economic analyses to establish the classes of technically sound options from which the chosen objective must be selected by aesthetic decisions. Such complex situations will not be discussed further.

5. HOW TO ESTIMATE CARRYING CAPACITY:

There are three broad approaches to estimating carrying capacities, which may be summarized as follows:

> The Analytical Approach: this approach aims at constructing an estimate of carrying capacity on the basis of analytical components of the plant-herbivore system, such as the maintenance and growth requirements of different types of herbivore and the production and quality of the vegetation under various conditions.

The Comparative Approach: this approach is based on the simple assumption that areas with similar physical and biological features will have similar carrying capacities.

The Manipulative Approach: this approach is based on the idea that the response of a plant-herbivore system to manipulation (i.e., an increase or decrease in off-take) can indicate the shape of the zero isocline and where on the isocline the system is currently resting and hence, the potential carrying capacities defined in their various ways.

a. The Analytical Approach:

This approach is well-illustrated by the work of Mentis (1974), Phillipson (1975), Mentis and Duke (1976), Mentis (1977), Le Houerou and Hoste (1977) and Rees (1978). Le Houerou and Hoste (1977), for example, based their estimates on ninety pairs of data points (each pair consisting of mean annual rainfall and mean annual pasture production) from eight countries in the Mediterranean basin and eight countries in the Sahelian-Sudanian zone. On the basis of these data, curves were constructed relating mean annual pasture production to mean annual rainfall in the two areas. Then, using a series of assumptions concerning the percentage of the annual production that is consumable, the energy content of the consumed forage and the energy requirements of a series of livestock types, these curves were converted into curves relating stocking rates in hectares per livestock unit to rainfall (1 Livestock Standard Unit, L.S.U., equals 1,000 pounds [= 454 kg] [Brown 1971]; 1 Tropical Livestock Unit, T.L.U., equals 250 kg [Boudet and Riviere 1968]). They finally derived equations which, for the Sahelo-Sudanian zone, was as follows:

$$y = 0.0004 x^{1.001} \qquad r = 0.89; n = 45$$

Where y is the number of tropical livestock units per hectare per year, x is the mean annual rainfall in millimeters, r is the correlation coefficient and n is the sample size. The authors made comparisons with other published data sets of the same type and noted broad agreement. However, they pointed out that the relationships determined for the Mediterranean and the Sahelo-Sudanian zone were significantly different from each other, net production being in the order of 50% higher per rainfall in the Mediterranean zone. They further noted that carrying capacities vary in relation to other factors than rainfall, and that, under given rainfall conditions, yields may vary as much as one to five times (and exceptionally one to ten times) according to soil type and range condition, while different management practices may lead to variations of equal magnitude.

A similar approach was used by Grimsdell and Bell (1975) to estimate the ecological carrying capacity of the Bangweulu floodplain, Zambia, for black lechwe. Here, the authors estimated by clipping the protein production of the peripheral floodplain (the area in which the lechwe spend the high flood season which is thought to be the limiting period). They then assumed 50% consumption of protein during the high flood period and, using an estimate of protein requirement derived by scaling from livestock, calculated a possible carrying capacity for lechwe. The result was a minimum of 155 lechwe per km^2 giving a total of 185,000 for the southern floodplains.

The analytical approach has many problems associated with it, mainly related to the difficulty of converting vegetation production estimates into animal stocking rates. As emphasized in Chapter 9, there is no simple relationship between total plant production and herbivore production; the relationships are complex and nonlinear since they are strongly influenced by the relative production of the various usable, nonusable, and inhibitory plant components (that is, by vegetation quality) and by vegetation structure (see Chapter 9). Moreover, the ability of different herbivores to convert any one vegetation type into animal biomass differs radically according to digestive physiology, morphology and body size (Bell 1969, 1970, 1971 and Chapter 9; see also Mentis 1977). In my opinion, current models relating primary to secondary production in African ecosystems are far too simplified to allow the analytical approach to be used successfully in all but the simplest situations (few species and low rainfall); I believe that the approach is liable to be inaccurate and possible seriously misleading.

b. <u>The Comparative Approach</u>:

In the comparative approach the area for which the carrying capacity is to be estimated is compared with other areas for which the carrying capacity is known and the carrying capacity of the most similar area is assumed to apply to the study area. This approach depends on two sets of factors:

Firstly, it depends on methods of classifying land units, by means of which the degree of similarity is assessed, that correctly identify the main factors controlling carrying capacity. Vegetation type, rainfall, soil type and the availability of surface water are the most widely used among these.

Secondly, it depends upon the reference areas actually being stocked at carrying capacity, and upon their animal biomasses being correctly estimated. It is always necessary to be aware that both assumptions may be false. Firstly, important species are frequently absent from faunal communities (i.e., elephant from Natal until recent reintroduction or white rhino from much of its range, Owen-Smith, in press). Secondly, most areas in Africa are subject to an unmeasured amount of illegal off-take in addition to any measured legal off-take, so that most conservation area populations do not fulfill the conditions for ecological carrying capacity, still less for Owen-Smith's conditions for saturation density. And thirdly, estimates of wildlife densities and biomass are notoriously inaccurate and unreliable.

East (1984) concludes that, since animal biomass are intelligibly related to certain environmental variables (i.e., rainfall, soils), therefore, the populations compared are at or near carrying capacity. I suggest, however, that the real implication of this result is that estimates of densities systematically depart from real carrying capacities in relation to rainfall, soils and vegetation. Thus, East African grasslands with good visibility of high densities of smaller herbivores probably produce density estimates close to actual carrying capacities because

(i) sustainable yields are high from high densities of small animals which have high rates of increase and are, therefore, less likely to be depressed by legal and illegal off-take;

(ii) hunting conditions in short grass plains are difficult for both predators and humans; and

(iii) estimation of population sizes is more accurate in conditions of good visibility.

In the basement woodlands, the opposite is true on all these counts so that density estimates are likely to be well below carrying capacities. Thus, while real carrying capacities are controlled by rainfall and landscape, observed values tend to exaggerate the contrasts in systematic ways, both through modification of densities by off-take and through counting bias.

