



2006 Hunting Season

Trophy Monitoring in Niassa National Reserve, Mozambique: Lion, Leopard, Buffalo, Hippo and Crocodile

Prepared for:

SRN

(Sociedade para a Gestão e Desenvolvimento
da Reserva do Niassa
Moçambique)

&

Savannas Forever



By

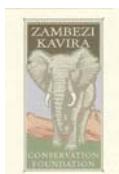
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January 2007

Acknowledgements

Our sincere thanks go to Sociedade para a Gestão e Desenvolvimento da Reserva do Niassa (SRN) and the Mozambican Government for granting us permission to work in the Niassa National Reserve (NNR). In particular we thank Anabela Rodrigues, Sandra Almeida, Agostinho Jorge, Steve Rhodes, Matt Rice (FFI) and Stuart Williams (FFI) for ongoing logistical and administrative support, advice and encouragement. Special thanks to our camp and field assistants Oscar Muemedi, Alberto Mussoma, Ndugu Alberto, and Euzebio Waiti for all their enthusiastic and dedicated help. In addition we thank Vernon Booth, Craig Packer, Luke Hunter, Michelle Souto and Andy Loveridge for providing answers to endless questions. Dr Mark Otto provided dental facilities for the X-raying of pulp cavities and guidance on the key factors in aging from teeth.

We are particularly grateful to Savannas Forever (Craig Packer and Susan James) for providing financial and other technical support in 2006 for the monitoring of lion, leopard and buffalo trophies. For general research running costs we are indebted to SRN and Fauna & Flora International (FFI). The trophy monitoring of lions in 2004-2006 is also financially supported by The Niassa Lion Project (Phase 1: 2004-2006), which has been funded by a wide variety of organisations and individuals. We sincerely thank Fauna & Flora International (Patrick Ward & Matt Rice); Safari Club International- Flint Chapter (Marc Somers); Zambezi-Kavira Conservation Foundation (Westley Logan, Derek Littleton & Don Price); Kambako Safaris (Jumbo Moore); Concerto Nominees Ltd (Gary Tullis, Howard Hunter); Londo Lodge (P.J and Evelijn); Luwire (Jamie Wilson & Derek Littleton); Gonzalo Banus, Bob Gerber, Eveline Stalling, Phillip Lowell and Stuart Godin. We also thank Sable Camp (Johan Calitz Safaris), Luwire and Lugenda Camp for assisting with additional diesel, and Rani Aviation for aerial radio tracking and transport.

Our special thanks to all the Niassa Professional Hunters and Operators for their hospitality, cooperation and for taking the time to collect blood samples and provide us with detailed information and photographs of their trophies. This information is invaluable to the success of the project. In particular we thank Jorge and Lauritz from Singa Camp, Niassa Hunters; Wim, Chalene, Albie, Joekie and Mario from Sable Camp, Johan Calitz Safaris; Jumbo, Stuart, George, Steve, Kerry, David, Jason and Johnnie from Kambako Safaris; Graeme, Shawn and Rusty from Campo Rio, Mozambique Bound Safaris and Jamie, Derek, Don, Matt and Mark from Luwire.



Summary

SRN (the management authority of the NNR) aims to secure, manage and develop the biodiversity of the Niassa National Reserve (NNR) and provide a quality eco-tourism and sport hunting experience to generate a local economy to finance NNR management activities (SRN Management Plan, 2006). Six sport hunting concessions are currently operational within the NNR protected area boundary situated as a buffer area around a core area. The aim is to maximise trophy quality and economic returns while maintaining the viability and growth of wildlife populations through ecologically sustainable hunting practises. Monitoring of trophy quality and hunt effort provides an indirect, relatively inexpensive means of determining whether current quota size and off-take are sustainable. In 2006, all five hunting operators within NNR agreed to be research consortium members of Savannas Forever (SF), a regional conservation initiative that aims to improve the conservation effectiveness of sport hunting companies through a third party certification program that will verify sustainable hunting practises and measure outcomes for key species. SF complements SRN management objectives. Six key species were monitored in 2006: lion, leopard, buffalo, hippo and crocodile. All hunting operators cooperated fully with the monitoring program.

Lion trophies are aged according to tooth wear, closure of the pulp cavity, mane development, nose pigmentation and general body condition. Only 33% of the lion trophies taken in 2006 (35% over the last three years) were considered acceptable trophies over the minimum age of six years. As a result, two concessions should receive a decrease in quota of one lion in 2007 and one concession should receive an increase of one lion as calculated by the SRN lion regulations and point system for quota allocation. The continued shooting of underage lions in NNR is of significant concern. Validation of visual aging cues shows that mane development can be used by PHs in NNR to place a lion in a broad age category (< 4 yrs, 4-6yrs; > 6 yrs) before it is shot with additional information provided by nose pigmentation.

Leopard are on Appendix I of CITES and trophy monitoring is essential to comply with CITES criteria. Assessment of tooth wear and closure of the pulp cavity suggest that only one (6%) of the leopards was significantly over four years of age. This is of particular concern and needs to be investigated further given that male age at first reproduction is 2-3 years. However, aging criteria still need to be validated against known age leopards in NNR and the results are preliminary. Utilization of buffalo has increased steadily over the last five years, with 56% of the allocated quota taken in 2006. Results suggest that horn size is not an accurate indication of age and encourages the shooting of young animals. Only male buffalo with a hardened boss are considered acceptable mature trophy animals and the hunting of males in breeding herds is discouraged. An aerial census to specifically investigate buffalo numbers is recommended as a high priority. Hippo densities and distribution were surveyed for the first time in 2006. Results suggest that while the NNR hippo population is viable and can probably support the overall current quota, their patchy distribution requires a reallocation of the quota between the concessions. For crocodiles, 60% of the allocated quota was used, which is a significant increase from 2005 (36%). Given the inherent difficulties in accurately censusing the adult crocodile population and the indication that adult crocodile numbers are low and patchily distributed, it is recommended that only adult crocodiles over a minimum size of 2.4m (8ft) should be considered acceptable trophies. Specific guidelines and recommendations for all the key species are provided.

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General Recommendations

Recommendations specific to the key species are provided at the end of each trophy monitoring section.

- **Hunt Returns:** Improvements in the both the design of the hunt returns and their completion are needed:
 - PHs need to be provided with specific guidelines on how to fill in the hunt registers.
 - GPS locations must be written in decimal degrees (e.g. 12.08009S/ 38.18868E) not degrees-minutes-seconds or decimal minutes, as this is the standard for NNR. All PHs should now be required to provide a GPS position rather than a map code, particularly for the key species
 - The size of the animal must be filled in. Guidelines should clearly indicate which measurements should be taken and how these measurements should be taken. Some PHs are filling in the skull measurements while others are providing body length measurements and many are providing no measurements at all. Of particular importance are critical measurements that need to be taken in the field and cannot be taken later during trophy monitoring e.g. leopard body length, crocodile body length. The onus is on the Operators to ensure that the PH responsible for the hunt fill in all the information.
 - The number of animals wounded and unrecovered is an important statistic and PHs should be encouraged to fill this in consistently as was done by Block B in 2006.
 - The hunt registers should be filled in on a daily basis. At the moment, many are filled in after the hunt has been completed by which time important information on trophy size, location, date, and comments have been forgotten or confused. In some cases clients are signing blank hunt returns before any data has been completed.
 - Some PHs have requested that the hunt registers not list the species individually as this causes a problem when clients shooting multiple individuals of the same species e.g. warthog, guineafowl, baboons. We would suggest that the species continue to be listed individually to ensure consistency and facilitate computerising data but that some unspecified rows be provided for additional trophies.
 - It would be useful if the hunt registers included a space to fill in the type of hunt and primary trophy species i.e. lion, leopard-lion, leopard-lion-buffalo, plains game.
 - A useful indication of hunting effort in key species (lion, leopards, buffalo) is provided by the numbers of hunting days it took to find a trophy. While this is currently filled in on the lion questionnaire, it might be useful to include this on the hunt register to ensure this data is collected consistently in future.

- Hunting Operators need to be encouraged to increase the percentage of the concessions that are utilised for hunting. Quotas are calculated based on the total estimated population of each species across the entire block, yet in some blocks only 10-20% of the concession area is actively hunted. By hunting the entire quota in a small area the potential for over-hunting and shooting of underage animals is significantly increased. There is anecdotal evidence that the best trophies taken each year come from areas that have been newly opened by the operators. This appears particularly true for lions and leopards. The current situation, where much of the hunting effort is concentrated on the Lugenda River is of particular concern, as this is a habitat identified as a priority for biodiversity conservation. It would be useful if some measure of concession area utilization could be used for future Operator assessments.
- General SRN hunting regulations/ guidelines could include the following:
 - No animals should be hunted without actual possession of the abate tickets in the block.
 - Labelling of the trophies needs to be improved in many of the blocks. In some blocks even the species were incorrectly labelled. Consistent labelling with self-locking tags is particularly important for the CITES animals (leopards and elephants) as it is a requirement of the CITES quota. SRN might consider producing a standardised label (purchased by each concession) that must be attached to each trophy before the trophies leave the block to ensure consistency.
 - No trophies should be removed from NNR before they have been checked by a SRN representative. The onus should be on the operator to contact the SRN representatives at least 2 weeks before trophies are to be removed to arrange a visit.
 - No trading of quotas should be tolerated either inside the reserve or with outside concessions. Quotas are meant to represent the ecologically sustainable off-take for each concession and trading defeats conservation objectives.
 - There needs to be better storage and security for valuable trophies that have a significant market value. This is particularly important for the CITES species: leopard and elephant.
 - All PHs leading hunts need to be cleared by SRN (and possibly in future the Niassa Hunters Association) and must be in possession of a valid hunting license, which needs to be indicated on the Hunt Return Registers.
 - Where trophy animals may be found inside the Lugenda riverbed, forming the border between concessions clear guidelines need to be provided on what is admissible. This is particularly relevant for hippo and crocodile (see relevant sections) and is potentially a critical issue when one side of the river is allocated for sport hunting concession and the other side is an eco-tourism concession.

- Improved and more regular communication by SRN with the PHs hunting in each concession is essential. At present little of the information from SRN / Operator reports, discussions and presentations is filtering down to the PHs. Communication could be improved by:
 - Providing an information package/ document to each PH at the start of the season that includest SRN “best practise” guidelines, pertinent Mozambican law, SRN special regulations, aging and measurement guidelines, conservation priorities, as well as a general overview of Niassa ecology , management plan and overall structure. Contact details of relevant SRN staff should be provided.
 - A meeting at the start of the hunting season specifically for PHs, perhaps in NNR (Mbatamila).
- The Niassa Hunters and Operators Association initiated in 2006 needs to be finalised and become a functional entity. It has been suggested that three conditions need to be met for effective hunting associations: they need to be committed to conservation, membership should be contingent on good conduct and associated with benefits, and expulsion must have significant effects on the PHs ability to do business (Lindsey 2007b). In this regard it might be useful if the Association could provide some regulation of PHs that hunt in NNR providing SRN with information on PHs whose behaviour is considered unethical and against a “Code of Conduct” developed by the Association. Clarity is needed on whether hunting with baits, dogs, spotlights, broadcasted calls and from a vehicle is acceptable for certain species in NNR. The issue of flying to look for trophies (particularly elephants) and then hunting in the same day also needs to be addressed.
- Training of Mozambican counterparts in trophy monitoring and aging is essential to ensure sustainability of the monitoring systems and should be initiated in 2007.

Background and Justification

Niassa National Reserve (NNR), located in northern Mozambique on the border with Tanzania, is an immense wilderness area of 42 000 km². Located within the Eastern Miombo Woodland eco-region (WWF 2001), NNR contains the full complement of herbivore (excluding black rhino) and carnivore species, albeit at relatively low densities at present. In addition, some 25 000 people are resident across NNR in approximately 40 villages. One of the goals of SRN (the management authority of the NNR) is to secure, manage and develop biodiversity, promote its wilderness quality and use NNR as a reservoir for biodiversity in the region. To achieve this, ecological research and monitoring are considered a vital part of the Management Programme. In addition sustainable utilization is an integral part of the SRN management plan and the aim is to provide a quality eco-tourism and hunting experience to tourists so as to generate a local economy to finance NNR management activities (SRN Management Plan, 2006).

At present, six sport hunting concessions have been developed within the NNR protected area boundary (Fig. 1), situated as a buffer zone around a core area. Sport hunting is generally considered a high return, low impact form of wildlife use compared to non- consumptive wildlife viewing or photographic safaris (eco-tourism). Certainly, in NNR, sport hunting has the potential to provide considerable benefits through improved anti poaching efforts and economic returns for both the communities and Reserve management. In addition, it can be successfully undertaken in areas that are considered marginal, not particularly scenically beautiful and/or logistically challenging where high levels of service are complicated. However, sport hunting is open to corruption and a focus on short-term goals. Furthermore hunting is open to moral and ethical questions as an animal is killed and the industry is increasingly coming under scrutiny. It is therefore an industry that requires careful regulation and a high degree of compliance with “best practice standards” (Patterson & Khosa, 2005: TRAFFIC). This is particularly important in NNR where the sport hunting concessions actually fall within the protected area not as a buffer area around it. The aim must be to maximise trophy quality and economic returns while maintaining the viability and growth of the NNR wildlife populations through ecologically and ethically acceptable sport hunting practices.

Quotas setting and Hunting regulations

Quotas for all trophy species are developed by SRN and the Mozambican Ministry of Tourism ((MITUR) and communicated to the operators at the SRN Hunting Operators Meeting in April of each year. General hunting guidelines are provided by the National Forestry and Wildlife Law but specific hunting regulations and guidelines for NNR are currently only in place for elephant and lion although this is under review by SRN. Ultimately trophies from all 28 animal species hunted in NNR will be monitored and assessed by SRN before the trophies leave the area. In 2006 only the trophies of six key species: elephant, lion, leopard, buffalo, hippo and crocodile were specifically inspected. The intention is not only to monitor hunting practices but, also provide baseline information on trophy quality that can be used for comparison in future years. This will ensure that quotas are sustainable and assist in the development of visual aging cues specific to NNR that can be used by Professional Hunters (PHs) to assess their trophy animals more accurately before they are shot.

Development of sustainable harvesting indicators

In 2006, as a result of the effective collaboration between hunting operators, SRN and researchers to conserve lions in NR, and the strong leadership shown by SRN in instituting a mandatory and monitored six year age limit for all trophy lions, hunting operators operating in NR were also invited to be founding members of a new conservation initiative, called “Savannas Forever” (SF). SF aims to improve the conservation effectiveness of Africa’s top hunting companies through a third-party certification program that will verify sustainable hunting practices and measure outcomes for key species such as lion, leopard and Cape buffalo as well as assess anti-poaching and community involvement efforts. A select group of founding members from Botswana, Tanzania and Mozambique will help to develop measurable indicators of sustainable harvesting, anti-poaching, and community conservation practices.

During the April 2006 SRN Hunting Operators meeting, all six of the Niassa Operators unanimously agreed to become members of SF. These hunting operators agreed to allow monitoring of trophy quality of the three key species (lion, leopard & buffalo). The SF program complements SRN management objectives and an MOU between SF and SRN is in production to facilitate this arrangement. All hunting operators also voluntarily agreed to allow monitoring of crocodile and hippo trophies to provide further information for SRN. This is an adaptive management process and will be streamlined as more data is collected from NNR through targeted research and monitoring programs. While field data from other areas such as Botswana, Tanzania and Namibia are useful for guiding aging and trophy monitoring, and in many cases is the only information currently available, it is essential that data specific to the Niassa system is collected to validate aging cues in this particular ecosystem.

Why these five species- lion, leopard, buffalo, crocodile and hippo?

- a. Ecologically these five species, along with elephant are critically important for habitat diversity and ecosystem functioning in NNR and are key indicators of the “ecological health” of the Niassa ecosystem. They represent the largest herbivores and carnivores present in NNR, in the absence of rhino, giraffe and cheetah.
- b. NNR provides one of the largest wilderness areas still intact for the conservation of these large bodied herbivores and carnivores. In 2006, NNR was identified as a priority lion conservation area in the Regional Conservation Strategy developed for the lion in eastern and southern Africa (Lowell *et al* 2006).
- c. Internationally, three of these species (lion, leopard and hippo) are listed as Vulnerable on the International Red List of Threatened Species (IUCN, 2006).
- d. In addition, leopard are on Appendix I of CITES where commercial trade in skins is banned but the import and export of hunting trophies is permitted provided that the scientific authority of both the exporting and importing nations are able to demonstrate that trophy hunting is sustainable. If Mozambique is to retain its CITES quota for leopard (60) careful monitoring of trophies is essential.
- e. In Mozambique, the Nile Crocodile is a CITES Appendix II species which allows the regulated trade in eggs, hatchlings and products of farmed animals as well as a quota for the export of the skins of sport hunted crocodiles (2006 CITES Quota = 900).
- f. Hippo, buffalo and crocodile were all hunted for meat and skins in the past in NNR. All these populations appear to be in recovery but need careful monitoring, as their densities are still relatively low given the available habitat. Current threats to these populations have not been adequately assessed.
- g. All of these species have significant aesthetic and economic value for NNR through eco-tourism and sport hunting and for the majority of stakeholder it is desirable that their populations increase. Lion, leopard, buffalo and elephant provide four of the “Big Five” dangerous game species sort after for wildlife viewing and sport hunting safaris. In the absence of large elephant quotas; lion, leopard and buffalo are the key trophy species in NNR and are vital for the financial viability of hunting operations.
- h. None of these species have been accurately censused in NNR in the past and current quotas were set based on little information of actual densities and distribution, although the quotas are conservative. This is particularly true for lion, leopard and crocodile where accurate censuses are difficult. For these species, trophy quality and catch effort provide a relatively simple and cheap indirect means of determining whether current quota size and off-take are sustainable (Lindsey *et al.* 2007).

- i. International concern for lions and leopards is mounting as they are difficult to census, heavily persecuted, the effects of trophy hunting are poorly understood, they are difficult to age in the field and population estimates are almost non-existent. Lion populations are particularly vulnerable to excessive male off-take owing to the potential impact of social disruption and infanticide following the removal of a breeding male. Recently, Whitman *et al.* (2004) demonstrated that the impact of infanticide could be largely avoided by restricting trophy hunting to males that are at least 6 yrs of age. In Niassa, continued off-take of underage lions (2004, 2005) has been of concern. Recently similar concerns about leopards have been expressed (L. Hunter pers. comm.) and need to be investigated.

