TABLE II

BODYWEIGHT AND WEIGHT OF STOMACH CONTENTS (in lbs.) OF 31 HIPPOS SHOT BETWEEN 3.00 AND 5.30 p.m.

Time	Total weight	Bodyweight (Total weight less stomach contents)	Weight of wet stomach contents	Weight of dry stomach contents
4.30	848	786	62	11.6
4.55	1098	988	110	20.6
4.45	1162	1060	102	19.1
4.45	1364	1179	185	34.6
4.30	1572	1424	148	27.7
5.30	1676	1504	172	32.2
4.00	1888	1624	264	49.4
3.45	2222	1962	260	48.6
4.10	2468	2152	316	59.1
4.00	2498	2232	266	49.7
4.30	2498	2232	266	49.7
4.40	2678	2234	444	83.0
5.15	2594	2286	308	57.6
4.45	2668	2308	360	67.3
5.30	2740	2350	390	72.9
4.15	2728	2392	336	62.8
4.15	2952	2478	474	88.6
4.20	2976	2488	488	91.3
3.48	3064	2489	575	107.5
4.45	2908	2518	390	72.9
3.45	3154	2566	588	110.0
5.10	2974	2574	400	74.8
5.20	2954	2582	372	69.6
4.15	3000	2597	403	75.4
4.15	2960	2600	360	67.3
5.00	3010	2650	360	67.3
4.50	3010	2666	344	64.3
3.00	3310	2740	570	106.5
4.20	3434	3038	396	74.1
4.55	4196	3656	540	101.0
4.45	4280	3860	420	78.5
Total	80,884	70,215	10,669	1,995.0
Average 4.32	2,609	2,265	344	64.4

TABLE III

TOTAL EXCRETION/INTAKE OF DRY MATERIAL (in lbs.) OF THE WHOLE GROUP OF 83 ANIMALS

Average bodyweight	Stomach contents per 100 lbs. body weight		Intake per 100 lb. bodyweight		Total intake/ 24 hours	
	Morning	Afternoon	During specified time (7 hrs. 46 min.)	In 24 hours	Animal weighing 900 lbs.	Average for whole group
(a) If excretion during the day and night proceeds at the same rate.						
2234 lbs.	3.499	2.839	0.660	2.041	18.369	45.95 lbs.
(b) If excretion during the night proceeds at a faster rate (1.5 x).						
2234 lbs.	3.499	2.839	0.660	2.553	21.977	57.034 lbs.

III(b), and the figures provided therein are regarded as a realistic reflection of the natural state.