Probably the best known example of the comparative approach in Africa is that based on the paper of Coe, Cumming and Phillipson (1976) relating herbivore biomasses to rainfall. These authors derived the following equation to predict herbivore biomass from mean annual rainfall:

$$y = 1.552\ (\pm\ 0.329)\ x - 0.62\ (\pm\ 0.903)$$

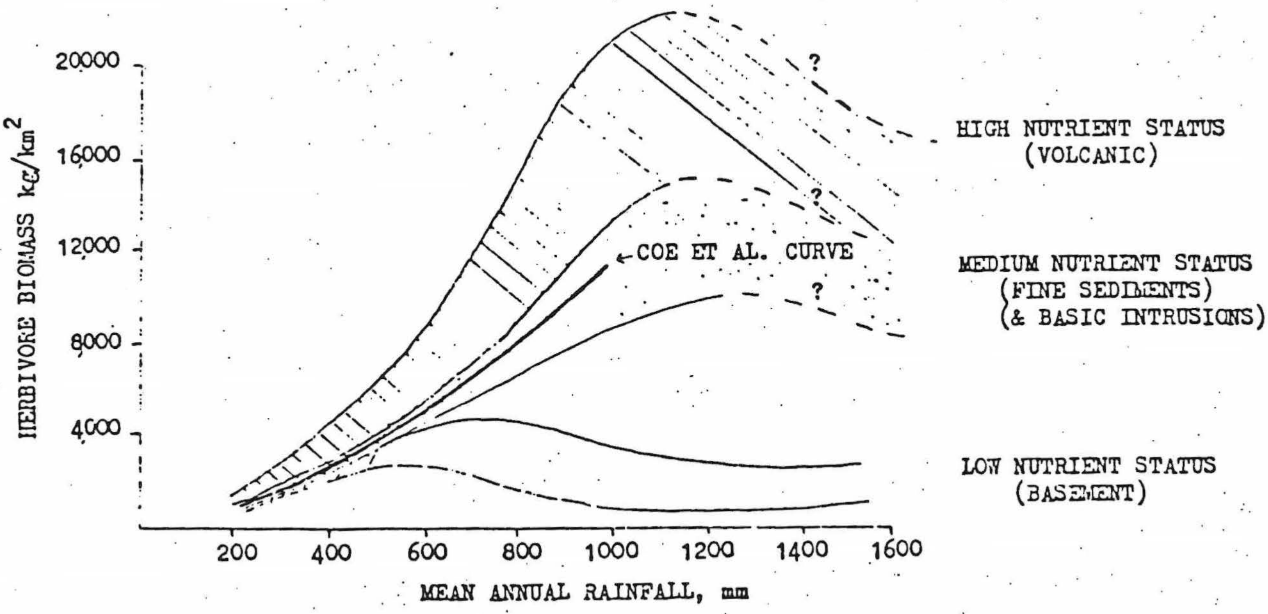
where y = log herbivore biomass (kg/km^2)
x = log mean annual rainfall (mm)

This equation was derived using data from 24 wildlife areas in eastern and southeastern Africa, and it has been widely used to predict biomasses around Africa. However, Bell (1982) has emphasized that the data points from which the equation of Coe, *et al.* (1976) is derived are biased towards the high end of the biomass spectrum; this, Bell argued, is because the density of biologists is correlated with the density of wildlife, so that low biomass areas are underrepresented in the data set. Furthermore, Coe, *et al.* (1976) themselves note that their regression probably does not apply to areas with annual rainfall above about 800 mm which were, however, rare in their data set.

Bell (1982) assembled a larger data set which included a wider range of geomorphological situations, soil types and vegetation types. He concluded that herbivore biomass is described by a family of curves relating biomass to rainfall, each curve being characteristic of a particular geomorphological situation. The higher biomasses, occurring in high nutrient status situations such as alluvial areas, correspond with the curve described by the equation of Coe, *et al.* (1976). This curve approximately defines the upper surface of probable biomasses below 700 mm annual rainfall, although it can be exceeded in special circumstances.

Lower nutrient status situations, particularly basement plateau areas, have much lower biomasses per rainfall. Further, there are indications that herbivore carrying capacities decline above about 800 mm of annual rainfall; this is particularly clear in basement situations (see Bell 1982), where the inflection of the curve probably occurs at lower rainfall than in high nutrient situations. The relationship between the carrying capacities for elephant and humans and geology and rainfall have been examined in more detail by Parker (1984), and are discussed in Chapter 9. The data of Coe, *et al.* (1976) and Bell (1982) are summarized in Figure 2.

FIGURE 2



Suggested relationships between herbivore biomass, mean annual rainfall and geomorphological situation. The shaded areas are adapted from Bell (1982) and the heavy line shows the curve derived by Coe, Cumming & Phillipson (1976). Few data points fall within the white area and this may represent a genuine discontinuity in the biomass spectrum equivalent to the distinction between arid-eutrophic and moist-oligotrophic communities.

It should further be noted that the influence of rainfall on primary and secondary production is not necessarily expressed by a simple function of mean annual precipitation. This point has been made by Walter (1951) and Le Houerou and Hoste (1977) among others; these authors point out the efficacy of rainfall in stimulating production is strongly influenced by potential evapotranspiration and, hence, by temperatures, wind, cover, etc. In consequence, winter rainfall tends to be more efficient than summer rainfall (see also Condon 1968). Other authors, such as Jager (1981) and Western (unpublished) have shown that the intensity and seasonal distribution of rainfall is important. Intense rainfall tends to be less efficient due to relatively high runoff, while double rain seasons appear to produce lower production and carrying capacities than the same rain total in single rain seasons, presumably because of the interruption of growth.

The most detailed example of the comparative approach is that of Condon (1968), developed for estimating livestock carrying capacities in arid lands in Australia. Condon's method is to relate the area in question to a standard reference area by means of comparative weightings on a series of axes each of which refers to a particular environmental parameter. Condon chose as his "base value" an area "with red sandy loam brown acid soil, of level to slightly undulating topography, carrying open mulga scrub with certain grass species pastures of moderate to good palatability. Long-term stocking records show this class of country to have a grazing capacity of 8.0 dry sheep per 100 acres (one sheep per 12.5 acres) at an average annual rainfall of ten inches (254 mm)." Note that Condon's grazing capacity more closely represents "economic" than "ecological" carrying capacity, the objective being to minimize soil erosion and pasture degeneration.