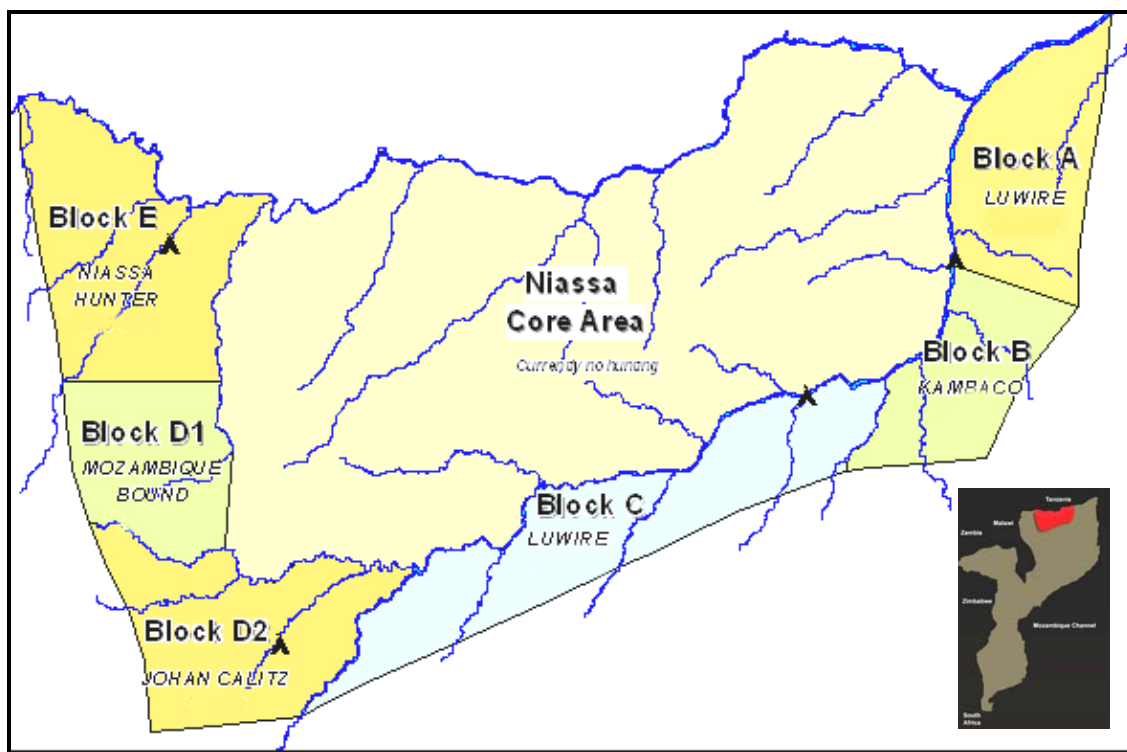


Fig. 1. Niassa National Reserve, northern Mozambique showing the position of the six sport hunting concessions surrounding the core area

Report Format

This report presents the results of the SRN/SF monitoring activities in NNR for lion, leopard, buffalo, hippo and crocodile during 2006. Results for elephants will be reported on by SRN separately.

The specific results of the trophy monitoring are provided for the 2006 hunting season with separate sections for each species. Results are presented per hunting block as well as for NNR as a whole. Specific recommendations are provided for each species.

This information can be used:

- a. To determine whether current quotas and hunting practices are ecologically sustainable.
- b. To provide a baseline of trophy quality in NNR against which future trophies can be assessed.
- c. To develop hunting guidelines and aging criteria for specific species.
- d. To assess the performance of hunting concessions.

Appendices:

More detailed information on the indicators and methods used to assess and age the trophies for each species are provided. This is a “work in progress” and will be added to as more research and monitoring is completed. It is hoped that this information can be used by SRN to develop a detailed monitoring protocol for these key species tailored specifically to NNR and for Professional Hunters (PHs) operating in NNR to improve the accuracy of their own field and trophy age assessments.

2006 TROPHY MONITORING RESULTS

1.0 Lion



2006 Lion trophy taken in Block D1 – Mozambican Bound Safaris, Niassa National Reserve, Mozambique (© Mozambican Bound Safaris). This was one of two top trophies taken in NNR in 2006 in terms of age and trophy quality (mane). Note the full mane filled in between the ears with no bare area behind the ears.

- The Niassa Lion Project (2004-2006) has been investigating the conservation status of lions in NNR for the past three years. The primary aims are to establish a sustainable monitoring system for sport hunting and to provide more detailed information on the basic ecology and threats facing this important lion population. The full results of Phase I of the Lion project will be available in February 2007. This project has shown that while lions can be hunted sustainably in NNR and excellent trophies are available, care needs to be taken due to the relatively low population density (0.01 – 0.03 adult lions / km², 500-1000 lions in NNR), unknown level of illegal off take, and continued off-take of underage lions by sport hunters.
- In 2006 the Niassa Points System for assigning quotas to concessions based on the quality of the lion trophies taken was instituted by SRN. This system requires in-depth monitoring and aging of all lions taken as trophies in NNR. A mandatory 6 year age minimum for lion trophies was instituted by SRN
- In addition, all hunting operators agreed to be research consortium members of Savannas Forever, allowing monitoring of lion, leopard and buffalo trophies and assisting in the development of measurable indicators of sustainable off-take.

1.1. Lion quotas – Niassa Points System

Setting fixed quotas for lion is problematic due to the difficulties and expense of accurately censusing a lion population. In addition due to rapid fluctuations in lion populations, survey results also have a short shelf life. In NNR, quotas are assigned independently for each concession dependent on the age of the lion trophies taken in the previous hunting season according to the Niassa Points System (Appendix 1). The Niassa Points System is fully explained in the 2006 SRN Lion Hunting Regulations and was accepted after discussion by all hunting operators at the SRN Hunting Operators Meeting held in Maputo in April 2006. This system rewards ecologically sound hunting by allowing an increase in quotas but penalizes the hunting of young lions. There is no penalty for not shooting a lion. Once each lion trophy has been examined and aged, it is placed in an overall aging category (< 4 years; 4-6 years; > 6 years) and points are assigned for that trophy according to the system shown in Table 1. For each concession, points are tallied for that year, divided by 3 and rounded up to the next whole number and that is the quota issued for the new hunting season.

1.2 Results of 2006 Hunting Season

- Nine (56%) of the 16 lions on quota were taken in 2006 from a total of 17 lion hunts (Table 5).
- Professional Hunters provided information (date, number of individuals, position, condition), photographs (mane, nose, full body) and blood samples for all nine of the animals. For two lions, nose photographs could not be used (A2-06; C2-06). All the skulls were provided for aging and measurement in November, and one premolar was taken from each skull for X-raying of pulp cavities.
- Lion trophies were aged based on tooth wear, closure of the pulp cavity, mane development, nose pigmentation and general body condition (see Section B) and placed in one of three age categories: < 4 years of age, 4-6 years and older than 6 years according the Niassa Points System.
- Photographs of the nine lion trophies and aging criteria are shown in Figure 2 (a-i).
- Only three lions (Figure 2 g-i) were considered over six years of age (33%) and acceptable trophies. Of these, two were marginal and only one lion appears to be significantly over six years of years of age (Figure 2i; Block D1, Mozambican Bound Safaris). All three of the acceptable trophies show full manes filled in between and behind the ears (no “mohawks”), noses more than 50% black, pulp cavities closed at the base in premolars, all teeth showing significant wear particularly on the enamel ridges of the canines (Figure 2c).
- Six lions were neither acceptable trophies in terms of age or in terms of mane development. Two lions were particularly young (Fig 2 a. b) according to the aging criteria. All of these lions showed little wear on all the teeth, slight wear on the canines with slight chipping of the canine enamel ridge, obviously pink noses, incomplete manes with prominent “Mohawk” and bald patches behind the ears and wide premolar pulp cavities. The four remaining trophies were between 4-6 years of age and showed intermediate characteristics (Fig 2c-f).

- According to the Niassa Points System, quotas for 2007 have been assigned independently for each block based on the total points achieved, where points are assigned based on trophy age (Table 1). For this year, the two young lions have been given the benefit of the doubt and assumed to be at least 4 years old as this is the first year of the Points System (Table 2).
- No lions were taken in Block B-Kambako (3 lion hunts, only one with bait) or Block E –Niassa Hunters (2 lion hunts) during the 2006 hunting season as no suitable trophies were observed either on baits or opportunistically. Kambako is commended for not taking any lions during 2006, despite sightings of underage lions.
- All three lions trophies from Block C were thought to be from the same coalition, though they were taken on different hunts as they were baited in the same place and were known individuals. Independently without knowing this before hand all were placed in the 4-6 year age category. The two lions taken in Block D1 were also both taken from the same bait site on separate hunts and may have been from the same coalition.

Table 1: Points assigned to lions of different ages in Niassa Reserve based on the quotas for each concession

Lion Quota	Number of Points for each trophy				
	> 6 yrs	No trophy	4-6 yrs	< 4 yrs	Incomplete info
For Quotas of 3 or more	4	3	2	-3	0
For Quotas of 2	4	3	2	0	0
For Quotas of 1	6	3	0	0	0

Table 2: Recommended quotas for 2007: Assigned for each hunting concession according to the age of the trophies taken in the 2006 hunting season, as calculated by the Niassa Points System

Hunting Block	Quota 2006	Used Quota	Number of lions taken in each age category				Points assigned based on age	Quota 2007	Change in quota
			< 4	4-6	> 6	None			
Block A	2	2	0	1	1	0	$2 + 4 = 6/3 = 2.0$	2	No change
Block B	3	0	-	-	-	3	$3 + 3 + 3 = 9/3 = 3.0$	3	No change
Block C	4	3	0	3	0	1	$2+2+2+3 = 9/3 = 3.0$	3	-1
Block D1	2	2	0	0	2	0	$4 + 4 = 8/3 = 2.6$	3	+1
Block D2	3	2	0	2	0	1	$2 + 2 + 3 = 7/3 = 2.3$	2	-1
Block E	2	0	-	-	-	2	$3 + 3 = 6/3 = 2.0$	2	No change
TOTAL	16	9	2	3-5	4	7		15	

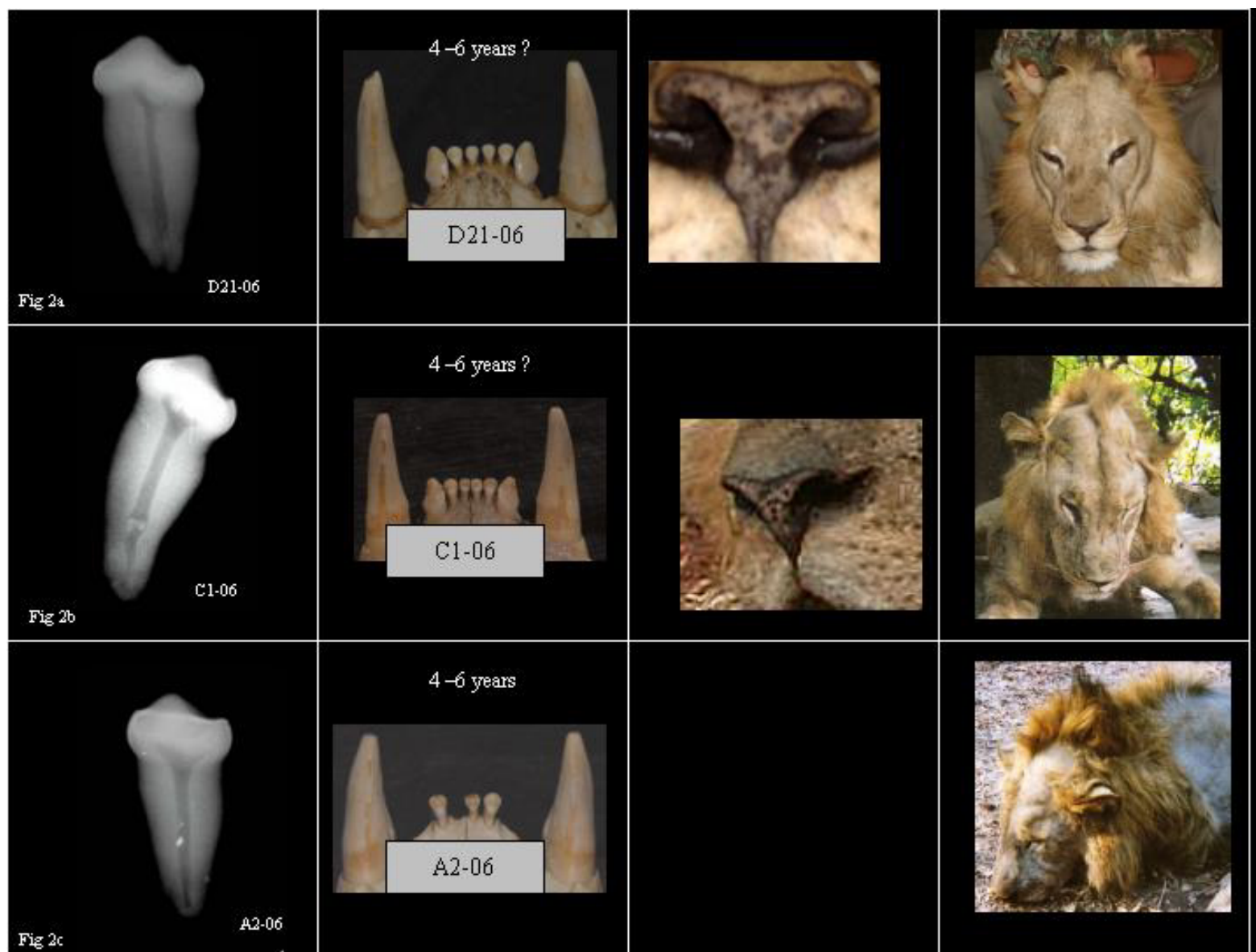


Fig 2a-c: 2006 Lion trophies. None of these lions are considered acceptable trophies. Suitable nose pictures were not provided for 2c



Fig 2d-f: 2006 Lion trophies. On the basis of closure of the pulp cavity, tooth wear, nose pigmentation and mane development these are marginal lion trophies. None are older than 6 years. All these lions fall into the 4-6 year old category but are closer to 6 years than 4 years.

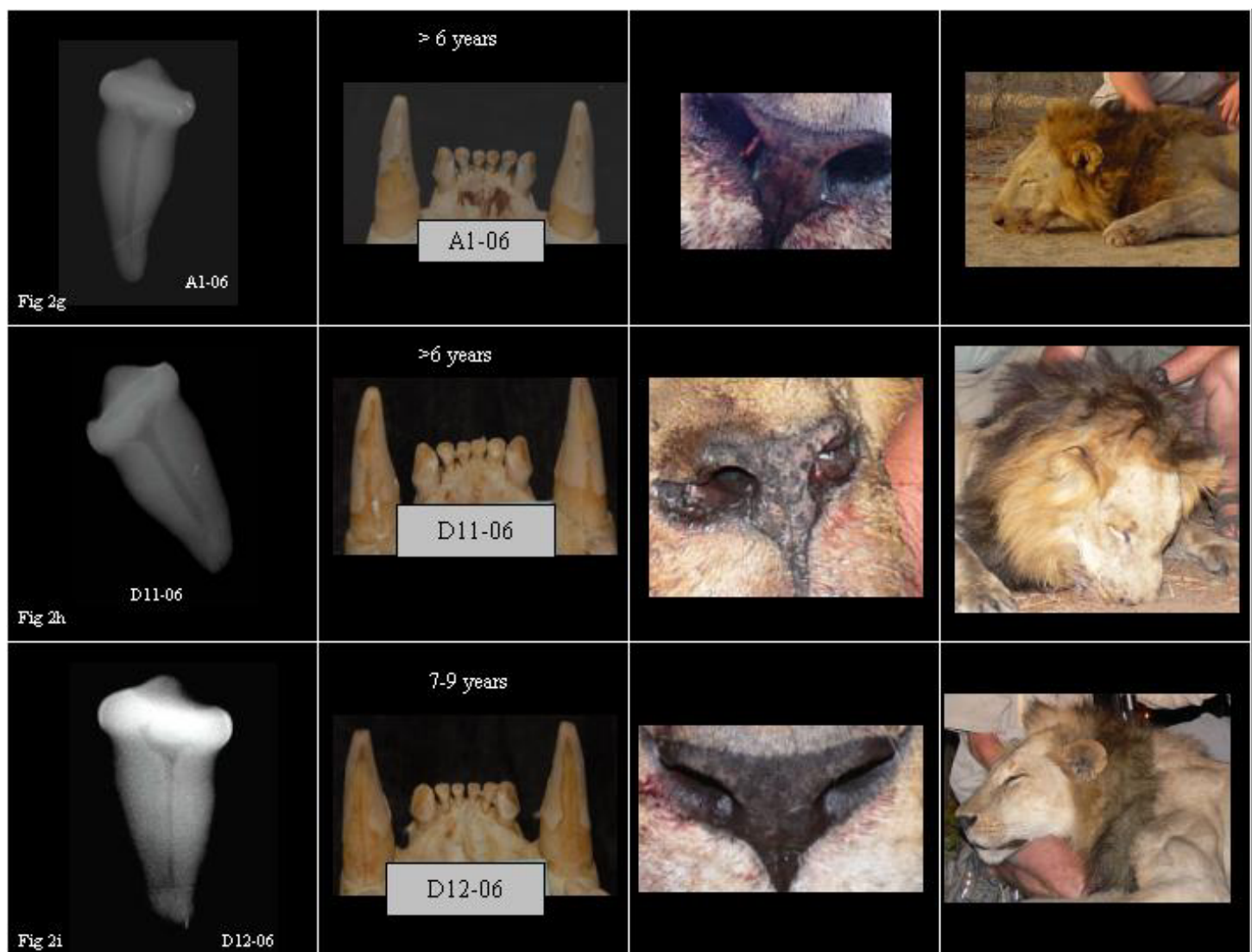


Fig 2g-i: 2006 Lion trophies. All of the above lions are considered acceptable trophies over the age of six on the basis of closure of the pulp cavity, tooth wear, nose pigmentation and mane development. Lion 2i is the by far the oldest lion taken in 2006 and believed to be 7-9 years of age, note the almost black nose, worn flat canine ridges, significant tooth wear on incisors and canines, narrow pulp cavity with a full, short mane (no bare area behind the ears)