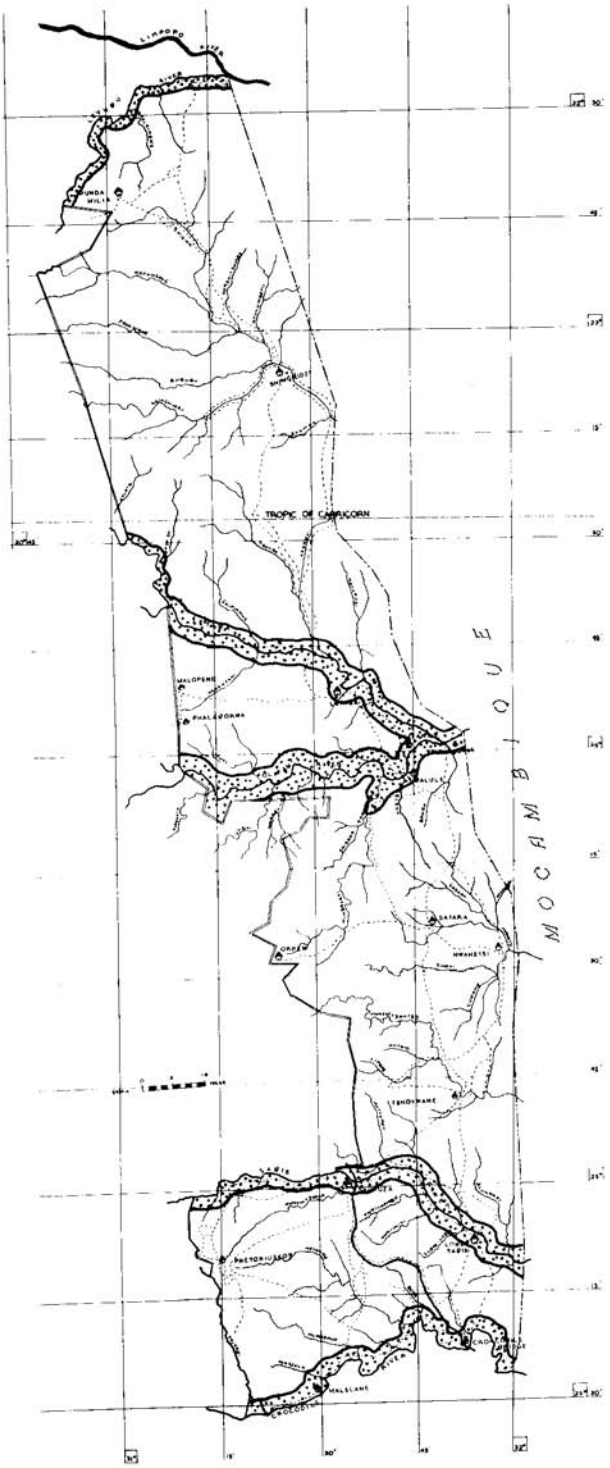
An average figure of food intake for an animal with a 900 lb. body weight is also provided in these tables for the sake of comparison with domestic herbivores. It is accepted in agricultural circles that cattle of ± 1,000 lb. (bodyweight ± 900 lb. after subtraction of moist stomach content), consume approximately 20-25 lbs. dry hay (moisture content ± 15% ∴ 17-21 lbs. absolute dry material) per day. The figures in Table III show that a hippo with corresponding weight relies on a dry food intake of 21.977 lbs. This would, therefore, be at approximately the same rate as obtains in the case of bovines.

If the wastage factor is set down as 10%, it would mean that the average hippo, in the experimental group, would use, under the present drought conditions, 57 + 5.7 lbs. = 62.7 lbs. absolute dry matter per day. This would correspond remarkably with three 900 lb. bovines. During summer, when there is normally no food shortage, this figure would be appreciably higher.

CARRYING CAPACITY AND GRAZING POTENTIAL OF THE RIVERINE GRAZING AREAS IN THE KRUGER NATIONAL PARK.

The census totals of hippo for the past three years are provided below as background to a discussion of the carrying capacity of the different river systems and riverine grazing areas.

River system	Numbers in 1962	Numbers in 1963	Numbers in 1964	Remarks
(1) *Crocodile River*	364	380	501	
(a) From eastern boundary to mouth of the Mbyamiti.	142	137	126	
(b) From mouth of the Mbyamiti to Boulders.	222	243	375	
(2) *Sabi River*	682	366	747	Totals for 1962 and 1964 unreliable. (Too high).
(a) From western boundary to Skukuza.	158	133	185	
(b) From Skukuza to the Sabi Gorge.	524	233	562	
(3) *Olifants River*	1567	1325	829	As a result of the 1964 drought large numbers emigrated eastwards and westwards from the Park.
(a) From the western boundary to mouth of the Timbavati.	1167	742	609	
(b) From the Timbavati mouth to the eastern boundary.	400	583	220	Large numbers emigrated to Mozambique during 1964.
(4) *Letaba River*	643	1492	678	Figures for 1963 possibly too high.
(a) From Letaba bridge to Olifants River junction.	—	—	440	
(b) From western boundary to the Letaba bridge.	—	—	238	A further 189 outside the Park, west of Mahlangene, in the Letaba river during the dry season of 1964.
(5) *Levubu River*	102	106	110	
(6) *Others* (Orpen dam, Timbavati, Bangu, Tsende, Shingwidzi, Nwanedzi dam, etc.).	+40	+45	+50	
TOTAL	3398	3714	2915	Large numbers left the Park as a result of the 1964 drought.



Map 1(b)—Grazing areas utilised by hippo along the perennial rivers of the Kruger National Park.

The available grazing areas for hippos along the permanent watercourses in the Kruger National Park are as follows:- (cf. accompanying map).