The environmental parameters used to modify this base value were:

a. rainfall, with weighting factors for winter and summer rainfall, using a rainfall-grazing capacity curve similar to that derived by Le Houerou and Hoste (1977);

b. soil fertility, moisture relationships and erodibility;

c. topography, with negative weighting for slopes leading to runoff and positive weightings for situations with runon;

d. tree densities, using a series of calibrated weightings for four tree types at different tree spacings and a weighting for tree clumpiness;

e. two weighting factors based on pasture type were used and one for pasture condition; and

f. barren areas, using a weighting factor related to the proportion of barren areas, i.e., salt pans, rocky areas, etc.

Thus, the grazing capacity of an area is given by the base value (1 = 8 sheep/100 acres) multiplied by a weighting value (i.e., 1.3 for rainfall, 0.7 for soil fertility, 0.2 for dense woodland of class C tree type, etc.) for each of the above factors.

My feeling is that this system is excellent in principle but impossible to put into practice in African wildlife situations, at present, since the necessary calibration data do not currently exist (which in any case would be different for each herbivore species). It would be a useful project to collate and generate the data needed to develop a system of this kind for African wildlife ecosystems; it would, however, be a colossal undertaking with many methodological difficulties. It would also require clear and consistent decisions as to which definition of carrying capacity was being used against which to calibrate weighting factors and as to how to handle oscillatory situations.

A simple version of the comparative approach to carrying capacity estimation was used by Grimsdell and Bell (1975) in a second attempt to estimate the carrying capacity of the Bangweulu floodplain for black lechwe. Here, the Kafue floodplain, where the Kafue lechwe was clearly at carrying capacity (Rees 1978) was used as a reference for comparison. Here, the lechwe occurred at a density of 1,000 lechwe per kilometer of floodline (Bell, Grimsdell, van Lavieren and Sayer 1973). Applying this figure to the 160 km of floodline in the southern Bangweulu floodplains, an estimated carrying capacity of 160,000 black lechwe was obtained.

c. <u>The Manipulative Approach</u>:

I use this term to refer to any of a variety of methods that make use of system models to estimate carrying capacity since such methods normally require the system to change to some extent in response to some form of manipulation in order for the particulars of the model to express themselves.

One such method is described by Caughley (1977), page 181, on the basis of a model developed by Morisita (1965). "If a population is increasing towards an assumed steady density of unknown magnitude (i.e., towards an unknown carrying capacity), a logistic curve can be fitted to the trend of numbers with time to provide estimates of r_m and k. During logistic growth, the trend of $(N_{t+1} - N_t)/N_t$ is linear on N_{t+1} such that

$$(N_{t+1} - N_t)/N_t = a-bN_{t+1}$$

where $a = e^{rm}-1$ and $b = a/K$. Consequently, both r_m and K can be estimated by least-squares regression if estimates of N are available from three or more consecutive years. MSY can then also be estimated from the instantaneous rate of harvesting, $H = r_m/2$ appropriate to a population of size K/2."

Grimsdell and Bell (1975) used a modification of this method to make yet a third estimate of the carrying capacity of the Bangweulu floodplains for black lechwe. It had been concluded that the population was stable at about 17,000 animals as a result of a harvest by lion and illegal hunters of about 4,130 animals per year, this being the sustained yield, SY, and that the intrinsic rate of natural increase, r_m, was 0.28. Now using the logistic equation shown in Caughley (1977) from Graham (1935):

$SY = r_mN(K-N)/K$ or $r_mN(1-N/K)$, where N is the population size at which the SY is required, a set of values of SY for an N of 17,000 was calculated using a series of values for K as follows:

N	K	SY
17,000	50,000	3,125
17,000	100,000	3,950
17,000	160,000	4,250
17,000	200,000	4,350
17,000	300,000	4,500

It can be seen that the K value that corresponds most closely to the estimated SY of 4,130 is 160,000, which agrees surprisingly well with the other two estimates by the analytical method (185,000) and the comparative method (160,000). However, it should be noted firstly that the method is very sensitive, that is, that a small difference in SY makes a big difference to the estimate of K, while the estimates of N and SY are likely to contain considerable errors. The best one can say of Grimsdell and Bell's example is that, on the face of it, it does not contradict the other estimates. This method might be useful if sufficient data are available to calculate the carrying capacity of an area for a population subjected to illegal off-take; it depends on a fairly good estimate of the rate of illegal off-take, for example, by the methods described in Chapter 22.

A simpler variant of this method has been suggested by Bell (unpublished letter, 1983) for situations such as national parks where the object is to specify a maximum tolerable limit to illegal off-take (see Chapter 35 on master plans), the goal being to keep the population in question close to carrying capacity, but where the carrying capacity is unknown. Here, it is sufficient to reduce the illegal off-take to a relatively low fraction of the intrinsic rate of natural increase, r_m (see below) as a multiple of the current population size; the population will then automatically increase to a level close to the carrying capacity. Monitoring of the level of illegal off-take and the population size should then allow rather good estimates of the zero isocline and the various yield parameters.

6. ESTIMATING CARRYING CAPACITIES--CONCLUSIONS:

The estimation of carrying capacities is the graveyard of ecological reputations. It is easy to be wrong; it is easy to be shown to be wrong; and being wrong can be expensive.

Estimating carrying capacity is one of the most difficult tasks facing a wildlife biologist. Firstly, he needs a clear statement of what definition of carrying capacity is intended, and secondly, he is faced with great technical difficulties in determining what density of animals corresponds with this definition. The estimate requires the use of one of several rather complex models of the plant-herbivore system and fairly accurate data on a number of factors that are not always easy to measure. Amateur conservationists use the term carrying capacity very freely and base a lot on it; however, it is fair to presume that they are usually unaware of the conceptual and technical difficulties involved.