1.3. Results of trophy monitoring: 2004-2006

Offtake

- Since 2000, (when SRN took over management of NNR), 44 lions have been shot as trophies (Table 3). Overall 50% (n =22) of these lions have been taken in Block C with the majority of lions shot by one company, Luwire (66%), which leases both Block A and Block C.
- Prior to 2000, an additional 10 lions at least were shot between 1996-1999 in Block B- Kambako and the southern section of Block A, but no official records were kept. Professional Hunter, J. Wilson, who was hunting in the area at the time, has provided details and photographs of many of these trophies.
- For the last four years the allocated quota has remained stable at 16 lions. All six blocks have been allocated a lion quota since 2005. Block B-Kambako has been hunted the longest with lion hunts taking place since 1996.
- In 2003 the off-take was 69% of the quota, however in the last three years since trophy monitoring was initiated the off-take has been between 50% and 56%. The percentage of the quota utilised between 2004-2006 varies widely between operators (Table 5):
 - Luwire (Blocks A & C) consistently utilises 80-100% of their allocated quota.
 - Kambako (Block B) has not taken a lion trophy in the last 2 years (22% offtake) since the block was taken over by new management. The reason given by J. Moore (pers. com) is the scarcity of acceptable lion trophies given that this area has been hunted the longest.
 - Mozambique Bound Safaris (Block D1) received their first lion quota in 2005 (no lions taken), but 2006 was their first year of full operation and the full quota was utilised.
 - Johan Calitz Safaris (Block D2) began hunting in the area in 2004. Their average off-take over the last three years has been 57%
 - Niassa Hunters (Block E) generally takes one lion a year with an off-take of 25%.Lkl
- The number of lions hunted per 100 km² provides a measure of off-take that can be compared between hunting blocks and with other areas (Table 6). The estimated density of lions in NNR is most closely comparable with Hwange National Park (HNP) in Zimbabwe. Average offtake in NNR over the last 3 years is slightly lower. In HNP, the off-take in neighbouring hunting concessions has had noticeable effects on the population structure of lions both in the hunting areas and in the neighbouring protected area (reduced the density of adult males, increased infanticide, increased turnover of territorial males) and is considered unsustainable (Loveridge *et al* 2007). In Selous Game Reserve (most similar in terms of habitat to NNR) the off-take of 0.13 lions / 100 km² is considered sustainable (Creel & Creel 1997). This is two times higher than the off-take in NNR, however the density of lions in SGR is 3-4 times higher, suggesting the current off-take in NNR may be unsustainable in terms of numbers, without even taking the age of the lions taken as trophies into account. This is why PHs are struggling to find lions of

the right age, they are probably not available in sufficient numbers to support the current quota. The situation is made even worse when only a small percentage of each hunting concession is utilised (Table 6).

- A simple generalized example illustrates the problem: if only 20% of a 4000 km² block is utilised, this equals an actual hunting area of 800 km² (in reality even less as most baits are hung along the rivers). If there is a density of 0.01 –0.03 adult lions/ km² (as is predicted by the Niassa Lion Project) this equates to only 8-24 adult lions, of which only 50% are likely to be males (4 –12 lions). In general, off-take of between 2-4 % of the adult male lion population is considered sustainable (C. Winterbach pers. com.) provided that only lions older than 6 years are taken. If we use the upper limit of 4%, then this equates to annual sustainable quota of less than one lion. Yet a concession of this size actually has a quota of 2-4 lions.

Trophy Age

- Trophy monitoring of lions was initiated in 2004 with the first investigation of tooth wear and blood sampling for FIV. In 2004, professional hunters were supplied with trophy kits containing a questionnaire, blood sampling kit, maps and a disposable camera and requested to provide photographs of manes, noses and body condition. In 2006 this was continued and X-rays of the pulp cavities of premolars was initiated.
- Of the 26 trophies assessed over this three-year period (2004-2006), 65% are considered unacceptable trophies (too young) with only nine lions over the six-year age minimum (Table 4). Three lions have been younger than 4 years (Table 4) with the remainder of variable quality in the 4-6 year age category.
- All the acceptable trophies had noses more than 50% black, manes forming a ring around the face with no mohawk or bare patches behind the ears and obvious tooth wear particularly on the enamel ridges of the canines (Fig 5).
- Between 2003-2006, lion hunts have been of variable length (7-24 days; n = 39 hunts). The average time taken to shoot a lion trophy is 10 days. Since trophy monitoring began, the average time taken to shoot an underage lion was 9 days (n = 14) while the average number of days taken to find a lion over the age of 6 years was 12 days. On two occasions, acceptable trophies have been taken on the first day of the safari. In both cases these lion hunts were held in new areas that had not been hunted before (Block C-Metarica, Block D1).
- The majority of lions continue to be shot in a narrow band along the banks of the Lugenda River in the case of Block A, B, C and the Rovuma River for Block E. The Luambeze River, the border between Block B and Block C, is one of the most heavily hunted areas in NNR. Multiple lion baits are hung in this area every year and at least seven lions have been shot in this area in the last 9 years (1998-2006). In 2006, a 4-5 year old, collared male lion was the pride male in the area with a home range of at least 350 km². At least two females are members of this pride with 5 young cubs presumably sired by

this male. Yet despite knowing that the pride male in this area was not a suitable trophy as he was too young, at least 5 different safaris baited and searched for lions in this area. Should this lion have been shot (and in our opinion he would have been if he had not had a collar on), it is likely that the new pride male would have killed the 5 young cubs.

Table 3: Total number of lions taken as trophies in Niassa National Reserve in the last seven years (2000-2006) since management was initiated by SRN, with additional data from 1996-1999 from Kambako.

Hunting Block	1996-1999	Years of SRN Management							
		2000	2001	2002	2003	2004	2005	2006	Total
A	-	-	-	-	2	1	2	2	7
B	10	0	0	0	2	2	0	0	4
C	-	1	3	3	4	4	4	3	22
D1	-	-	-	-	-	-	0	2	2
D2	-	-	-	?	2	0	2	2	5
E	-	-	-	-	1	1	1	0	3
Total	10	1	3	3	11	8	9	9	54

Table 4: Age category of lion trophies taken per hunting block per year in Niassa National Reserve since trophy monitoring was initiated in 2004 (n = 26 lions). Note that for the lions shot Block E during 2004 and 2005, photographs were provided but the skull was not provided for aging.

Year	Number of lions shot in each age category in each block																									
	< 4 years old						4-6 years old						> 6 years old						Total per block						Overall	
	A	B	C	D1	D2	E	A	B	C	D1	D2	E	A	B	C	D1	D2	E	A	B	C	D1	D2	E	TOTAL	
2004	1	2	0	0	0	0	0	0	2	0	0	1	0	0	2	0	0	0	1	2	4	0	0	1	8	
2005	0	0	0	0	0	0	1	0	3	0	1	0	1	0	1	0	1	1	2	0	4	0	2	1	9	
2006	0	0	0	0	0	0	1	0	3	0	2	0	1	0	0	2	0	0	2	0	3	2	2	0	9	
TOTAL	1	2	0	0	0	0	2	0	8	0	3	0	2	0	3	2	1	1	5	2	11	2	4	2	26	
	3 lions < 4 years old						14 lions 4-6 years old						9 lions older than 6 years						26 lions assessed							

Table 5: Lion off-take in Niassa National Reserve per hunting block and overall

Category	Hunting Blocks in Niassa National Reserve						
	Block A	Block B	Block C	Block D1	Block D2	Block E	Total
2006 Results							
Allocated lion quota 2006	2	3	4	2	3	2	16
Number (%) of lion quota used 2006	2 (100%)	0 (0)	3 (75%)	2 (100%)	2 (67%)	0 (0)	9 (56% used)
Lion off-take / 100 km ²	0.07	0	0.06	0.06	0.05	0	0.04 lions/100 km ²
Percentage of lion trophies older than six years.	50%	-	0	100%	0	-	33% acceptable
Number of lion hunts	2	3	5	3	2	2	17 (53% success)
Overall 2004 - 2006	Block A	Block B	Block C	Block D1	Block D2	Block E	Total
Total lion quota allocated 2004-2006	6	9	12	4	7 ^b	8 ^c	46
Total lion quota used (%) 2004-2006	5 (83%)	2 (22%)	11 (92%)	2 (50%)	4 (57%)	2 (25%)	26 (57 %)
Percentage of total lion trophies older than six years.	40%	0 ^a	36%	100%	25%	50%	10 (39% acceptable)

^a Block B-Kambako was taken over by new management in 2005. In the last two years no lions have been hunted.

^b Block D2 had a lion quota of 2 in 2004 and 2005, this was increased to 3 in 2006.

^c Block E had a lion quota of 3 in 2004 and 2005, this was reduced to 2 in 2006

Table 6: Densities and off-take of male lions in NNR compared to other areas. Offtake in NNR is calculated as an average per total area of each hunting concession over the last three years (a) and an average per 20% of the total area of each hunting concession over 2006 (b)

Area	Density	Average Offtake	Reference
Selous Game Reserve	8-13 adults / 100km ²	0.13 / 100 km ²	Creel & Creel 1997
Hwange National Park	2.7 adults / 100 km ²	0.09-0.18 / 100 km ²	Loveridge 2007
Serengeti National Park	8-14 adults / 100 km ²	-	Packer 1990
Kruger National Park	10 adults / 100 km ²	-	Creel & Creel 1997
a) Niassa National Reserve	1-3 adults / 100 km ²	0.06 / 100 km ²	This report
b) Niassa National Reserve	1-3 adults / 100 km ²	0.3 / 100 km ²	This report

1.4 Visual cues to aging lions in NNR

- One of the primary aims of the Niassa Lion Project is to validate visual aging cues that can be used by PHs in the field to assess lions before they are shot and thereby decrease the number of young lions that continue to be taken as trophies.
- It is mane development, body size, and on some occasions, nose colour that are most commonly used by PHs for assessing age in lions along with additional information on general body condition and scarring.
- There is a clear correlation between nose pigmentation, mane development and tooth wear in Niassa lions (see 2006 trophy results, Fig 2).
- A recent book by K Whitman and C. Packer (“A Hunters’ Guide to Aging Lions in eastern and Southern Africa”, Safari Press” has recently been published and provides detailed guidance on visual cues for aging lions in a variety of other habitats. One copy of this book will be distributed to each Hunting Concession in NNR by the Niassa Lion Project in 2007 to assist PHs..

Mane Development

- In Niassa, as in other areas, mane development occurs in defined stages with some individual variation. Hair on the chest appears earliest (“dinner jacket mane”; Fig 5B & C), followed by the back of the neck and then the sides of the face. The hair on the forehead is the last to develop with males typically having a “Mohawk” between the ears until at least 5-6 years with obvious bare patches on the side of the forehead and behind the ears (Fig 5b). The length of the hair on the chest is no indication of age. Long mane hairs found at baits do not necessarily indicate an old lion, as hair on the chest appears first and is the longest (Fig 5c).
- In general, any Niassa lion with a prominent “Mohawk”, bare patches behind and between the ears and no extensive mane extending between the shoulder blades is likely to be younger than 6 years and should be avoided (Fig 5).

- In contrast, any lion with a full mane forming a complete circle around the head, filled in between and behind the ears is likely to be older than 6 years of age (Fig 6). As lions age the mane may become sparser, shorter and may look patchy, but does not seem to revert back to the “Mohawk” typical of young lions.
- Mane development can be used by Niassa PHs to place a lion in a broad age category (< 4 years, 4-6 years, older than 6 years). The accuracy is improved if other aging criteria are also used: nose colour, body condition and canine condition (often visible when an animal yawns).
- The differences are most marked at the ends of the age categories. In much the same way as it is relatively difficult to distinguish between a 14, 15 or 16 year old child but easier to distinguish between an 12 year old and an 18 year old, a young lion can be relatively easily distinguished from an old lion, but it is much more difficult to distinguish between a 4, 5 or 6 year old with any accuracy.
- The target is to hunt old lions not fixate on the minimum acceptable age of 6 years.

Age and body size

- There is little relationship between age and body size in mature adult male lions. Male lions reach adult body size by 3-4 years of age although they may not have reached muscle mass (Whitman & Packer 2006).
- Safari Club International and Roland Ward use a skull measurement (skull length in inches + skull width in inches) to provide their minimum record book sizes for lions. For Roland Ward, the record book minimum is 24” while the SCI record book minimum is 23”. These measurements are taken when skulls are aged and inspected at the end of each hunting season.
- The SCI and Roland Ward record book minimums therefore encourage the shooting of lions that are too young. PHs should not be using size as the only indication of a suitable trophy in lions and clients should not be encouraged to shoot a record book lion without consideration of age if they wish to hunt sustainably.
- For interest, overall Niassa lion trophies have an average skull measurement of 23.4 (n = 25). 64% of the lions taken in the last three years equal or exceed the minimum SCI minimum record book size and 20% exceed the Roland Ward minimum.
- However, the results show clearly that skull size has no bearing on lion age. Within each age category skull size varies widely. In fact the two youngest lions taken as trophies in NNR between 2004-2006 had the largest skulls (Fig 3, Fig 5H and 5J).

Nose pigmentation

- There is no doubt that the noses of NNR lions darken with age. This is clearly illustrated by the nose photographs of a radio-collared male lion over the period of a year (Fig 4). On the basis of tooth wear and mane development this male was 3-4 years old when first collared in May 2005. In 2006 (4-5 years old) he was a pride male with at least 2 females and five cubs in his pride. This lion remains collared and will continue to be followed to assess further changes in nose pigmentation and mane development as he ages.
- Of the nine lions taken in the last 3 years considered to be over the age of 6 years, nose pictures were provided for seven individuals. All these lions had noses more than 60% black.
- Nose pigmentation does therefore provide a visual indication of age when it can be seen. In 2006, we know of at least two PHs that took digital pictures of potential lions feeding on a bait and magnified the images to check on nose colour before the lion was shot. In our experience the pink noses of young lions are more obvious than the black noses and can be seen with binoculars. Lions with obviously pink noses should be avoided. Unfortunately in many cases visibility is too poor to allow adequate checking and mane development remains the most visible cue.

▪

Body condition and other visual characteristics of age

- There are also other indications of age that can be used to add in decision-making. These are all clearly illustrated in Whitman & Packer Field Guide on lion aging (2006)
- Old males generally have noticeable more scars than young males, particularly on the face
- Many old males tend to lose body condition and have a prominent spine.
- In old males, noticeable yellow and worn canines with blunt ends can sometimes be seen through binoculars when a lion yawns.

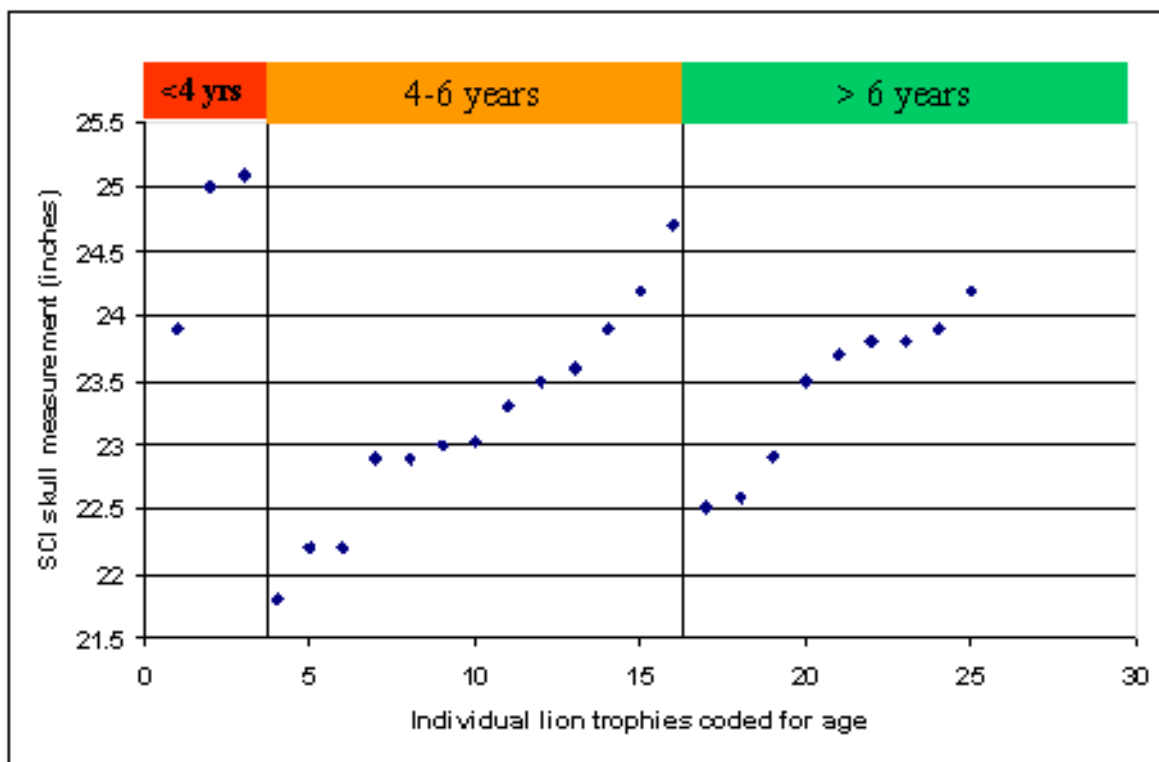


Fig. 3: The skull size (in inches) and age category (tooth wear) of male lions taken as trophies in NNR (2004-2006; n = 25).



NM01-07/2005 (3-4 years old)



NM01-07/2006 (4-5 years old)

4a: Changes in nose pigmentation over a year period



NM01-10/2005 (3-4 years old)



NM01-11/2006 (4-6 years old)

4b: Mane development over a year period. Note the increasingly black mane and increase in length of the mane hairs on chest. This male still has a “mohawk” with significant bald patches on the forehead and behind the ears

Fig. 4: Increasing nose pigmentation and mane development in a radio-collared male lion in NNR over a one-year period. In 2006 he was a pride male with five young cubs from two females. If hunted it is likely that the cubs would have been killed by the incoming male as all were under one year of age

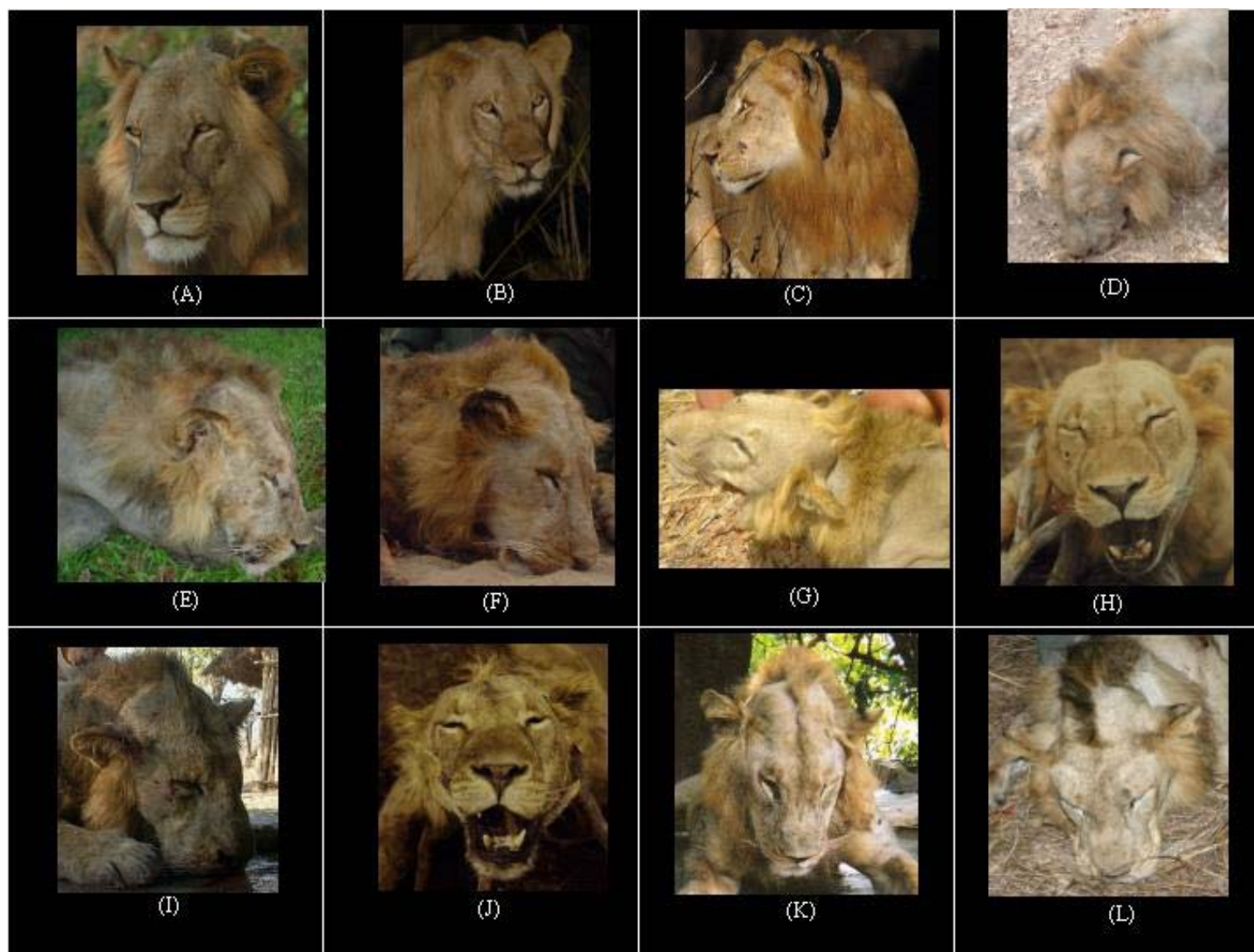


Fig. 5: Mane development in NNR: All these lions are considered younger than six years of age based on tooth wear and nose pigmentation. None of these lions are acceptable trophies. Note the prominent “mohawks” and bare patches between and behind the ears. Lions H-L are particularly young lions. All these images were taken in NNR between 2003-2006.



Fig. 6: Mane development in lions considered six years and older on the basis of tooth wear and nose colouration. Lions C, D & E were the oldest lions (7-9 years) in terms of tooth wear. All lions had more than 60% black noses. Note that in (D) and (E) the manes are not as dense but still form a full circle around the head with not bare patches behind the ears. None of these lions show a prominent “mohawk” or bare patches between and behind the ears. All these images were taken in NNR between 2003-2006 with the trophy hunted lions coming from Blocks A, C, D2, D1 and E.

1.5 Comments

- The aim is to maximize trophy quality and economic returns while maintaining the viability and growth of the NNR wildlife populations through ecologically sustainable and ethically acceptable sport hunting practices. This is particularly important in NNR, which is a designated protected area and national heritage.
- The young age of some pride males (4-5 years old), small size of male coalitions (1-2 males), presence of “empty territories”, opportunistic sightings and a call-up survey all suggest that the density of lions in NNR is relatively low (0.01 –0.03 / km²; 500-1000 individuals; Niassa Lion Project) but believed to be viable.
- Given the density of lions, current quotas and off-take may be unsustainable particularly given the low proportion of each hunting concession that is actively hunted (Table 6). This is exacerbated by the hunting of underage male lions, which has been shown to suppress the birth rate and reduce cub survival due to infanticide. In addition, the continual creation of open territories on the boundary of the core area is likely to have the effect of drawing males from inside the non-hunting area into the hunting area. This ultimately results in males even well within the core of the protected area being exposed to sport hunting mortality (Loveridge *et al* 2007). In addition the level of non-hunting mortality is still poorly known (inadvertent snaring and poisoning and direct persecution) and should be added to the off-take.
- Poor trophy quality and the high proportion of under age lions shot as trophies in NNR (66%) is therefore reason for significant concern. Any decline in the lion population is contrary to the goals of NNR, which supports conservation of biodiversity as well as sustainable use and is contrary to regional conservation strategies, which have identified NNR as a priority lion conservation area (Nowell *et al.* 2006).
- There may also be significant financial costs associated with the current situation. NNR lions under the age of six are not high quality trophies and the overall quality of the trophies taken from NNR in the last 3 years has been poor. These trophies do not provide a good advertisement of NNR as a top sport hunting destination and could harm future marketing initiatives.
- Lions are also critical for the financial viability of Niassa hunting operations (in the absence of a large elephant quota) and any decrease in quota for whatever reason will put added financial pressure on the operators.
- The majority of PHs will agree that the decline in trophy quality is often a warning sign that sustainable hunting practices are not in place and off-take is too high. In this case, we suggest that as long as off-take is restricted to mature lions and a relatively high proportion of the concession area is utilized, off-take and quotas will adjust to the actual lion population in each concession due to the Niassa Points System for quota allocation. This needs to be closely monitored.

- In many cases, poor trophy quality in NNR is more a reflection of continued poor hunting practices and insufficient search effort rather than a reflection of quotas that are too high.
- If managed carefully and hunted sustainably, the Niassa lion population has the potential to increase quickly and dramatically given the large area under protection, increasing prey populations and improved anti-poaching efforts. As in other areas, provided only mature lions are targeted, NNR has the potential to provide excellent trophies. This would serve conservation goals and improve the financial viability of hunting operators.

1.6 Why do underage lions continue to be taken as trophies?

We need to look more closely at why under age lions continue to be taken as trophies in NNR despite the potentially negative consequences for operators, SRN and NNR as a whole.

In our view there are only three possible reasons why this is continuing.

Either,

- A. It is impossible to tell the age of a lion from visual characteristics in Niassa and therefore it is unrealistic to expect PHs to comply with the six-year minimum. Aging can only be done once the lion is already dead.

or,

- B. There are visual aging cues that can be used in the field, but PHs and clients are not aware of these and they are shooting underage lions due to ignorance not intent. It is a matter of education.

or

- C. The short-term costs to operators and PHs of not shooting a lion on a booked lion hunt are still greater than the costs of shooting an underage lion. It is driven by financial pressure.

A: It is impossible to tell the age of a lion from visual characteristics in Niassa and therefore it is impossible for PHs to comply with the six-year minimum.

- This is not a valid argument in NNR or elsewhere. The results from three years of trophy monitoring and research in NNR, show convincingly that visual characteristics, particularly mane development can be used to place lions into broad age categories in the field before the animal is shot. We will be able to refine this even further once more data has been collected from a larger sample of lions.
- The problem is that PHs are attempting to distinguish between 4, 5, or 6 year old lions where individual variation prevents clear cut distinctions and it is easy to make mistakes. If there is doubt over whether a lion is 4 or 6 then the lion is too young, is not a suitable trophy and should be passed up. PHs should be targeting obviously old lions with full manes and dark noses where there is little chance for confusion and not fixating on the lower limit of the acceptable trophy range (see point B below).

B: There are visual aging cues that can be used in the field, but PHs and clients are not aware of these and they are shooting underage lions due to ignorance not intent. It is a matter of education.

- For the most part, this is a valid argument in NNR.
- Lions in the 4-6 year old age category are the most common male lions seen at present. This reflects the typical pyramid age structure of most wildlife populations with a predominance of young adult animals and scarce old individuals. This is exacerbated in NNR by the low density of lions ((01.01-0.03 lions / km²), which makes old lions particularly “rare”. The predominance of young animals may also reflect a population in recovery, responding to increasing prey populations and better protection in NNR.
- As result many PHs have not seen an old Niassa male lion; they have only seen these young males. This has lead to the widespread, but false belief amongst PHs that Niassa lions do not develop full manes. As a result PHs are simply choosing the oldest lion they see rather than an old lion.
- General client and PH ignorance about how to identify an old lion and what constitutes an acceptable trophy appears to be widespread, and is not confined to PHs that hunt in NNR. Trophy quality appears to have declined in many areas with young adult lions becoming accepted as the norm for acceptable trophies in many areas. The decline in lion populations across Africa, associated decreases in hunting quotas and canned lion hunting in SA also means that many PHs have had little experience in hunting wild lions. Without old lions for comparison or sufficient lion hunting experience, many PHs lack the experience to distinguish between the different age categories. In 2006, one apprentice PH in NNR still believed that an old lion could be identified by large body size alone.
- In NNR, reports, newsletters, and presentations are for the most part only reaching the operators who attend the meetings not the PHs who have to make the decisions in the field. This is exacerbated by the high turnover in PHs in some Blocks and the use of PHs for only a single season or single hunt. These PHs have not had the time to develop experience in the specific characteristics of the NNR lion population.

C: The short-term costs to operators and PHs of not shooting a lion on a booked lion hunt are still greater than the costs of shooting an underage lion.

- This is true in NNR.
- Hunting operators are running a business like any other. Lions as high value trophy species are critical for NNR operators to remain financially viable in the absence of large elephant quotas.
- In NNR, only fixed quotas are available. This means that trophy fees have to be paid regardless of whether the animal is trophy hunted or not. The client only pays the trophy fee if the trophy is actually taken, so an unsuccessful hunt is a financial burden on an operator resulting in considerable pressure for lion hunts to be successful so that the trophy fees can be recouped.

- SRN does try to ease the financial pressure this places on hunting operators by allowing them to pay for the quota in blocks throughout the season. However this type of fixed quota provides little incentive for hunting operators to reject lions that are too young if the hunts have already been sold.
- The tips earned by the PHs for a successful lion hunt are substantial. If the client is not concerned about the quality of the lion this can place significant pressure on the PH to shoot the lion even if the lion is too young.
- Some PHs are only in the area for one hunt and do not have a vested interest in the long term sustainability of the NNR lion population. For some of these PHs, insufficient effort is given to finding a suitable trophy especially when hunting with clients that do not know the difference. The taking of any trophy becomes more important than taking a good trophy because of the financial rewards and potential for a booking for a subsequent hunt..
- There is also a general perception that clients that do not get a trophy will not return in future and if this is ongoing this will impact on the reputation of the company. However, a recent questionnaire survey completed at the Dallas Safari Club and Houston Safari Club conventions in January 2005 where clients (n=150) and operators (n = 127) were interviewed suggests this may not be as much of a problem as suggested by the operators (Lindsay *et al* 2005). The results showed convincingly that a guarantee of obtaining the trophy during a hunt was less important to clients than operators realized. The key may be in the marketing.
- One operator suggests that an unsuccessful lion hunt is more damaging and costly than no lion hunt. Some companies offer a discounted rate on future hunts if no suitable trophy animal is found. Another option might be to offer a discount on daily fees but an increased trophy fee for those hunts where only high quality trophies will be taken.
- Some operators remain concerned that their quotas will be decreased if they do not shoot the full quota they are allocated and that they will therefore be penalized in future seasons. However, in NNR, the Points System was specifically designed so that operators would not be penalized for not taking a lion only for taking an underage lion.

Lion Recommendations

- Continued collaboration between operators, PHs, researches, SRN and Savannas Forever is essential to refine visual aging criteria and the Niassa Points System.
- Trophy monitoring of lions should continue to include:
 - Distribution of the lion kits for each lion on quota with questionnaires and provision of disposable cameras to provide image of full body, mane and nose photographs of all trophies.
 - Examination of tooth wear before the skulls leave NNR
 - Removal of a premolar for X-raying of the pulp cavity (K & C. Begg; Savannas Forever).
- It is no longer necessary to collect blood samples, as the FIV status (positive) of the NNR lion population has been determined and is unlikely to change.
- It is essential that the quota changes calculated by the Niassa Points System are followed through. By this system two blocks will receive a decrease in quota of one lion each, while one block will receive an increase of one lion in 2007. This will:
 - Provide an economic incentive to PHs to reject lions that are too young in order to avoid a decrease in the next year's quotas and a potential decrease in economic returns.
 - Provide an incentive to hunting blocks to put more effort into finding high quality lion trophies so that they can get an increase in their quotas.
 - Result in a change in off-take that will more reliably reflect the actual density of acceptable lion trophies in each concession and the percentage of each block that is being effectively utilised. By this system if the shooting of underage lions continues, some concessions will be reduced to a quota of zero until the lion population recovers in their area.
- Operators need to be reminded that only lion hunts of a minimum of 18 days are allowed in 2007, as stipulated in the SRN Lion hunting regulations.
- The use of optional quotas for a portion of the lion quota whereby operators only pay the trophy fee and other SRN fees if the animal is actually taken might be worth considering. This will remove the financial costs to an operator for turning down underage males. This might be particularly useful for key species that are of specific international conservation concern e.g. lion, leopard, hippo.
- Information needs to be more effectively distributed to PHs. For lions, the Niassa Lion Project will:
 - Produce another edition of the Niassa Lion Newsletter to present results in an accessible way and will be widely distributed to PHs, clients and operators in Niassa.
 - Purchase and distribute eight copies of the newly published book "*A Hunters Guide to Aging Lions in eastern and southern Africa*" by Karyl Whitman and Craig Packer (2007; \$16.95) that clearly illustrate the most up to date aging methods for lions in Southern and East Africa. These will be distributed to each hunting concession, SRN, and Reserve Headquarters.

2.0 Leopard



2006 Trophy leopard taken in Kambako-Block B (Client: J. Kniestedt; PG: S. Taylor; © Kambako Safaris). On the basis of tooth wear and closure of the pulp cavity this was one the oldest leopards taken in the 2006 hunting season

- Leopards are on Appendix I of CITES, which means that the import and export of hunting trophies between countries is permitted provided that quotas systems are adhered to and details and evidence are provided of the scientific and management basis for the proposed quota and that the requested quota will not be detrimental to survival of the species (“non-detriment finding”, Thorson, 2006).
- Effective quota monitoring is therefore essential.
- Mozambique has an annual CITES leopard quota of 60 leopard, distributed amongst all the national hunting concessions. In theory , this quota should also include leopard problem animal skins that are exported.
- This is the first year of leopard trophy monitoring in NNR. As such it will provide the baseline for future monitoring activities and is the first stage in the development of visual aging criteria and hunting guidelines for SRN and SF
- The aging of these trophies is preliminary based on aging criteria that have been developed in other areas, this still needs to be ground-truthed in Niassa
- An objective in 2007 is to initiate a Niassa Leopard Project (similar to the lion project) that will investigate the status of leopards in NNR and develop an effective trophy monitoring system.
- The aims will be to develop and validate aging criteria in collaboration with SRN, SF, Operators and researcher and investigate potential threats to the leopard population including human-leopard conflict.

This will be combined with basic ecological research to determine home range size, movement patterns, age structure and densities.

- This type of information is needed to ensure continued allocation of a CITES quota

2.1. Results of the 2006 hunting season

- In 2006, 19 leopards were taken as trophies although a quota of only 17 was allocated (Table 7). Two additional leopards were taken in one block.
- Over the last 5 years the annual leopard quota allocated by the Ministry of Tourism has varied erratically (Table 7). Between 2005 and 2006, the quota decreased from 26 to 17. This resulted in the quota being over-utilized in 2006 as leopard hunts in one block were booked 2-3 years in advance on the assumption the quota would remain stable. The operator went ahead despite the quota decrease.
- We assume some of the variability in the allocated quota is due to the static CITES quota of 60 animals being distributed between an increasing number of hunting concessions /courtadas throughout the country. However, this cannot be the only reason as the quota has not been consistently decreasing, it has varied erratically. This makes it difficult for operators to market hunts ahead of time.
- On average over the last 5 years, 66.6 % of the quota has been utilised, varying between 42% and 100%. We would expect the percentage utilization of the quota to drop when the quotas are high and increase when the quotas are low, but there is no obvious pattern in percentage utilization.
- Photographs were provided of 15 of the leopard trophies and the skulls of 17 leopards from NNR were provided for trophy monitoring with an additional trophy from the Kambako courtada. One leopard was taken after the trophy-monitoring trip and one leopard was injured (survived).
- The skull of an old leopard that was killed by Niassa residents as a problem animal in Milepa (Block E) provided an example of extensive tooth wear
- All skulls were measured (skull width, skull length, jaw width, length, canine width and length) and placed into an age category (<2 years, 2-4 years, > 4 years) based on tooth wear (Section B). A premolar or incisor was taken for pulp cavity X-rays.