In my opinion, the analytical approach to deriving carrying capacities from primary production estimates via estimates of herbivore food chain efficiency is decidedly premature in the present state of our understanding of the feeding ecology of African wildlife. I feel that the most reliable means of getting a reasonable "ballpark" estimate of carrying capacity is by means of the comparative approach as used by Coe, *et al.* (1976) and modified by Bell (1982) and Parker (1984). However, this method must be used with caution. Firstly, it depends upon a valid comparison between areas, based on an objective system of landscape classification (see Chapter 8). Ultimately, the aim should be to develop an analytical approach to landscape comparison of the sort advocated by Condon (1968). Secondly, one must recognize that many, or even most of the biomass data points used by Coe, *et al.* (1976), Bell (1982), Parker (1984) and others do not accurately represent systems at carrying capacity, either because species are missing altogether, or because of unmeasured off-take, or because of census errors; this problem is particularly severe in low carrying capacity areas which are relatively vulnerable to harvesting pressure (see below). Finally, they are subject to a variety of problems due to variations in rainfall patterns and efficiency, to intrinsic and extrinsic oscillations, to animal movements and to predation pressures.

The manipulative approach has two great advantages. Firstly, the manipulation itself contributes to the manipulator's understanding of the system, that is, it embodies the concept of adaptive management; it makes use of management to improve the quality of management. It means that the manager need not be paralyzed by lack of good information. Secondly, it provides direct information on harvesting rates, which is often the reason why carrying capacity is being estimated. The manipulative approach is, therefore, probably appropriate to progressive fine tuning of the estimate after a broad estimate had been made by the comparative approach.

7. DETERMINING OFF-TAKE QUOTAS:

We are here concerned with two types of off-take quota, firstly quotas for sustainable yields of average adult animals, usually for meat (subsistence quotas), and secondly, quotas for sustainable yields of exceptional large males, for trophies (trophy quotas):

a. Subsistence Quotas:

There is a large literature on this subject, but it has been reduced to a few simple principles by Graeme Caughley in his 1977 book "Analysis of Vertebrate Populations," Chapter 11. The main points are quoted here, but the reader is referred to that book for the full treatment.

The simplest model of population growth is the logistic model. It is oversimplified and rather unrealistic but provides a useful introduction to the subject. The logistic equation is as follows:

$$r = r_m . (1 - N/K)$$

where N = population size,

r = its rate of exponential increase,

r_m = its maximum intrinsic rate of increase, and

K = population size at steady density (i.e., carrying capacity).

Graham (1935) first applied the logistic equation to sustained yield questions. He pointed out that because rN is the instantaneous production of animals over and above the production required to hold the population stable, it also equals the sustained yield. The rate of harvesting (H) required to hold the population constant at N can now be found from the equation:

$$HN = r_m N (1 - N/K)$$

The sustainable yield, SY equals HN for any level of N, so that the maximum sustained yield, MSY can be calculated very simply:

> The MSY is obtained from a population size of $N = K/2$ at a harvesting rate of $H = r_m/2$ to yield $HN = r_m K/4$ animals each year. Put more simply, the MSY is produced when the population is reduced to half its density at carrying capacity and harvested at half its maximum intrinsic rate of increase.

Caughley (1977) goes on to show how using the logistic model in various circumstances, the values of r_m, K and SY can be calculated, some of these methods have been touched on in Section 5 of this Chapter. However, he continues by pointing out that the logistic model is considerably less realistic than interactive models of plant-herbivore interactions with or without consideration of a predator trophic level. Such models are more complex than the logistic model and, as Caughley says, at this stage of the game it is too much to hope that the data needed to use them in practice might be available. He notes, however, that there are approximate methods of calculating MSY by the interactive model which circumvent the need to estimate the full range of parameters. Although approximations, they are liable to return estimate more accurate than logistic estimates. These calculations are shown in Caughley (1976), but briefly, they lead to estimates of MSY generally somewhat lower than the equivalent logistic estimates. Further, the MSY is produced by a larger population (0.7 x carrying capacity instead of 0.5 x carrying capacity) than that estimated by logistic models. The disparity between the two sets of estimates of MSY serves as yet another warning against an uncritical approach to the estimation of carrying capacities and sustainable yields.

b. Estimation of r_m:

The next requirement in calculating sustainable yields from the above models is an estimate of r_m, the maximum intrinsic rate of increase of a population. There is now a considerable and growing literature giving empirically determined values for a wide range of African wildlife species. Some of the data is reviewed by Western (1979) and Caughley and Krebs (1983). These authors derive the following equations relating life history parameters to mean body size:

(i) Birth rate (b_r) as a % of the population per year:

(1) For artyodactyls (Western 1979):

$$\log b_r = 3.18 - 0.35 \log W \quad (W \text{ in grams});$$

$$b_r = 1{,}513W^{-0.35}$$

(2) For all ungulates, carnivores and small mammals, Western (1979):

$$\log b_r = 3.09 - 0.33 \log W \quad (W \text{ in grams});$$

$$b_r = 1{,}230W^{-0.33}$$

(ii) r_m as a fraction of population size:

(1) For a range of species (Caughley and Krebs 1983):

$$r_m = 1.5W^{-0.36} \quad (W \text{ in kg});$$

(2) For a range of homeotherms (Fenchel 1974, quoted by Western 1979):

$$r_m = 1.4W^{-0.28} \quad (W \text{ in kg}).$$

These equations give the following values expressed as % of population size for three species of mean weights of 10, 100, and 1,000 kg respectively:

	MEAN WEIGHT (kg)		
	10	100	1000
br (Eq ia) :	60.2 %	26.9 %	12.0 %
br (Eq ib) :	58.9 %	27.5 %	12.9 %
r_m (Eq iia) :	65.5 %	28.6 %	12.5 %
r_m (Eq iib) :	73.5 %	38.5 %	20.2 %

These figures show a fair correspondence between the first three equations, while the last equation (Eq iib of Fenchel 1974) seems to give values of r_m which are too high for most large African herbivores. It is interesting that Eq iia of Caughley and Krebs (1983) for r_m gives slightly higher values than Western's (1979) equations (Eq ia and Eq ib) for birth rate, although the difference is very small and probably insignificant. This implies that r_m is achieved when mortality is very low or absent.