2.2 Trophy age

- Seven of the 18 aged trophies (39%) showed no wear on the canines and incisors and no chipping of the enamel ridge (Fig. 7, Fig 8). Two of these trophies were particularly young, with very small skulls, canines and open pulp cavities. According to available aging criteria, none of these individuals are likely to be much over two years of age and several are possibly younger.
- The small size of some of the skulls suggests that some of the trophies may have been from females. A recent survey in Tanzania found that 28% of leopard trophies reported as males were actually from females.
- On the basis of tooth wear, ten trophies fell into the two to four year old age category (56%), and only one trophy was obviously over four years of age.

- Leopard killed in Milepa was significantly older than any of the trophies taken in 2006, with extensive wear on the canines and incisors (Fig. 7 & 8).
- Tooth wear, particularly of the canines, enamel ridge and incisors is likely to provide the best indications of age in leopards (Fig. 7). V. Booth (pers. com) also suggests that exposure of the dentine below the gum line provides an accurate indication of age. This does seem to be the case (Fig. 7). The next step is to calibrate these changes with age.
- There does appear to be a clear correlation between pulp cavity closure and tooth wear in leopards (as there is in lions) but again this needs to be calibrated with age (Fig. 8).
- Despite a specific request at the beginning of the season for body length measurements of leopards to be taken (and the provision of guidelines on how the measurement should be taken), measurements were only provided by Block B. Yet, both PHs and researchers have suggested that body length might be the best visual indicator of age in leopards. It is therefore important that this measurement becomes a standard measurement taken by PHs from each trophy.
- PHs suggest that indirect measures such as of track size, the height and width of scratch marks in bait trees and amount of bait eaten provide additional indications of age and sex in leopards.
- Of the leopard trophies that have been measured in NNR to date (16 in 2006, 9 in 2005), the average SCI measurement was 14.1 (skull width in inches + skull length in inches) with a range of 11.6-15.8. This is below the Roland Ward minimum for leopards of 15 but above the SCI minimum of 14. The average was affected by the inclusion of two very young leopards with small skulls that were taken as trophies in 2006 (11.6 & 11.8, Fig. 8 Q and R). There is little evidence to suggest that mature male leopards in NNR are significantly smaller than in other areas.
- It has been suggested that a minimum age of four years should be set for acceptable trophies to minimise social disturbances to the population. Male age to first reproduction varies between 2-3 years (Bailey 1999) and leopards under the age of 4 are therefore unlikely to be old, mature males. Leopards also show infanticide with cubs are killed by an incoming male if the territorial male is removed (L. Hunter pers. com).
- While preliminary aging of the trophies suggests that many of the leopards hunted in NNR are below four years of age, it would be impossible and unfair to enforce a four-year age minimum age limit in NNR at present as reliable visual aging characteristics have not been developed and tested. Instead a minimum body length measurement (2.4m as in force in Tanzania) might be more appropriate as it is likely to be related to age and will minimize the number of young and female animals taken. Again more information is needed from the NNR population.

Table 7: Used and allocated leopard quotas for each Block in NNR from 2002-2006

Hunting Concession		Year				
		2002	2003	2004	2005	2006
Block A	Quota	2	3	3	4	2
	Utilized	1	3	4	3	2
Block B	Quota	5	5	3	5	4
	Utilized	0	5	2	1	4
Block C	Quota	5	6	5	6	4
	Utilized	5	6	3	4	6
Block D1	Quota	-	-	2	3	2
	Utilized	-	-	0	2	2
Block D2	Quota	4	4	3	4	2
	Utilized	0	1	0	0	2
Block E	Quota	3	4	2	4	3
	Utilized	2	3	3	1	3
TOTAL	Quota	19	22	18	26	17
	Utilized	8	18	12	11	19

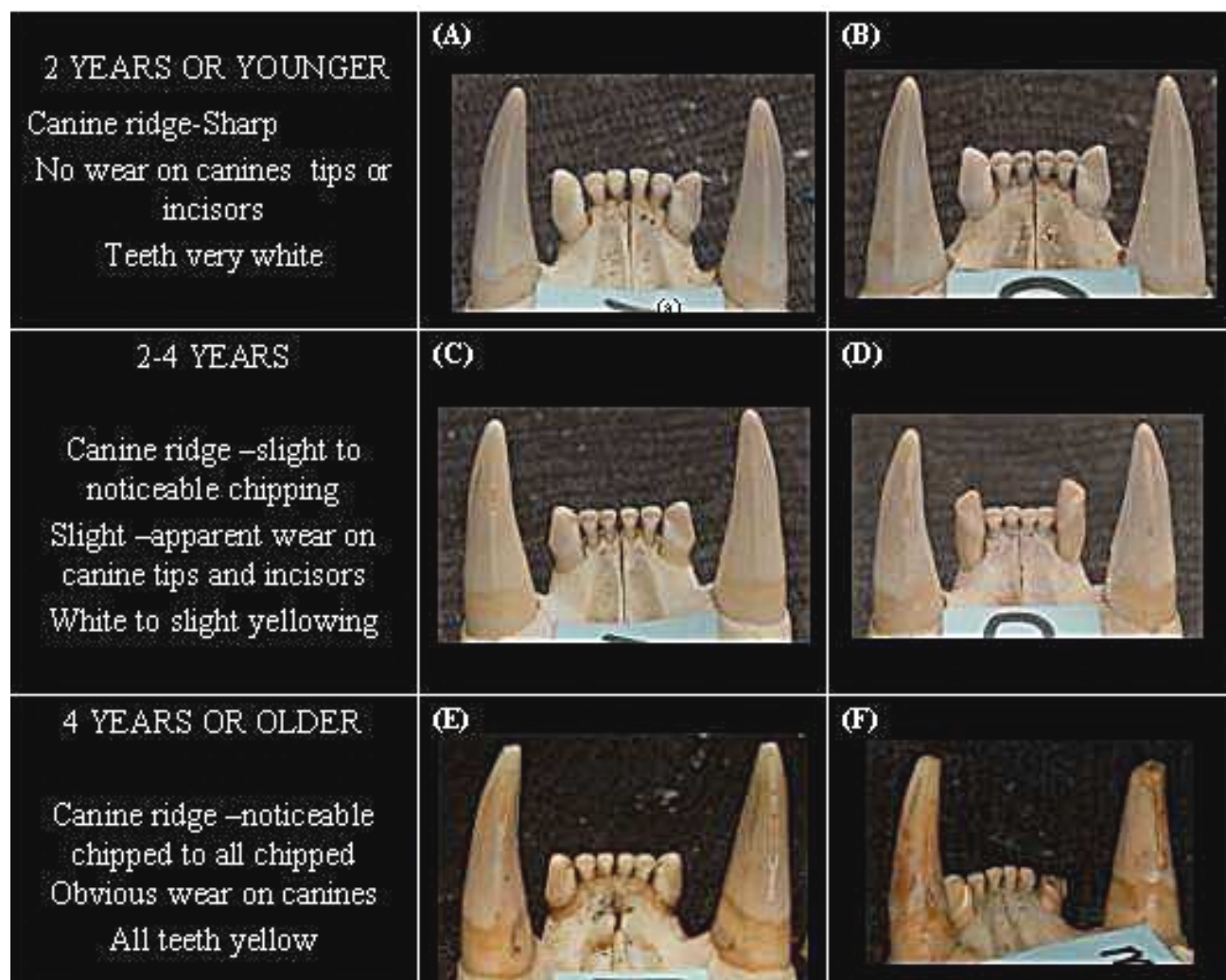
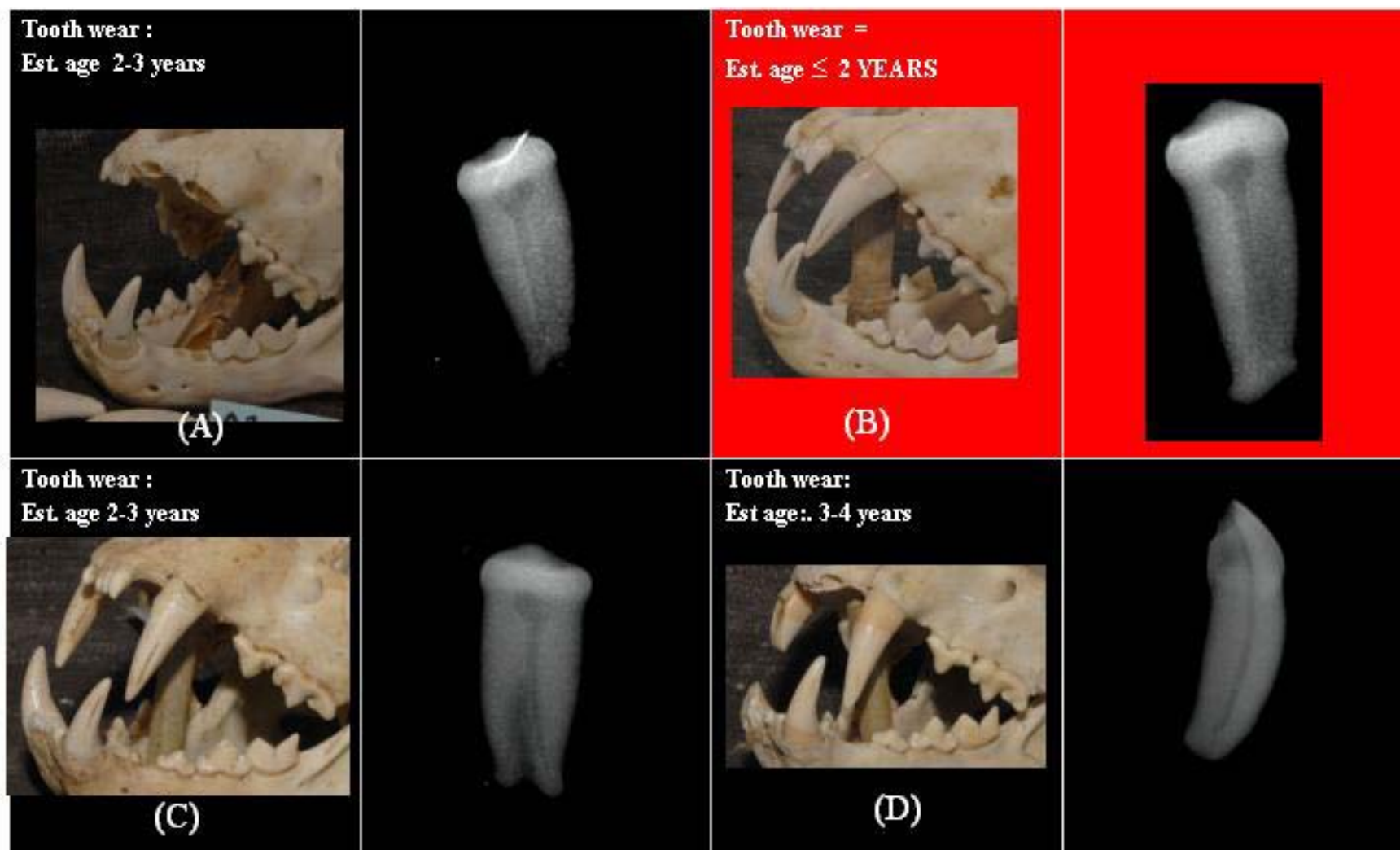
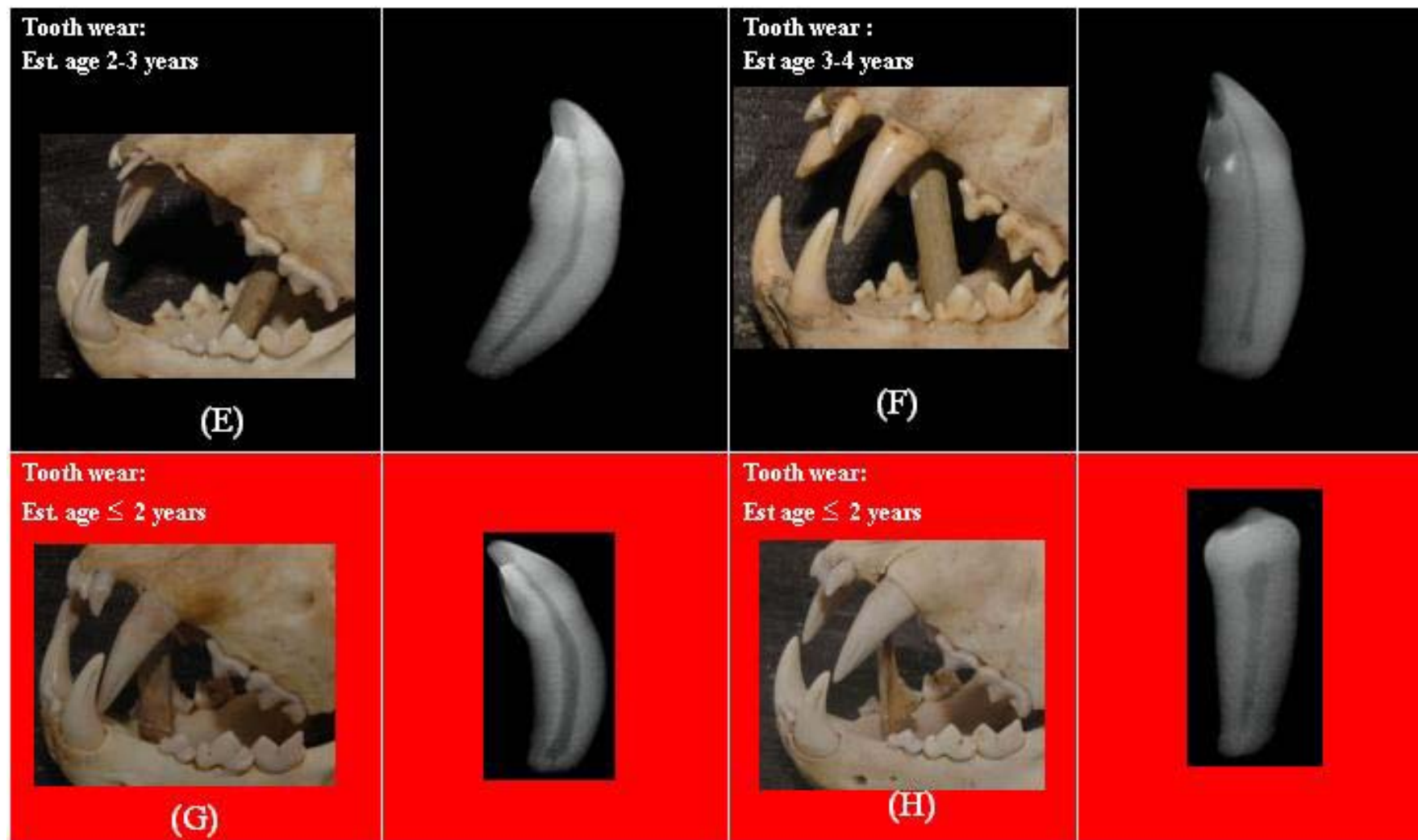
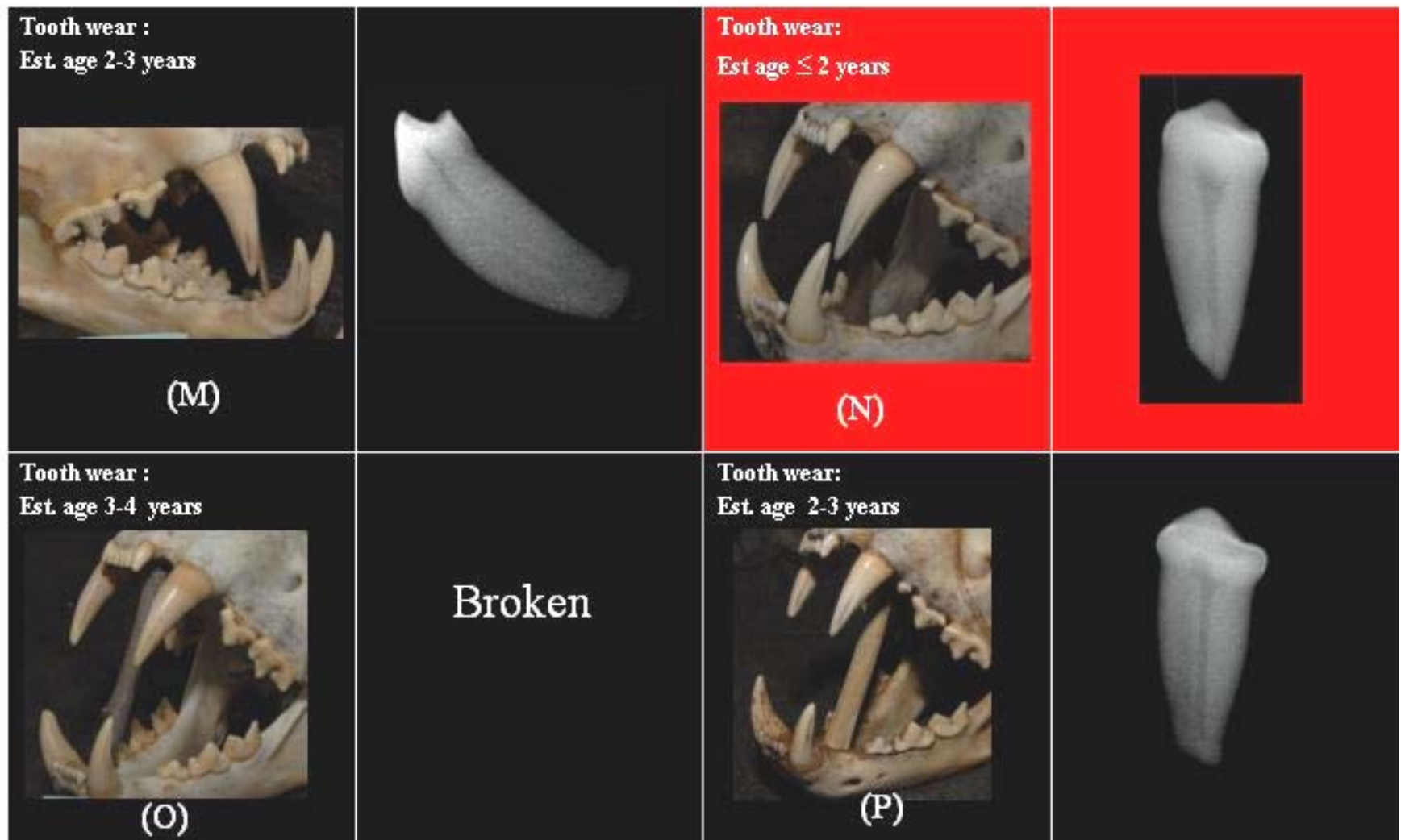


Fig. 7: Aging on the basis of tooth wear in leopards. Preliminary results suggest that leopards can be placed in broad age categories based on canine and incisor wear, chipping of the enamel ridge, exposure of the dentine below the gum line and the colour of the teeth . Images A-E are from trophy leopards taken in the 2006 hunting season. Image F is from an old male killed as a problem animal in a Mashamba in Milepa.









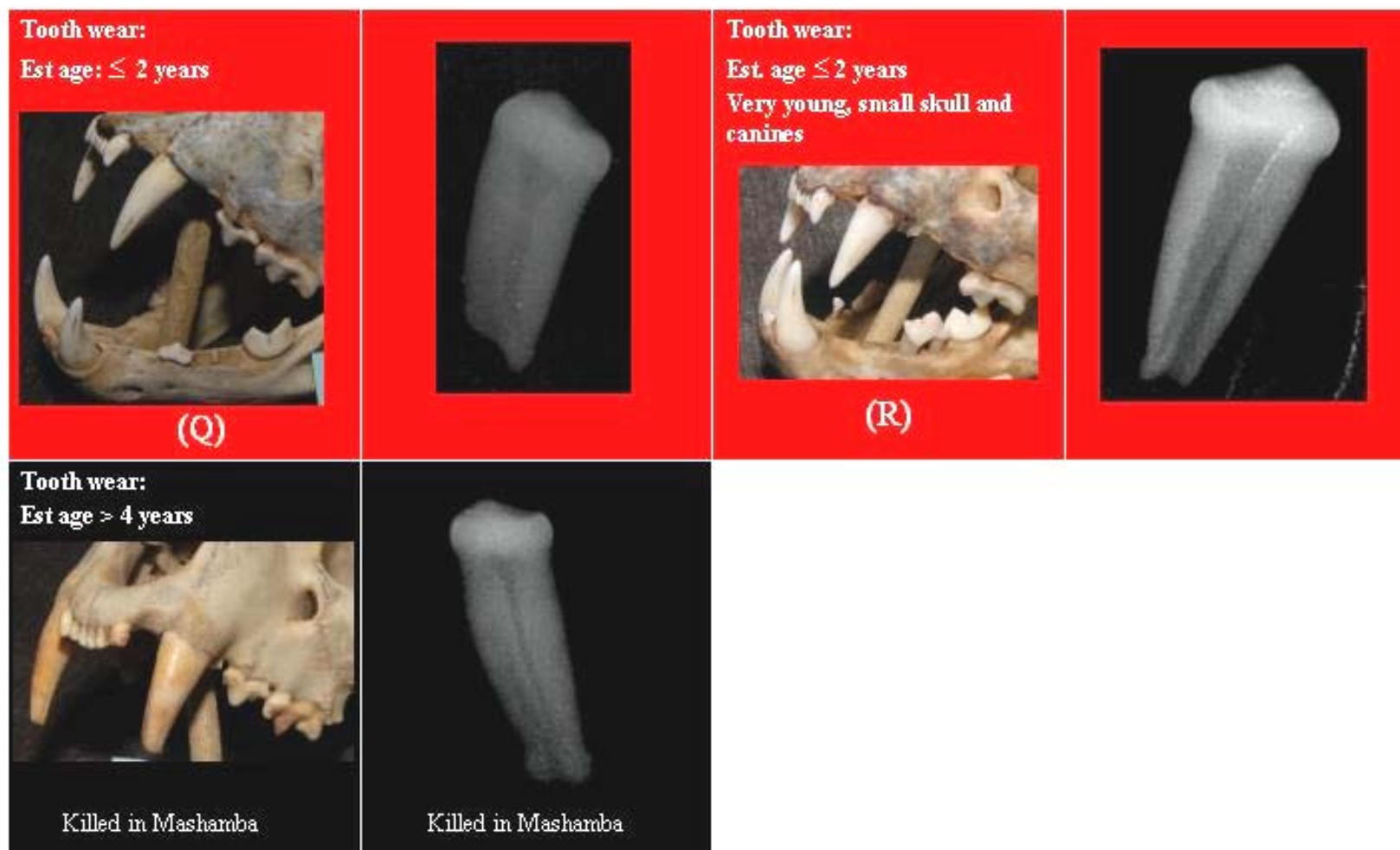


Fig. 8: 2006 Leopard trophies showing differences in tooth wear (Stander 1997) and closure of the pulp cavities. The trophies in red are the youngest leopards taken during the season but their actual age is unknown and requires more information from known age leopards. There appears to be a clear relationship between pulp cavity closure and tooth wear. Q & R are the youngest trophies taken, with no wear, open pulp cavities and small skulls (SCI ratings of 11.6 and 11.6 respectively).

Leopard recommendations and hunting guidelines

- Continued collaboration with researchers from other areas and additional research in NNR is essential to improve on our knowledge of the effects of sport hunting on leopard populations (particularly the hunting of subadult leopards and effects of infanticide), sustainable quotas, leopard densities and movement patterns and accurate aging techniques.
- Only male leopards should be hunted. In future we recommend that all leopard skins be provided for inspection at the end of the hunting season. Leopards should be skinned with the scrotum attached to prove that the animal was a male. Any skins that do not show the scrotum will be assumed to be a female.
- In addition in 2007, we recommend that a small 1cm x 1cm skin sample be taken from each skin for DNA analysis. The data will be used to assess geographic differences in leopard populations across their range and each animal will be sexed (in collaboration with Prof C. Matthee, Stellenbosch University, South Africa).
- For each leopard on quota, a questionnaire should be provided that needs to be filled in immediately after the hunt similar to the lions (or hunt return forms need to be adapted to provide information needed; see general recommendations)
- All PHs should be expected to taken a body-length measurement of the leopard in the field using the measurement guidelines provided.
- All leopard trophies (skulls and skins) should be labeled with self locking tags clearing indicating the calendar year, state of export, number of the specimen in relation to annual quota to comply with CITES regulations.
- As in 2006, one premolar should be removed from each trophy for X-raying of pulp cavities to determine age.
- As with lions, we recommend that leopard baits and hunting effort should be more widely spread across the entire hunting concession and not focused on a narrow band along the Lugenda River.

3.0. Buffalo



2006 Buffalo trophy from Block D2 (PH: A. van der Westhuizen; Client: R. Potgieter). This was both an excellent quality trophy in terms of size (tip-to tip: 980mm; maximum width: 1090mm, boss curvature 345mm) and age (© Johan Calitz Safaris)

3.1. Buffalo trophy monitoring results 2006

- 27 Buffalo were taken as trophies inside NNR in 2006 representing 56% of the allocated quota (n = 48). An additional two buffalo were taken in the Kambako courtada and provided for measurement.
- Three buffalo were reported as wounded (6%). This may be under reported.
- The allocated quotas have remained steady over the last five years, however utilization had gradually increased from 32% in 2002 to 56% in 2006 (Table 8).
- Despite requests to do so, few lower buffalo jaws were kept for aging and in several cases when they were kept they were not tagged and could not be related to the upper jaws. Block D2 was the only block to keep a tagged lower jaw. Aging from tooth wear could therefore not be done.
- 26 Buffalo skulls were available for photographing and measuring. One skull was not kept as the buffalo was shot for lion bait and the trophy discarded. It is assumed that this was not a SCI record book animal.

- Three measurements were taken from each skull: A tip-to-tip measurement of the horns, widest outside width of the horns (Roland Ward measurement) and SCI curvature of the boss width. The total curved width of the underside of the horns was not taken (SCI measurement).
- Results from the 2006 trophies were as follows:
 - Tip-to-tip measurement: Average = 728 mm (28.7 inches); Range = 425-980mm
 - Widest outside width of horns: Average = 929 (36.6 inches); Range = 765-1090mm
 - Width of Boss curvature: Average 316mm (12.4 inches); Range = 250-370mm).
- As pointed out by a Niassa PH, these measurements encourage the shooting of younger bulls as immature animals can score high on the SCI and Roland Ward measurements. This is proven by the fact that the Roland Ward record is held by a 64 inch female. Some reports suggest that maximum horn length in buffalo occurs at 54 months, but this is also the age at puberty (approx. 5 years) and therefore these should not be trophy animals. In NNR the young animals taken as trophies (soft boss) were not the smallest trophies according to the measurements.
- The horny plate or boss of a buffalo is usually covered with hair from birth to the age of 2-3 years (Bothma, 1989). Examination of the Boss (hardening and wear) showed that six trophies were of poor quality from immature animals (Fig.9, Fig 10), two were intermediate and the remainder were from mature to old animals. An animal with a completely hardened boss is thought to be approximately 7 years old.
- For the 18 trophies where data was available 33% were shot in a breeding herd, 50% came from a male group and 17% were solitary bulls. Five of the young animals were shot in a herd.

Table 8: Buffalo quota allocated and used in NNR between 2002 and 2006, per block and overall with data from 2002-2005 provided by SRN

Hunting Concession		Year				
		2002	2003	2004	2005	2006
Block A	Quota	3	4	6	7	7
	Utilized	2	3	4	4	5
Block B	Quota	13	13	13	13	13
	Utilized	1	5	12	9	9 ¹
Block C	Quota	8	10	10	10	10
	Utilized	8	6	4	4	9
Block D1	Quota	-	-	4	4	4
	Utilized	-	-	0	0	0
Block D2	Quota	6	6	6	7	7
	Utilized	-	0	3	3	2 ²
Block E	Quota	7	7	7	7	7
	Utilized	1	1	0	2	2
TOTAL	Quota	37	15	23	22	48
	Utilized	12 (32%)	40 (37.5%)	46 (50%)	48 (45.8%)	27 (56%)

¹ = Two were wounded, 2 additional buffalo were tkane in the Courtada (not included here)

² = 1 wounded in 2006

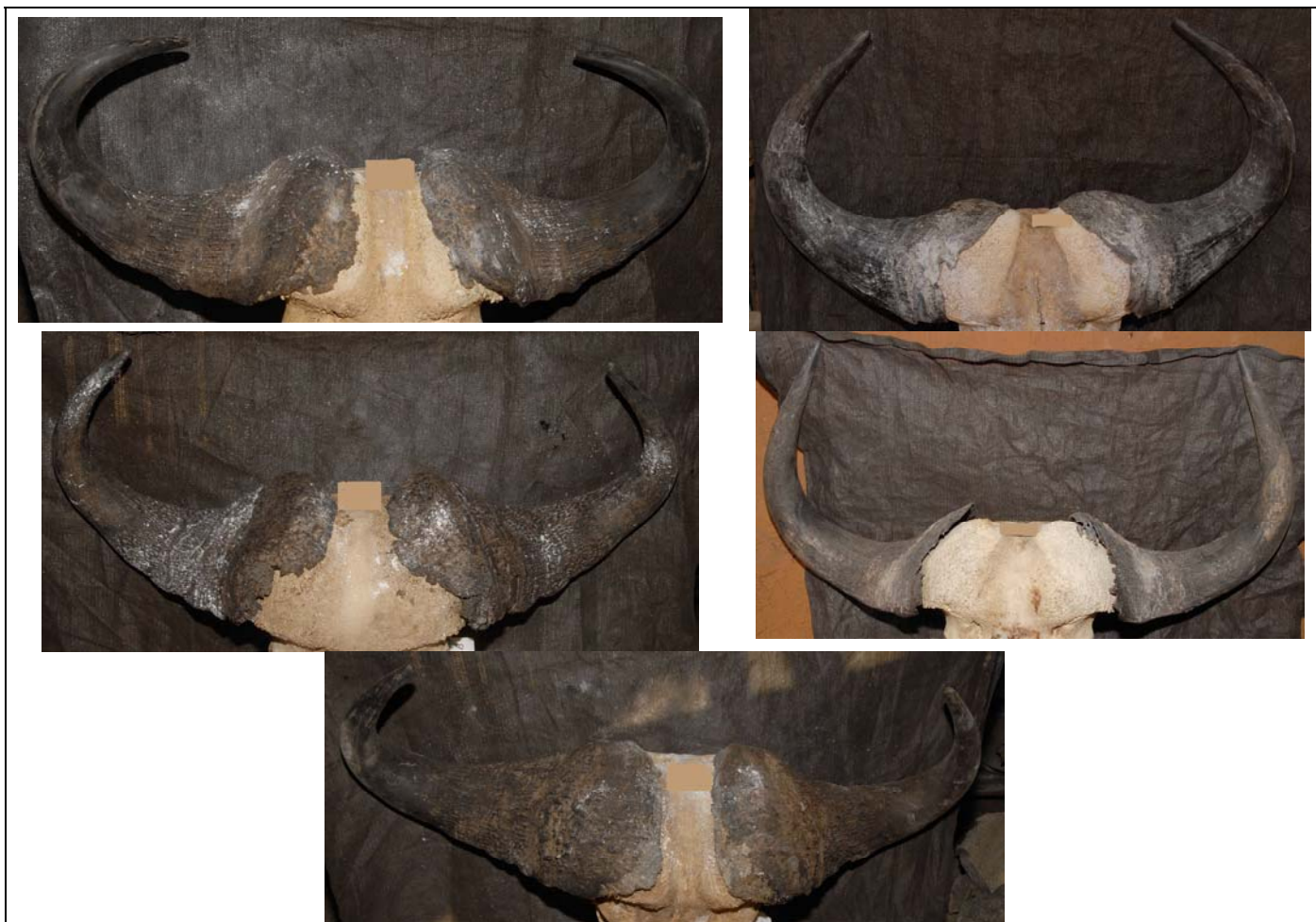


Fig. 9: Poor quality trophies from immature buffalo taken in 2006 hunting season in NNR



Fig. 10: Two of the six young buffalo taken as trophies in 2006

Buffalo Recommendations and Hunting Guidelines

- At present the biannual aerial census does not provide accurate population estimates for buffalo and is likely to underestimate total population densities. An aerial census designed specifically to count buffalo should be a priority.
- Only male buffalo should be acceptable trophies.
- As with hippo, there is a strong relationship between buffalo hunting and lion hunting as buffalo are frequently used as bait. However, even when buffalo are simply shot for bait, PHs should endeavor to shoot old bulls.
- Hunting should be confined to solitary bulls or males in male groups not breeding herds, to minimize the chance of shooting a young animal or female and to minimise disturbance of the breeding herds.
- Only males with a hardened boss are considered acceptable trophies.
- All lower jaws of buffalo should be kept by operators and correctly labeled so that buffalo trophies can be accurately aged from teeth wear and the age related to boss hardening and horn length.

4.0. Hippo



2006 Hippo Trophy from Block D2: Johan Calitz Safaris. This hippo had the largest tusks and was also one of the oldest individuals taken. (PH: A van der Westhuizen; © Johan Calitz Safaris)

- The Hippo Specialist Group reevaluated the status of the Hippo in 2004. They found dramatic population declines in key countries with widespread poaching and a rising number of human conflicts. The status of the hippo has therefore been upgraded from Near Threatened to Vulnerable on the IUCN International Red List (IUCN, 2006).
- As large herbivores, hippos have significant effects on vegetation. Hippos are likely to be important for maintaining open plains areas close to the major rivers and for nutrient cycling in the rivers.
- While hippo are not included as one of Savannas Forever key species, their importance for hunting and eco-tourism in Niassa, relatively low numbers and international conservation status suggests that monitoring of trophies should be initiated.
- This can be used to provide baseline information on trophy quality, inform hunting guidelines and to assess whether current quotas are sustainable.

4.1. Hippo trophy monitoring results in 2006.

- 13 hippos were taken as trophies in 2006 representing 68% of the allocated quota.
- The approved quota has increased progressively from 9 hippos in 2002 to 19 hippos in 2006 with an associated increase in off-take from 5 to 13 individuals (Table 9).
- Percentage utilization of the quota has also increased from 55% in 2002 to 73% in 2005 and 68% in 2006 (Table 9).
- Operators provided 12 of the 13 skulls for measuring and photographing (Fig. 11). One skull was destroyed however the teeth were available for inspection.
- Of these trophies, at least one, possibly two were from females.
- Eight (72.7%) of the hippos were taken from breeding herds, while the remainder were solitary bulls
- Average jaw length was 620 mm (n = 13), average skull width was 389 (n = 13), and average circumference of the biggest tusk was 170mm.
- Laws' (1968) method of estimating the age of hippos from their teeth is widely accepted and diagrams are provided in Section B for reference. Age classes are determined from the eruption and wear of the premolars and molars in the cleaned lower jaw of the hippos and were calculated from 1244 lower jaws of Ugandan hippos.
- Provisional results based on these characteristics suggest that 8 hippos (67%) were over 20 years of age (age class XI and older), three were between 10-20 years old (age class VIII-XI), and one was younger than ten and unlikely to be a mature, breeding male. Hippos are believed to be adult at ten years.

4.2. Hippo densities, distribution and Quota Recommendations

- Hippo densities in the Lugenda were calculated from visual counts of hippos from the Lugenda Canoe survey (345km) completed in August 2006 (full report to be completed end of Feb 2007), supplemented by an intensive foot survey of the extensive braided channels between Mbamba and Chipaputa (Block C and B; September 2007). Hippo numbers (actual counts and estimates) from other observers (fishermen, J. Wilson, W. Ebersohn, J. Cariso, Lauritz, D. Langerman,) were used to estimate hippo numbers in Lutize, Lusheringo, and Lureco Rivers, which are also in the Lugenda catchment.
- Hippo densities in the Rovuma River bordering Block E were counted from a foot survey by the Selous Niassa Wildlife Corridor team, Tanzania (R Hahn, pers. com; final report February 2007). Hippo densities in the Rovuma River bordering Block A are unknown but reports of at least one group was provided by D. Littleton (Luwire-Block A).
- It is likely that some solitary bulls or small male groups were missed: an extra 5% has therefore been added to the population estimates.