Since the two curves are so similar, it is immaterial which is used; however, the birth rate has the conceptual advantage that it does not include an unknown quantity of "natural" mortality, so that when calculating the proportion of the population increment available for harvesting, one makes out a total estimate of mortality, including "natural," predation, illegal hunting, control hunting, etc. Any surplus between the sum of these forms of mortality and the birth rate is available for harvesting (Bell and Mphande 1980), or for population increase (see Chapter 22 and 26).

A final point worth noticing is that the values of b_r or r_m derived from these equations (leaving aside Eq iib) are all somewhat higher than the r_m values modelled for a range of African ungulates. For example, Grimsdell and Bell (1975) derived an r_m value for black lechwe (mean weight 63 kg) of 0.28, using a young age distribution and a sex ratio biased slightly in favor of females. However, equations ia, ib and ic give values of 0.32, 0.32 and 0.34 respectively, for this mean weight. For elephant, using the mean population weight of 1,725 kg from Coe, *et al.* (1976), the equations give r_m values of 0.099, 0.107 and 0.102 respectively. Hanks and McIntosh (1973) argued from a computer simulation that under optimum conditions an elephant population cannot increase at a rate higher than 4% per year. However, Hall-Martin (pers. comm.) has collated data to show that the confined elephant population in Addo National Park increased at a mean rate of 7% per year over a 25-year period, while Van Wyk and Fairall (1966) quoted by Barnes (1979) show that the elephant population of Kruger National Park grew at a constant rate of 9% p.a. over a 70-year period (although counting bias and immigration may contribute to this). My guess is that the birth rate of 9% p.a. for elephant quoted by Western (1979) from Laws (1966) gives a reasonable estimate of r_m for this species. My impression, then, is that computer simulations of r_m tend to err on the low side since they usually include significant mortality, whereas in an erupting population well below carrying capacity, mortality may be very low indeed. This underestimation of r_m may be exaggerated with elephant as recent revisions of Laws' (1966) aging criteria (Jachmann, in press; Craig, unpublished) indicate that elephants may conceive at significantly younger ages than has previously been assumed.

c. Estimation of Trophy Quotas:

As Rowan Martin points out in Chapter 17, sport hunting has quite different characteristics from other forms of off-take in that the harvest is usually confined to a relatively minute segment of the population so that the impact on the population is very small. Various complex models have been developed for some species to predict the productivity of trophy class animals under different conditions. These, however, are impractical in most African conditions, so I will here simply quote figures derived empirically for the setting of sport hunting quotas by the Department of National Parks and Wildlife Management, Zimbabwe (Cumming, pers. comm.):

Suggested Trophy Quotas as % of Total Population Per Year

Elephant	0.5%	
White rhino	1.0%	
Black rhino	1.0%	
Hippo	1.0%	
Lion	10 %	
Leopard	10 %	
Ungulates of mean adult weight 100 - 1,000 kg		2%
Ungulates of mean adult weight less than 100 kg		2%

In many cases, it is desirable to initiate hunting in areas where population sizes are unknown. In these situations it is meaningless to attempt to set quotas on a percentage basis, and it may be preferable to set quotas by specifying minimum sizes of individuals that may be taken. For example, any elephant might be allowed with a combined tusk weight in excess of 30 kg, or any *Pterocarpus angolensis* tree might be cut with a basal diameter greater than, say, 50 cm. The quota is then regulated by the rate of recruitment of individuals to the permitted size classes. This quota system has been advocated by Bell (1984) and it is suitable for species where the feature, which is the basis of selection, increases continuously with age, so that only the older individuals are removed, leaving a protected segment of breeding adults. This is not true of most African antelope, which tend to achieve maximum horn length in early maturity then lose length from wear (Grimsdell and Bell 1975; Berry 1984). (There are exceptions, notably among the Tragelaphines, Bell, unpublished data). The system has been further criticized on the grounds that it will lead to selection for smaller trophies, but I am not convinced that, in this respect, it differs from any other form of trophy hunting. Further pros and cons are discussed by Bell (1984).

8. OFF-TAKE QUOTAS--CONCLUSIONS:

The setting of off-take quotas is an obvious candidate for adaptive management. We have "ballpark" methods of estimating the two required parameters, K and r_m and a variety of models for estimating the MSY from these. Provided we do not consistently exceed the MSY, we are unlikely to do the ecosystem any irreparable harm. If we use Western's (1979) equation for artyodactyl birth rates (b_r = 1,513 $W^{-0.35}$; weight in grams) to estimate r_m and Graham's (1935) logistic equation (MSY = 0.5 r_m x 0.5 K), to estimate MSY, we are probably fairly safe to begin with.

Once initiated, the off-take program itself provides the best means of refining both the system model and the estimates of its various parameters. Usually, the only really reliable statistics available are the legal off-take and the condition data derived from harvested animals. As Caughley (1977) pointed out, the off-take can be used to estimate numbers by relating to an index of population size. This method was used by Bell (unpublished data) to obtain an estimate of warthog numbers in Lengwe National Park, Malawi. Here, an annual count of sightings at water holes had been made for 17 years showing a smooth increase of sightings of 35% p.a. (Bell 1981). In 1983, the sighting rate was 783 warthog per day, so that given a 35% increase, the sighting rate in 1984 should have been 783 x 1.35 = 1,057. However, during 1984, a total of 154 warthog were shot in a culling program. Following this, the 1984 water hole sighting rate was 301 warthog per day, that is, 28.5% of the expected number. This means that removal of 154 warthog reduced the sighting rate by 759 sightings per day, so that each warthog removed was worth 759/154 = 4.9 sightings per day. This implies that warthog in those (very hot) conditions visit water holes 4.9 times per day each, a figure that agrees well with Cumming's (1975) conclusion that warthog drink four times per day in very hot weather. This, in turn, implies that the warthog population was 200 in 1983, increased to about 216 by mid-1984, and was then reduced by a cull of 154 animals to a total of about 61 by late 1984. In this case the population size, and hence, the off-take quota, had been seriously overestimated (Bell 1981, notwithstanding), but the cull itself provided a means of correcting this error.

The same emphasis on monitoring and feedback from off-take, for example, by catch-per-effort records, applies to sport hunting.