- A total of 636 hippos are believed to be present within the Lugenda River, portions of the Rovuma River and large tributaries within the hunting concessions (Lugenda density 1.6 hippo / km of river; Table 10).
- Hippos are not equally distributed along the length of the Lugenda River, but are more commonly found in the rocky channel habitat, particularly in deep pools in the braided channels with the highest densities recorded between Ndapata and Luatize River (Full results to be presented in Feb 2007).
- Fishermen suggest that the areas around the main villages (Mbamba, Negomano, Mussoma) were heavily hunted and hippo numbers have not yet recovered to previous levels. However, fishermen who have been fishing on the river for more than 20 years report that the population has substantially increased in the last 10-15 years.
- The NNR hippo population therefore appears to be viable and potentially increasing.
- Little reliable information is currently available on the effects of trophy hunting on hippo populations (R. Lewison, IUCN Hippo Specialist Group, pers. com). Management is complicated by the paucity of information on hippo ecology in general, specifically their complicated social organization.
- SRN generally calculates sustainable quotas as 2-4% of the total hippo population. Given that it is only males that are hunted we have calculated a quota for each block based on 4% of the total population and 4% of the male population (based on the ratio 1 male: 1.2 females; Eltringham, 1999). We suggest that it is more reliable to calculate a quota based on the predicted male populations rather than the total populations given that it is only males that are territorial, and are hunted.
- The actual quota for 2006, lies between the two quota calculations and suggests the current quota is sustainable overall. However, the problem lies in the unequal distribution of hippos along NNR river systems. (Table 11; see recommendations).

Table 9: Hippo quota allocated and used in NNR between 2002 and 2006

Hunting Concession		Year				
		2002	2003	2004	2005	2006
Block A	Quota	1	1	1	1	1
	Utilized	1	1	1	1	0
Block B	Quota	2	3	3	3	3
	Utilized	0	2	3	3	3
Block C	Quota	3	4	4	5	5
	Utilized	3	3	4	5	5
Block D1	Quota	-	-	4	3	3
	Utilized	-	-	0	1	1
Block D2	Quota	1	2	3	4	4
	Utilized	-	1	2	3	3
Block E	Quota	2	3	3	3	3
	Utilized	1	1	1	1	1
TOTAL	Quota	9	13	17	19	19
	Utilized	5 (55%)	8 (62%)	11 (64%)	14 (73%)	13 (68%)

Table 10: Hippo numbers in the Lugenda and Rovuma Rivers in NNR, counted by canoe and on foot in 2006 with additional sightings from PHs and managers.

Block	River	River zone	Total Distance (km)	Distance surveyed (km)	Visual Count	Reported count	Est. Hippo Population (+ 5%)
C & D2	Lugenda	Western Reserve limit-Luatize confluence	72	55	96	-	101
C	Lugenda	Luatize Confl –Luambezi confl.	184	184	348	-	365
B	Lugenda	Luambezi confl –Block A Boundary	48	48	73	-	77
A	Lugenda	Block A boundary –Rovuma confl	55	55	0	1	1
A	Rovuma	Rovuma confl –eastern limit of NNR	51	-	-	30	32
E	Rovuma	Lussanando confl –Luguluzia Confl	126	113	8	-	8
E	Lucheringo	Lower Lucheringo	78	--	6	25	33
D1	Lucheringo	Upper Lucheringo	1	--	6	-	6
D2	Luatize	Lower Luatize	30	--	4	8	13
TOTAL			645	455	465	64	636

Table 11: Recommended quotas for hippo hunting in each hunting block based on hippo numbers and distribution

Block	River Distance km)	Hippo population size		Recommended Quota		Current Quota
		Total	Est. Male Population (1 male:1.2 females)	4% of Total Population	4 % of Male Population	
A	106	33	15	1	1	1
B	48	77	35	3	1	3
C	256	415	186	17	7	5
D1	1	6	3	0	0	3
D2	72	63	28	3	1	4
E	204	41	18	2	1	3
TOTAL	687 km	636¹	331	26	11	19

¹636 Hippo with 101 hippo shared by Block C and Block D2. Quotas are calculated as if Block C & D2 each has 50 hippo in this shared section.

Hippo Recommendations & Hunting Guidelines

- Trophy monitoring and off-take needs to be carefully monitored given that:
 - Hippos are the primary bait animals for lion hunts and on occasion appear to be shot simply to provide bait with little regard for trophy quality. .
 - Hippos are listed as Vulnerable and there is concern about worldwide populations. This is likely to be the main population in Mozambique.
- Hippo surveys should be completed at regular (5 years) to assess population growth and distribution.
- Eco-tourism operations are planned for the north bank of the Lugenda River in some areas and hippo are likely to be important for game viewing. There need to be clear guidelines on where hippos can be hunted in the river when they are a shared resource.
- Quotas should be reassessed based on the distribution of the hippo throughout the hunting concessions as they are patchily distributed.
 - No hippo should be hunted in Block D1.
 - No hippo should be hunted on the Lugenda River in Block A, with a minimal quota in Block A-Rovuma.
 - The hippo quota for Block E, D2 and B should be decreased (Table 11).
 - The hippo quota for Block C could be increased

Recommended Hunting Guidelines:

- Only male hippos should be hunted
- In some countries hippos may only be hunted when they are out of the water on land (early morning; Zimbabwe). This allows a better assessment of size and sex, does not disturb the group, and is more in keeping with principles of “Fair Chase”. This should be considered to NNR.
- Hunting should be confined to solitary bulls or bulls in small bachelor groups. Bulls within female groups should not be hunted as:
 - The potential for shooting a female or a young animal is increased when shooting into a breeding group (as happened in 2006). In addition, it is more difficult to determine whether a shot missed or an animal was injured.
 - Observations during 2006 suggested that shooting into a breeding group can cause substantial disturbance and may cause the group to move from its favoured site or disperse taking more than 10 days to regroup. This is a particular problem when the same groups are targeted year after year.
 - Given that male hippos fight for territories, and have exclusive mating rights to females in their territory (Eltringham, 1999), it is likely that removing a large male within a breeding group removes the prime mating males and should be avoided.

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(A) Age Class > XII



(B) Age class =V111



(C) Age Class =V111



(D) Age Class = V11



(E) Age Class >XII



(F) Age Class = XI



(G) Age Class = XII



(H) Age class =IX



(I) Age Class =X11



(J) Age Class = X11



(K) Age Class =XI



(L) Age Class > XII

Fig. 11: Lower jaws of hippo taken as trophies in NNR during 2006 with an estimation of age class based on tooth wear from Laws (1968; see Section B) Trophy 10B was from a female

5.0 Crocodiles



2006 Crocodile Trophy from Luwire – Block C (PH. D. Price; Client G. Day, © Luwire). This crocodile was over 14ft and identified as a problem animal by the fishermen in the area.

- The Nile crocodile is listed on Appendix II of CITES in Botswana, Ethiopia, Kenya, Malawi, Mozambique, South Africa, Tanzania, Zambia and Zimbabwe.
- Mozambique has a CITES quota of 900, which includes sport hunting and control of problem animals. Ranching programs are permitted under CITES (under certain guidelines) while direct cropping of wild populations is discouraged but is still occurring.
- In NNR, crocodiles are the top predators (other than man) in the river systems, particularly the Lugenda River.
- A CITES permit is currently not required from US Fish and Wildlife Service to import a personal sport hunted trophy (including skulls) from these Appendix II populations provided that the unmounted skin bears an intact uncut tag from the country of origin. However, a CITES export permit issued by Mozambique is needed to accompany the trophy when imported into the USA (www.fws.gov/permits).
- In depth information on the current status, distribution and densities of crocodiles in Mozambique in general and NNR in particular are lacking. However, preliminary surveys (tracks, spotlight, visual, conflict with humans) in NNR suggest that the numbers of large adult crocodiles are relatively low (Begg *et al* 2005) compared to historical figures when crocodiles were extensively hunted on the Lugenda River.

- At present, the biggest threats to crocodiles in NNR are their conflicts with Niassa residents. Crocodiles are a significant threat to human life, particularly for fishermen on the Lugenda River. Increasing populations of both crocodiles and people are likely to result in increased conflict in future.
- In NNR threats to crocodiles include direct persecution of adult problem animals, destruction and disturbance of nests, and the inadvertent netting and subsequent killing of large crocodiles (rare) and small crocodiles (common). There is also some evidence that crocodiles are being killed for their skins, although this appears to be minimal at present.

5.1. Trophy monitoring results 2006

- In 2006, 12 crocodile trophies were taken, representing 60% of the allocated quota (Table 12).
- Percentage off-take has increased steadily since 2002 (Table 12) with a particularly noticeable increase in quota utilization between 2005 (36%) and 2006 (60%).
- Body length was only provided for 8 of the trophies and varied between 9ft and 14ft. In previous years, crocodiles as small as 7ft have also been taken (2004, 2005).
- The majority of crocodiles are baited (75%) and some at least are shot at night although how frequently this occurs is unknown.

Table 12: Crocodile quota allocated and used in NNR between 2002 and 2006

Hunting Concession		Year				
		2002	2003	2004	2005	2006
Block A	Quota	1	2	2	3	3
	Utilized	0	0	1	1	1
Block B	Quota	5	5	5	5	3
	Utilized	1	2	3	3	3
Block C	Quota	5	5	5	5	5
	Utilized	4	1	2	2	3
Block D1	Quota	-	-	2	2	2
	Utilized	-	-	0	0	1
Block D2	Quota	2	4	4	4	4
	Utilized	-	1	1	2	3
Block E	Quota	3	3	3	3	3
	Utilized	0	1	0	0	1
TOTAL	Quota	16	19	21	22	20
	Utilized	5(12.5%)	5 (26.3%)	7(33.3%)	8 (36%)	12 (60%)

Crocodile Recommendations and Hunting Guidelines

- The current quota in NNR may not be sustainable given all the indications that the adult crocodile population in NNR is relatively low.
- In addition, adult crocodile populations and prime breeding sites are not equally distributed along the entire length of the Lugenda River but concentrated in the rocky channel habitats with vegetated islands (See river survey report, due in Feb 2007).
- However, based on the inherent difficulties in accurately surveying crocodiles in these habitats, and the associated difficulties in setting accurate quotas, we suggest that as long as PHs only target crocodiles above a certain minimum size (age) the actual off-take will be sustainable (as is the case with lions) and will vary with the available population.
- For this to be effective continued trophy monitoring is essential.
- We suggest that the following hunting guidelines be put in place for crocodiles following the lead of Tanzania:
 - Only adult crocodiles with a minimum total length of 2.4m (8ft; adults) from tip of the mouth to end of the tail should be harvested as trophies.
 - The minimum size of the skin allowable for export is 60cm belly width.
 - All trophies must have tags affixed according to CITES regulations.
 - All PHs must take an accurate body length measurement and this, as well as a GPS location, must be filled in on the hunt return forms.
 - All skulls and skins must be available for measuring at the end of the hunting season before they leave NNR
- Community involvement in the hunting of crocodiles might be an option in NNR given that crocodiles are significant threat to human life in certain areas (bathing areas of Mbamba and Mussoma villages). Particular communities could potentially be given a quota to hunt problem crocodiles (under the same guidelines as operators) and receive training in cutting and curing the skins. These skins could be sold locally for export. In Tanzania, a community initiative of this nature earned US\$150-\$200 per skin for 23 skins. This money went back to the community and was used for local community projects.

References

- Begg, C.M., Begg, K.S., Begg, G.W. & Muemedi, O. 2005. Ecological observations from a portion of the Lugenda valley, Niassa Reserve: resource utilization and densities of key animal species. Unpublished SRN report.
- Bothma, J. du P. 1989. *Game ranch management*. J.L Van Schaik Publishers.
- Creel, C. & Creel, N.M. 1997. Lion density and population structure in the Selous Game Reserve: evaluation of hunting quotas and offtake. *Afr. J. Ecol* **35**: 83-93.
- Dunham, K. 2002. Age determination criteria for Trophy Animals in the Save Valley Conservancy: Compiled from published sources. Unpublished report
- Eltringham, S.K. 1999. *The Hippos*. Poyser Natural History: Academic Press.
- Grimsdell, J.J. R 1973. Age determination of the African Buffalo, *Syncerus caffer*. *East African Wildlife Journal* **11**: 31-53.
- Laws, R.M. 1968. Dentition and ageing of the hippopotamus. *East African Wildlife Journal* **6**:19-52
- Lindsey, P.A., Frank, L.G., Mathieson, A. & Romanach, S.S. 2006. The potential of trophy hunting to create incentives for wildlife conservation in Africa where alternative wildlife-based land uses may not be viable. In press:.
- Lindsey, P.A., Roulet, P.A. & Romanach, S. 2007. Economic and conservation significance of the trophy hunting industry in sub-Saharan Africa. *Biological Conservation* **134**: 455-469
- Loveridge, A. J., Searle, A.W. Murindagomo, F. & Macdonald, D.W. 2007. The impact of sport-hunting on the population dynamics of an African lion population in a protected area. *Biological Conservation* **134**: 548-558.
- Packer, C. 1990. *Serengeti Lion Survey*: Report to TANAPA, SWRI, MWEKA and the Game Department. Unpublished report, 5 pp.
- Smuts, G.L., Anderson, J.L. & Austin, J.C. 1978. Age determination of the African lion (*Panthera leo*). *J. Zool (Lond)* **18**: 115-146.
- Smuts, G.L., Anderson, J.L. & Austin, J.C. 1978. Age determination of the African lion (*Panthera leo*) *Journal of Zoology, London* **185**: 115-146
- Stander, P.E. 1997. Field age determination of leopards by tooth wear. *African Journal of Ecology* **35**: 156-161.
- TRAFFIC. 2006. Sport hunting in the southern African Development Community (SADC): An overview. www.traffic.org (12/3/2006).

- Whitman, K., Starfield, A.M., Quadling, H.S. & Packer, C. 2004. Sustainable trophy hunting of African lions. *Nature* **428**:175-178.
- Whitman, K.L & Packer, C. 2006. *A Hunter's Guide to Aging Lions in Eastern and Southern Africa*. Safari Press.
- IUCN SSC Cat Specialist Group. 2006. Regional Conservation Strategy for the lion *Panthera leo* in Eastern and Southern Africa. www.felidae.org

Appendices

Appendix A: Lion

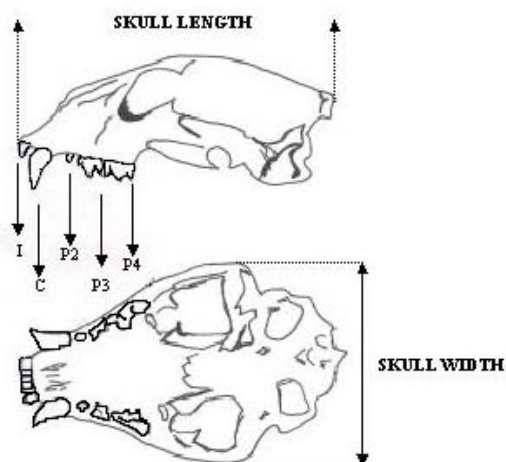
1. **Measurement of lion skulls** follows the standard Safari Club International and Roland Ward guidelines (Length (inches) + width over zygomatic arches (inches) = SCI rating & Roland Ward rating, Table 13). Additional measurements of jaw length and height, and canine width and height are also taken to assess skull size.
2. **Tooth wear** in the upper and lower jaw is graded into broad categories based on research of known age lions provided by Smuts *et al* (1978) with additional information from Whitman & Packer (2007) and Dunham (2002) and guided by specific information collected during radiocollaring exercises from Niassa (Table 13). Where the level of tooth wear differs on bottom and top jaw, the category of most wear is taken. A photograph is taken of the skull to provide archival data on tooth wear should disputes arise.
3. **X-rays of the pulp cavity** of one premolar from each skull are examined. Data from known aged lions in Tanzania has shown that the pulp cavity is completely closed at the based by 4.5 years; this provides a minimum age estimate (Fig 12). Unlike mane development and tooth wear, closure of the pulp cavity in mammals is not affected by local conditions such as diet etc. for example there should be no difference in captive vs. wild lions as tooth development this is set by embryology and genetics not body condition. This technique is the most objective method currently available for assessing young lion (Whitman & Packer 2007).
4. **Carbon-14 analysis.** In collaboration with Savannas Forever and sponsored by Fauna and Flora International and the Niassa Lion Project, the possibility of using carbon dating of premolars was also tested using premolars from five 2005 Niassa lion trophies. Unfortunately the results were inconclusive with a wide error around known ages for the trophy hunted lions from both Niassa and Tanzania possibly due to methods of preparation (full details will be provided in the Niassa Lion project final report). In addition the method is prohibitively expensive without absolutely reliable data. At this stage this method will not be pursued for aging in Niassa until more definitive results are obtained or costs are reduced
5. **Mane development:** Provides a useful visual guidelines within broad age categories particularly in lions younger than six. Details are provided in Section A. See Whitman & Packer 2007.
6. **Nose pigmentation** and age (known age lions) are clearly related in the Serengeti with the nose becoming completely black at 8 years of age (Whitman *et al.* 2004). The Niassa Lion Project has shown that there is little doubt that there is also a relationship between nose pigmentation and age in Niassa's lions although sample sizes are still too small to determine the exact rate of darkening in NNR at this stage. Photographs taken by the professional Hunters both with disposable cameras in the

lion kits and digital “client” photographs as well as data from collared Niassa lions are used to visually assess nose colour and place each lion in one of four categories: Speckled-< 25% black (2-3 yrs old) ; Mottled 25-50% black (3-5 years old); Splotched 50-75% black (5-8 years old) and Livered > 75% black (> 8 years old). While the nose-colouration technique is a useful indicator of age in the field, it should be supplemented with other information such as tooth wear that can be assessed after the lion has been shot.

7. **General body condition** relates to a variety of visual characteristics of the lions and is determined both by the comments of the professional hunters (particularly those PHs that have extensive experience in lion hunting) as well as through examination of the full body side view photographs taken by the PHs with the disposable cameras. Indications of age are darkening of top of the muzzle which is apparent by 5-6 years, the presence of old scars on the body and face, missing teeth, , prominent spine and a general loss in body condition and sparse manes. An old lion (> 8 years) is obvious even without examination of his teeth.



Fig. 12: X-rays showing the closure in the pulp cavity of the premolars by 4.5. years from lions in Tanzania (C. Packer pers. com)

Table 13: Tooth wear categories and skull measurements from Smuts (1978) with additional information provided by Packer (2006).

Age Category	Tooth Eruption and wear
3-4 Years	Signs of wear may be visible on the tips of some incisors (I), canines (C) and possibly premolars. Canine ridge running down the rear edge of the canines is often irregularly chipped
5-6 years	Canine and incisor wear is apparent as is wear on the tips of the highest cusps of the upper 3 rd (P3) and lower 4 th premolars. Cusps of the upper 2 nd (P2) and lower 3 rd premolars show little to no wear No exposed pulp chambers visible on incisors Rear enamel ridges of all canines chipped and worn along most of their length Teeth generally white but with first signs of yellowing may be visible on premolars.
7-9 years	All teeth (except sometimes upper 2 nd premolar show some wear Incisor & canine wear is obvious with exposed pulp chambers evident on upper and lower 1 st incisors. Rear enamel ridges worn flat. Carnassial teeth (P3) show clear signs of wear on cusps which becomes increasingly obvious Enamel margin on canines has started to recede towards tooth cusps. Yellowing of teeth noticeable
10+ years	Conspicuous wear on all teeth with broken canines, premolars and molars Incisors worn down to short stumps with exposed pulp chambers clearly visible Enamel on distal sides near edge of canines has worn away while enamel margin shows marked advancement towards tooth cusp. All cusps of upper 3 rd and lower 4 th premolars & sometimes lower 3 rd premolar show some wear.

NIASSA LION TROPHY AGING FORM

LION ID. NO: **PROF. HUNTER:** **BLOCK:**

TROPHY YEAR: **CLIENT NAME:** **DATE SHOT:**

MANE: GENERAL DESCRIPTION	CONSPICUOUS ON NECK & CHEST	YES / NO	PHOTO: DIG: NEG:
	EARS CONSPICUOUS	YES / NO	
	CENTRAL TUFT	YES / NO	
	BARE PATCHES BEHIND EARS	YES / NO	
	HEAVY MANE ENCIRCLES HEAD	YES / NO	
HAIR BETWEEN SHOULDERS	YES / NO		

NOSE:	2-3 YRS	3-5 YRS	5- 8 YRS	> 8 YRS	PHOTO
	SPECKLED < 25 % BLACK	MOTTLED 25 -50 % BLACK	SPLOTCHED 50% -75% BLACK	LIVERED >75% BLACK	DIG / NEG

TEETH: *	2-3 YRS	3-4 YRS	5- 6 YRS	7-9 YRS	>9 YRS
ENAMEL RIDGE	SHARP	IRREGULARLY CHIPPED	ALL CHIPPED	WORN FLAT	WORN FLAT
CANINE WEAR	NONE	LIGHT	APPARENT	OBVIOUS	OBVIOUS
I³ WEAR	NONE	LIGHT	APPARENT	OBVIOUS	STUMPS
P³ & P₄ WEAR	NONE	NONE	LIGHT	APPARENT	APPARENT ALL CUSPS
P² & P₃ WEAR	NONE	NONE	NONE	LIGHT	APPARENT
PULP CAVITY I¹	NONE	NONE	NONE	EVIDENT	EXPOSED
COLOUR	WHITE	WHITE	YELLOW ON CHEEK TEETH	YELLOW ALL TEETH	YELLOW ALL TEETH

COMMENTS:

SKULL (mm):

SKULL LENGTH	<input type="text"/>	SKULL WIDTH	<input type="text"/>	SCI-VALUE (inches)	<input type="text"/>
JAW LENGTH	<input type="text"/>	JAW HEIGHT	<input type="text"/>		

U-CANINE -HGT	<input type="text"/>	U-CANINE WDTH	<input type="text"/>
VISUAL AGE VERDICT:	< 4 YRS	4 - 6 YRS	> 6 YRS
PULP CAVITY AGE VERDICT	< 4.5 YRS	4-6 YRS	> 6 YRS

REPORTER: **SIGNATURE:** **DATE:**

Appendix B: Leopard

- Tooth wear characteristics have been provided for Namibian leopards (Table 14, Fig. 13)
- Body length measurements for leopards should be taken from every trophy. The measurement should be taken from the nose tip to tail tip, not along curves. To take this measurement measure with a tape alongside the leopard laid out with neck held straight, nose pointing forwards and tail straight (L. Hunter pers. com; Fig. 14). If the measurement is taken along the curves, then this must be noted on the Hunt Register.

Table 14: Tooth wear categories for leopards provided by Stander (1997) slightly simplified for trophy monitoring purposes in NNR

Age Category	Tooth Eruption and wear
1.5-2 years	Permanent canines fully erupted, teeth white with no wear.
2 years	Complete permanent dentition Slight wear on tips of canines, incisors and upper 3 rd and lower 4 th premolars, slight and irregular wear of canine ridges.
3 years	Wear apparent on incisors, canines, and highest cusps of upper 3 rd and lower 4 th premolars Noticeable chipping and wear of canine ridges Slight yellowing noticeable on premolars and molars
4 years	Wear present on all teeth Pulp cavities may show on upper and lower incisors Canine ridge worn along the length of the canine Yellowing of teeth including canines, well advanced
> 4 years	Wear obvious to extensive on all teeth 1-2 incisors may be absent or worn flat, pulp cavities visible Canine ridge worn flat, with canines worn down Extensive yellowing Flaking of enamel layers and broken canine tips amongst males

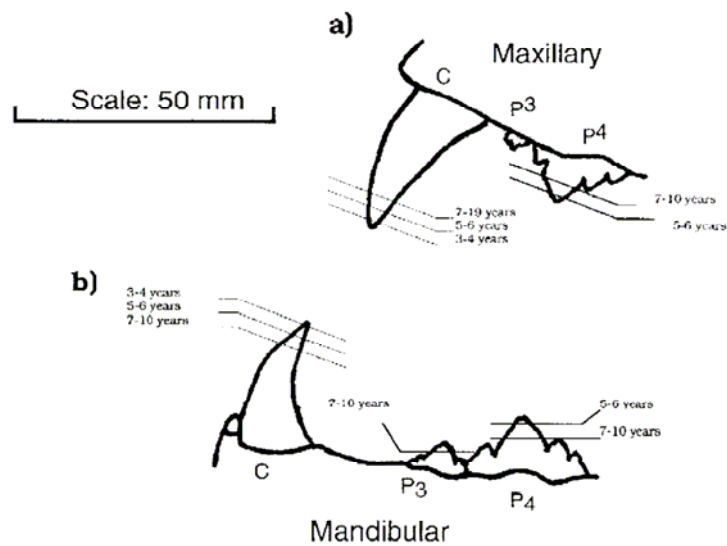


Fig. 13: Guide for aging leopards according to tooth wear (Stander 1997)

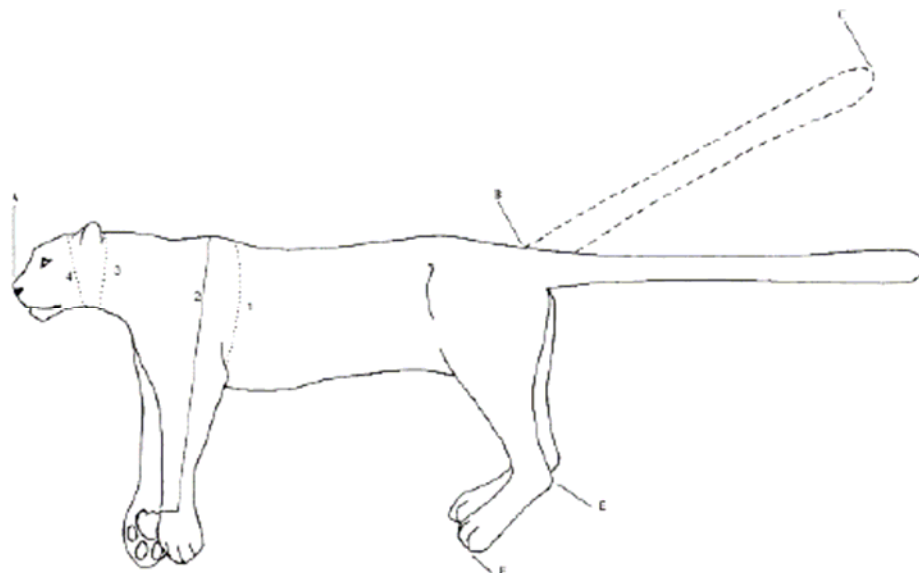


Fig. 14: Guide to taking body length measurements of leopard (L. Hunter)

NIASSA LEOPARD TROPHY MONITORING FORM

LEOPARD ID. NO:		PROF. HUNTER:		BLOCK:	
TROPHY YEAR:		CLIENT NAME:		DATE SHOT:	

BODY CONDITION		PHOTO:	DIG:
----------------	--	--------	------

TEETH:	1-2 years	2-3 years	3 years	4 years	> 4 years
ENAMEL RIDGE	SHARP	SLIGHTLY CHIPPED	NOTICEABLE CHIPPING	ALL CHIPPED	WORN FLAT
CANINE WEAR	NONE	SLIGHT	APPARENT	OBVIOUS	OBVIOUS, ENAMEL FLAKING
I ³ WEAR	NONE	SLIGHT	APPARENT	OBVIOUS	OBVIOUS
P ³ & P ₄ WEAR	NONE	SLIGHT	LIGHT	APPARENT	APPARENT ALL CUSPS
P ² & P ₃ WEAR	NONE	NONE	NONE	LIGHT	APPARENT
PULP CAVITY I ¹	NONE	NONE	NONE	MAYBE EVIDENT	EXPOSED
COLOUR	WHITE	WHITE	SLIGHT YELLOWING	YELLOW ALL TEETH, INCL CANINES	YELLOW ALL TEETH

COMMENTS:	BROKEN TEETH?
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* IF UPPER AND LOWER CANINE WEAR FALLS INTO DIFFERENT CATEGORIES, CHOOSE CATEGORY OF MOST WEAR

TEETH AGE (FLIP STANDER)					
MAXILLARY	CANINES	3-4 years	5-6 years	>7 years	See diagram
	P4		5-6 years	>7 years	See diagram
MANDIBULAR	CANINES	3-4 years	5-6 years	>7 years	See diagram
	P4		5-6 years	>7 years	See Diagram

SKULL (mm):				
SKULL LENGTH		SKULL WIDTH		SCI-VALUE
JAW LENGTH		JAW HEIGHT		
U-CANINE -HGT		U-CANINE WDTH		

TOTAL LENGTH -NOSE TO TAIL (mm)			
PREMOLAR X-RAY	YES	NO	
REPORTER:		SIGNATURE:	DATE:

Appendix C: Buffalo

- Horn measurements taken by SCI and Roland Ward are not a measure of age in buffalo and are not detailed.
- The best indication of a an acceptable buffalo trophy is a hardened, well developed boss
- Buffalo can also be aged from the rate of wear of the 1st molar for adult animals (Fig. 15).

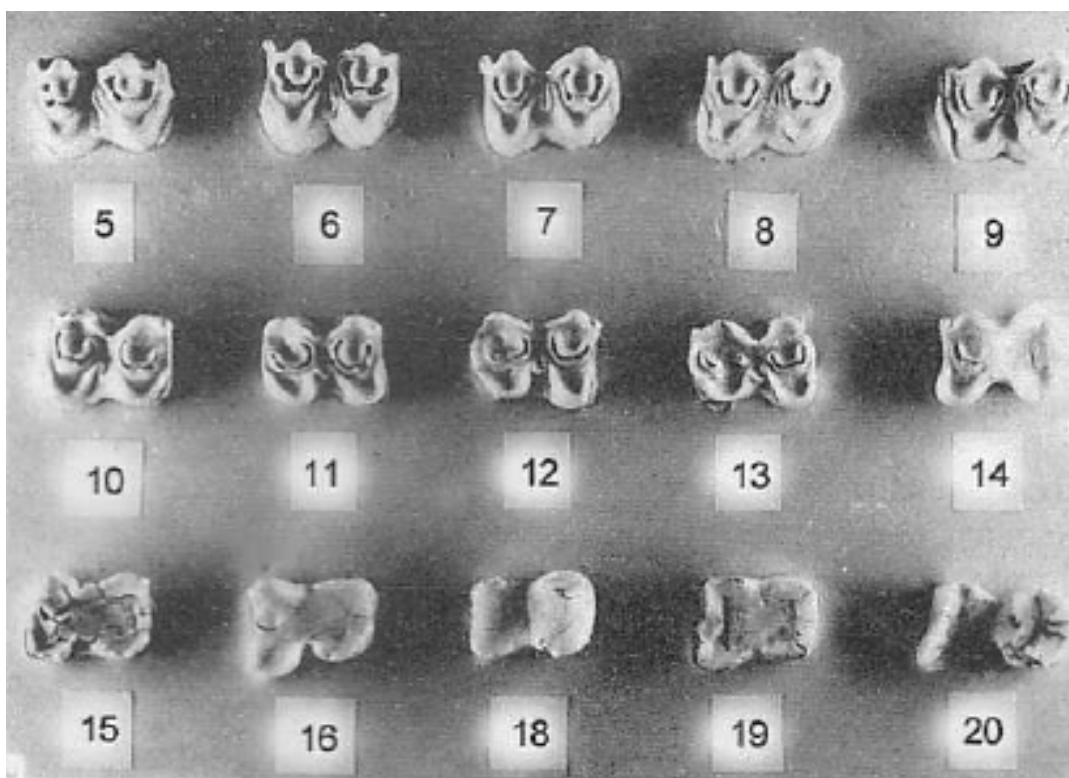


Fig. 15: Patterns of wear on the first molars in the lower jaw of the buffalo where the number refers to the age of the animal in years. Photograph from Grimsdell (1973) reproduced by Dunham (2002).

Appendix D: Hippo

- Hippos are aged using wear and eruption of the teeth in the lower jaw
- Hippos are placed into distinct age classes (I to XX) determined from the pattern of tooth wear on the molars (Fig 16). These criteria were first developed by Laws (1968) on the basis of 1244 lower jaws from Queen Elizabeth National Park Uganda.

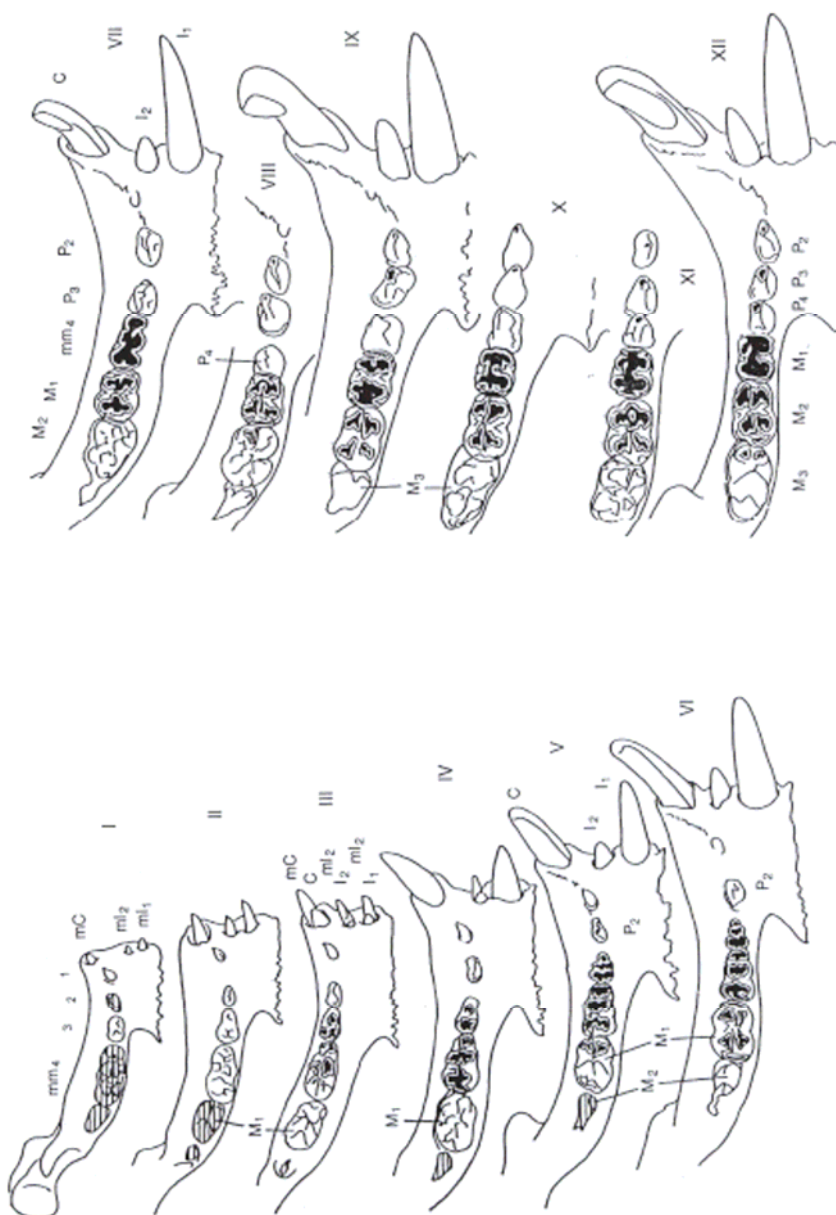


Fig. 16: Age class of the hippo based on the eruption and wear on the molars and premolars in the lower jaw.

Appendix E: Crocodile

- Measure the length of the body from the tip of the nose to the tip of the tail. The measurement should be taken over the curves along the centre of the back. The cable or tape must be kept in contact with the skin as much as possible, but it should be kept tight and not pushed down into the depressions. This is a field measurement taken before skinning.
- Juvenile crocodiles are less than 1.8m in length, subadult between 1.8 m and 2.3 m and adult crocodiles large than 2.3m
- The total score is the body length in feet and inches or in metres.