9. MULTI-SPECIES SITUATIONS:

The emphasis in this paper so far has been on relatively simple single species situations. However, most African wildlife situations are considerably more complex, with a wide range of herbivore species actually or potentially involved. Key questions in planning the use and management of an area, are:

What is the total carrying capacity of the area?

How will the biomass be partitioned between species? and

To what extent are the contributions to the biomass by different species interchangeable?

We have already covered the question of total carrying capacity. In discussing the second question of partitioning of biomass between species, a range of perceived "optimal mixes" can be expected, corresponding to the different perceptions of the concept of carrying capacity. We will here only consider the "ecological species mix" corresponding to the equilibrium "saturation densities" as defined by Owen-Smith (in press) of a full faunal community as reconstructed from records of recent historical occurrence in the area concerned, existing in an enclosed hands-off situation. As with carrying capacity, the same three approaches are theoretically available, but here we will use only the comparative approach.

No two faunal communities are identical in species composition or relative densities; communities vary continuously, presenting conceptual difficulties in community classification as discussed by Clarke and Bell (in prep.) The best known classification of the zoogeographical zones of African ungulates is that of Ansell (1971). While the factors influencing faunal community structure have been discussed by Lamprey (1963, 1964), Bell (1969, 1971, 1981a and b, 1982 and Chapter 9), Mentis (1974), Cumming (1982), Huntley (1982) and Owen-Smith (in press) among others.

Briefly, we can identify nine main types of African ungulate community as follows:

1 :	Desert and semi-desert communities	a :	Sudano-Sahelian
	Desert and semi-desert communities	b :	Karoo, Kalahari, Namibian
2 :	Arid-eutrophic savanna communities	a :	with woodland
	Arid-eutrophic savanna communities	b :	grassland
3 :	Moist-oligotrophic savanna communities	a :	with woodland
	Moist-oligotrophic savanna communities	b :	grassland
4 :	Forest communities	a :	Eutrophic
	Forest communities	b :	Oligotrophic
5 :	Floodplain communities		

In classifying large herbivores into ecological groups, it is useful to distinguish between grazers, browsers and mixed feeders and between animals with mean body weights in the ranges:

Large : over 1,000 kg = Megaherbivores of Owen-Smith (in press);

Medium : 100 - 1,000 kg; and

Small : under 100 kg.

This gives a matrix of nine ecological groups; it is also useful to distinguish a tenth group, containing only zebra and buffalo, from the group of medium grazers, in order to separate this subgroup of relatively unselective coarse feeders from the remainder of this group which are relatively selective for vegetation structure and quality. I personally do not find the category "bulk and roughage feeder" of Hofmann (1973) a very useful category since it confuses species which are tolerant both of structure and quality (i.e., elephant and buffalo), with those that are tolerant of quality only (i.e., wildebeest) and not particularly tolerant even of that. The ecological groups of herbivores are summarized in Table 1.

TABLE 1

ECOLOGICAL GROUPS OF LARGE AFRICAN HERBIVORES

FEEDING TYPE / MEAN ADULT WEIGHT	GRAZERS		MIXED FEEDERS		BROWSERS	
LARGE, i.e., over 1000 kg	White Rhino Hippopotamus		Elephant		Black Rhino Giraffe	
MEDIUM, i.e., 100-1000 kg	Oryx Roan Sable Waterbuck Hartebeest Topi	Buffalo Zebra Wildebeest Cattle	Eland Addax Scimitar Oryx		Greater Kudu Bongo Okapi Camel	
SMALL, i.e., less than 100 kg	Warthog Forest Hog Lechwe Reedbuck Kob Puku	Blesbok Oribi Sitatunga Sheep	Bushpig Nyala Impala Grant Gazelle Thomson Gazelle Springbok	Ostrich Goat	Lesser Kudu Bushbuck Gerenuk Duikers Suni Grysbuck	Steinbuck Klipspringer

I do not have access to good data sets from all nine community types to show how the herbivore biomass in each is distributed between groups. The following is therefore open to correction when better data become available, bearing in mind also the caveats against assuming that biomass data represent accurate estimates of complete communities at carrying capacity:

1a: Desert and semi-desert community; Kalahari, from Graham (unpublished):

% OF TOTAL BIOMASS IN EACH HERBIVORE GROUP

	GRAZERS	MIXED	BROWSERS	TOTAL
Large	0	0	5	5
Medium	10 50	20	5	85
Small	0	10	0	10
Total	60	30	10	100

2a: Arid-eutrophic savanna community; with woodland; Luangwa Valley, Zambia, data combined from Caughley (1973) and Douglas-Hamilton, *et al.* (1979):

% OF TOTAL BIOMASS IN EACH HERBIVORE GROUP

	GRAZERS	MIXED	BROWSERS	TOTAL
Large	10	73	1	84
Medium	12 1.5	0.5	0.2	14.2
Small	0.5	1	0.3	1.8
Total	24	74.5	1.5	100

2b: Arid-eutrophic savanna community, grassland, Western Serengeti, Tanzania, from Bell (1969):

% OF TOTAL BIOMASS IN EACH HERBIVORE GROUP

	GRAZERS	MIXED	BROWSERS	TOTAL
Large	0	0	5	5
Medium	63.5 18	6.5	0	88
Small	2	4	1	7
Total	83.5	10.5	6	100

These data refer to the Western Serengeti as a whole. As was emphasized by Bell (1969), this area contains a series of subcommunities related to land form that differ considerably in the ratios of grazers, the shorter grass areas in northwest being dominated by wildebeest and gazelles, the taller grass areas in the southeast being dominated by buffalo, zebra and topi. The populations increased considerably in subsequent years (see Sinclair and Norton-Griffiths 1979), but species ratios remained approximately similar. The Serengeti migratory populations resemble more closely those of the northwestern corridor, being dominated in biomass by wildebeest, zebra and gazelle. The comparative scarcity of elephant in the Serengeti may be at least partially an artifact of the human history of the area, although in the pure grassland areas, they cannot survive.

3a: Moist-oligotrophic savanna, with woodland; Kasungu National Park, Malawi, from Bell (1983):

% OF TOTAL BIOMASS IN EACH HERBIVORE GROUP

	GRAZERS	MIXED	BROWSERS	TOTAL
Large	1	55	0.5	56.5
Medium	22 11	3.5	1.5	38
Small	1.5	0.5	3.5	5.5
Total	35.5	59	5.5	100

The percentage of biomass contributed by elephant and buffalo could probably rise considerably higher since both species are currently below carrying capacity as a result of past settlement and current illegal hunting. However, in the moister and more oligotrophic parts of this community, bordering on the oligotrophic forest in, say, northern Zambia, northern Angola and southern Zaire, the contribution of elephant to this community falls conspicuously and the overall biomass is correspondingly reduced, see for example, Huntley (1982).

3b: Moist-oligotrophic savanna, grassland; Nyika plateau, Malawi, from Bell (unpublished data):

% OF TOTAL BIOMASS IN EACH HERBIVORE GROUP

	GRAZERS	MIXED	BROWSERS	TOTAL
Large	0	0	0	0
Medium	29 16	24	0	69
Small	28	1.5	1.5	31
Total	73	25.5	1.5	100

4a: Forest communities, eutrophic; no reliable data exist; the following is based on an unpublished aerial survey of the treetops salient, Aberdares National Park, Kenya, by Watson, Graham, Woodley and Bell in 1966.

% OF TOTAL BIOMASS IN EACH HERBIVORE GROUP

	GRAZERS	MIXED	BROWSERS	TOTAL
Large	0	40	5	45
Medium	37 2	1	5	45
Small	5	0	5	10
Total	44	41	15	100

4b: Forest communities, oligotrophic; no reliable data exist, but the following is based on information supplied from Sapo National Park, Liberia, by N. Bell and N. Penn (unpublished):

% OF TOTAL BIOMASS IN EACH HERBIVORE GROUP

	GRAZERS	MIXED	BROWSERS	TOTAL
Large	0	5	0	5
Medium	10 0	0	0	10
Small	5	20	60	85
Total	5	25	60	100

It is not clear whether the relatively low densities of forest elephant and buffalo represent carrying capacity densities or whether these species are reduced by hunting. Nonetheless, it seems clear that there is a real distinction between the contribution of the larger herbivores to the biomass in the oligotrophic as opposed to the eutrophic forests.

5: Floodplain communities, the Bangweulu floodplain, [illegible] Grimsdell and Bell (1975):

% OF TOTAL BIOMASS IN EACH HERBIVORE GROUP

	GRAZERS	MIXED	BROWSERS	TOTAL
Large	1	5	0	[illegible]
Medium	10 5	0	0	[illegible]
Small	76	1	2	[illegible]
Total	92	6	2	[illegible]

It is likely that all species in the Bangweulu floodplain were below carrying capacity at the time of these surveys and that larger species, particularly elephant and buffalo, had been disproportionately affected. Bangwelu is a relatively oligotrophic floodplain; in more eutrophic floodplains such as the Zambezi delta, Mozambique, the Elephant Marsh, Malawi and Mana Pools, Zimbabwe, the biomass is dominated by large species, particularly hippo, buffalo and elephant.

10. SPECIES MIXTURES--CONCLUSIONS:

Four general points can be made about multi-species mixtures:

Firstly, the data on which to base comparisons to predict mixed species carrying capacities are very poor: counts are unreliable and unevenly biassed; many communities are incomplete; and most populations are more or less influenced by human activity. These departures from the ideal are most pronounced in oligotrophic woodlands where visibility is poor, distributions clumped (and therefore liable to large sampling error), and animal densities low (and therefore vulnerable to hunting pressures). Therefore, caution is required in predicting species mixes from such data.

Secondly, herbivore community structure is extremely flexible in response to differences of landscape type. Classification of communities as attempted above is of marginal value at best. Perhaps the approach towards which we should be aiming is to attempt to build up a picture of the carrying capacities of individual landscape units and land facets (see Chapter 8), so that the carrying capacity of an area can be estimated by the relative proportions of its component facets, bearing in mind that a particular combination of facets may boost the carrying capacity above that of the sum of its parts, as in the Serengeti ecosystem.

Thirdly, we agree with Owen-Smith (in press) that in most savanna communities, megaherbivores usually contribute 40%-70% of the biomass, except where they have been eliminated by man or where fibre production is limited by low infiltration (Serengeti, Nyika) or by flooding (floodplains), (see Chapter 9).

Fourthly, I would expect that there is relatively little opportunity for substitution of biomass by species *between* ecological groups, although there may be some opportunity for substitution *within* groups, particularly of medium grazer biomass by livestock. If for any reason the biomass contribution of megaherbivores cannot be taken advantage of, it is doubtful if much of it can be made up for with other species.

* * *

As a postscript, a recent paper by East (1984) examines the relationship between biomass, rainfall and soil nutrients for a wide range of large African savanna mammals. From East's regressions, a range of carrying capacities for mixed communities might be built up from individual species values, on the assumption of rather limited interaction or substitution between species biomass. East concludes that the relationships between biomass, rainfall and soil nutrients proposed by Watson (1972), Coe, *et al.* (1976), and Bell (1982) for whole communities apply to the majority of individual herbivore species. In addition, he recognizes a division of savanna herbivores into two groups, which he calls "arid savanna herbivores" and "moist savanna herbivores." "Arid savanna herbivores," which dominate total herbivore biomass, include grazers, mixed feeders and browsers and include the very tolerant species such as elephant, buffalo and hippopotamus. Their biomass tends to decline at higher levels of rainfall on low nutrient soils, and only the very tolerant members of this group (listed above) are widespread in moist-oligotrophic situations with over 1000 mm annual rainfall. "Moist savanna herbivores" are mainly highly selective grazers such as sable, roan, hartebeest, reedbuck, oribi and warthog. They occur widely in moist-oligotrophic situations; their biomasses are usually low, but are distinguished by the fact that they show a positive correlation between biomass and rainfall, even in high rainfall areas.

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ANNEXE 4
[redacted]

DEPARTMENT OF NATIONAL PARKS AND WILDLIFE MANAGEMENT

TROPHY FEES FOR 1988

ANIMAL	FEE (Z$)
Elephant - Male	5 000
Elephant - Female	2 000
Elephant - Tuskless	500
Buffalo - Male	750
Buffalo - Female	400
Lion - Male	2 000
Lion - Female	1 000
Leopard	1 200
Sable - Male	800
Kudu - Male	450
Kudu - Female	200
Waterbuck - Male	450
Zebra	400
Eland - Male	600
Eland - Female	300
Impala - Male	75
Impala - Female	30
Reedbuck	200
Bushbuck	200
Wildebeeste	300
Ostrich	200
Nyala	800
Klipspringer	200
Duiker	30
Steenbok	30
Grysbok	30
Warthog	70
Bushpig	60
Hippopotamus	800
Crocodile	500
Jackal	50
Bat-eared Fox	50
Caracal	50
Serval	50
Civet Cat	50
Genet Cat	25
Wild Cat	25
Giraffe	500
Hyaena	100
Baboon	10
Porcupine	15
Tsessebe	450

ANNEXE 4

[redacted]

GOVERNMENT TROPHY FEE RECOMMENDATIONS

	1984	1985	1986	Recommended 1988	
Elephant – Male	2000	3000	3500	5000	
Elephant – Female	700	700	1200	2000	
Elephant – Tuskless	250	250	300	500	
Buffalo – Male	350	500	500	700	750
Buffalo – Female	150	300	350	350	500
Lion – Male	1000	1000	1500	2000	
Lion – Female	600	750	1000	1000	
Leopard	600	600	700	1000	/1200
Sable – Male	500	600	800	800	
Sable – Female	200	200	400	400	? Remain
Kudu – Male	200	200	250	450	
Kudu – Female	75	75	100	150	200
Waterbuck – Male	250	250	300	400	450
Waterbuck – Female	75	75	100	150	? Remain
Zebra	250	250	400	400	500
Eland – Male	350	350	400	500	600
Eland – Female	175	175	200	250	300
Impala – Male	30	50	50	60	75
Impapa – Female	20	30	30	30	
Reedbuck	100	100	150	200	
Bushbuck	100	100	150	200	
Wildebeeste	130	130	200	300	
Ostrich	100	100	100	200	
Nyala	200	200	600	700	800
Klipspringer	75	75	100	150	200
Duiker	15	15	15	30	
Steenbuck	15	15	15	30	
Grysbok	20	20	20	30	
Warthog – Male	25	40	50	50	70
Bushpig	25	40	40	50	60
Hippopotamus	500	500	600	700	800
Crocodile	300	300	300	500	
Jackal	25	25	25	25	50
Bat-eared Fox	50	50	50	50	
Caracal	50	50	50	50	
Serval	50	50	50	50	
Civet Cat	50	50	50	50	
Genet Cat	15	15	15	15	25
Wild Cat	15	15	15	15	20
Giraffe	400	400	400	500	
Hyaena	60	150	150	50	100
Baboon	10	10	10	10	
Porcupine	15	15	15	15	
Tsessebe	400	400	400	450	

Safari Operators' Association
Harare
24.iv.87

ANNEXE 5

DEPARTMENT OF PARACLINICAL VETERINARY STUDIES

UNIVERSITY OF ZIMBABWE

DIAGNOSTIC PARASITOLOGY

HOSPITAL ACCESSION NO. ____________________ DATE ______________

SUBMITTER __________________________ OWNER ______________________

SPECIES _______________________ BREED ___________________________

SEX ___________________________ AGE _____________________________

RELEVANT HISTORY & CLINICAL FEATURES

OTHER AFFECTED ANIMALS

AGE ______________ NO. SICK ____________ NO. AT RISK _______

SPEC. SUBMITTED: Faeces/Urine/Skin scraping/Blood.Others

EXAMINATION(s) REQUESTED ____

LABORATORY REPORT

ACADEMIC/TECHNICIAN ____________________ DATE REPORTED ____________

ANNEXES

GAME POST-MORTEM FORM

FARM:

TELEPHONE:

ADDRESS:

DATE:

SPECIES:

SEX: Male / Female / Lactating

AGE: Newborn / Young / Adult / Aged

TIME SINCE DEATH (Estimate): Hours

EXTERNAL EXAMINATION:

1. Wounds / Cuts / Abrasions / Bruising / Fractures / Damaged Horn(s) / Predator damage

2. Ticks / Other parasites .... None / Few / Moderate / Many

   Position of parasites: Face / under tail / between front legs / between hindlegs / whole body / near wounds

3. Abnormal discharge from nose / mouth / eyes / anus / vulva / udder

   Consisting of .... froth / pus / blood / saliva / faeces.

4. Mouth inspection: worn teeth / long teeth / missing teeth / temporary teeth (milk teeth) / foreign material / other abnormalities

   ....

5. Skeletal muscles .... dark red / patchy pale areas.

ANNEXES

INTERNAL EXAMINATION:

1. Quantity of fat .... None / moderate / large amount
2. Organs .... With gas formation / Without gas formation
3. Contents of chest cavity .... None / watery fluid / blood / pus / food / yellowish plaques

   Contents of belly .... None / watery fluid / blood / pus / food / yellowish plaques
4. Lungs .... Colour .... Normal (pink) / abnormal / diffuse (whole of lungs affected) / nodular (local swellings) / patchy / front parts of lungs affected

   Contents of airways .... None / pus / froth / blood / worms
5. Heart .... Colour .... Normal (medium brown) / abnormal / abnormal material attached to internal wall of heart

   Fluid in sac surrounding heart: Yes / No Colour ....
6. Liver .... Colour .... Normal (medium brown) / pale / dark / diffuse / focal / multifocal (more than one area)
7. Kidneys .... Colour .... Normal (medium brown) / pale / dark brown / red / diffuse / focal / multifocal
8. Spleen .... Colour .... Normal (grey-red) / abnormal
9. Bladder .... Contents .... Normal (urine) / dark urine / stones
10. Uterus .... Non-pregnant / Pregnant / size of foetus — from base of tail to base of skull .... cms. / blood / pus / bones
11. Gut .... Outside .... Normal colour (grey-white) / red / greenish-black / diffuse / patchy

    Contents.............................. Normal / watery / bloody / dry / worms

    Forestomachs.............................. Defects inner wall / abnormal contents ....

    Stomach..........Contents.......... Watery / Semi-solid / dry food / milk / blood / worms / other ....