(1) Levubu river (one bank only)=48 x 2 miles, i.e. 96 sq. miles (28,992 morgen).

(2) Letaba river (both banks)=65 x 2 x 2 miles, i.e. 260 sq. miles (78,520 morgen).

(3) Olifants river (both banks)=70 x 3 x 2 miles, i.e. 420 sq. miles (126,840 morgen).

(4) Sabi river (one bank only in part)=30 x 2 miles + 39 x 2 x 2 miles (both banks), i.e. 216 sq. miles (65,232 morgen).

(5) Crocodile river (one bank only)=75 x 2, i.e. 150 sq. miles (45,300 morgen).

TOTAL — 1,142 sq. miles (344,884 morgen).

If the latest census figures are accepted, then 1,142 sq. miles of available riverine grazing supports some 3,000 hippo as well as, especially during the winter months, a large number of associated herbivorous species.

In contrast, an available grazing area of 400 sq. miles (120,800 morgen) between Lake George and Lake Edward in the Queen Elizabeth Park in Uganda, carries the massive total of 14,000 hippos, together with large numbers of elephant, buffalo, waterbuck, kob and others, all competing for the available grazing. Bere (1959) mentions definite signs of overgrazing and surface erosion, yet the animals are not suffering from an acute lack of food. He calculated that by halving the numbers, all problems of overpopulation would be solved here. At an average bodyweight of 2,440 lbs. per hippo (cf. table above), the 400 sq. miles would carry a total hippo biomass of 34,160,000 lbs. (i.e. 85,400 lbs./sq. mile).

The grazing on the heavy clay soils of this portion of Uganda, would have a decidedly higher carrying capacity than that covering the banks of the perennial rivers of the Kruger National Park. The relatively flat surface of this area would also be less susceptible to trampling and erosion than for example the undulating and sparsely covered gravel knolls along the Letaba river.

A certain amount of trampling, especially during the dry season, will always take place in the immediate environs of the rivers, where these cumbersome animals exert their heaviest grazing pressure. This may be accepted as natural. Unnatural concentrations, or excessively large numbers of these animals could create definite erosion problems, as well as a threat to the habitat, long before a general food shortage becomes evident.

The number of hippo pools providing adequate daytime shelter, constitute a natural limiting factor, and will affect the numbers of hippos in a particular river system before the food resources deteriorate.

For purposes of comparison, the maximum biomass totals (in lbs.) are provided below for each of the grazing strips along our perennial rivers, in respect of the mixed mammalian communities supported by them during the dry season.

(1) *Levubu river.*

Area available: 96 sq. miles.

Species	Number	Average bodyweight	Total biomass in lbs.	Biomass per sq. mile	Differential percentage of total biomass
Hippo	110	2,440	268,400	2,795.8 lbs.	11.94%
Elephant	86	7,000	602,000	6,270.1	26.79
Buffalo	500	1,100	550,000	5,729.2	24.47
Waterbuck ...	150	450	67,500	703.1	3.00
Kudu	400	380	152,000	1,583.3	6.76
Zebra	300	475	142,500	1,484.4	6.34
Impala	3,800	90	342,000	3,562.5	15.22
Nyala	650	120	78,000	812.5	3.47
Others	900	50	45,000	468.8	2.00
	6,896		2,247,400	23,409.7	99.99

(2) *Letaba river.* Area available: 260 sq. miles.

Species	Number	Average bodyweight	Total biomass in lbs.	Biomass per sq. mile	Differential percentage of total biomass
Hippo	678	2,440	1,654,000	6,362.71 lbs.	15.10%
Elephant	800	7,000	5,600,000	21,538.5	51.12
Buffalo	1860	1,100	2,046,000	7,869.2	18.68
Waterbuck ...	350	450	157,500	605.8	1.44
Zebra	850	475	403,750	1,552.9	3.68
Kudu	700	380	266,000	1,023.1	2.43
Impala	8000	90	720,000	2,769.2	6.57
Nyala	100	120	12,000	46.2	0.11
Giraffe	30	1,500	45,000	173.1	0.41
Others	1000	50	50,000	192.3	0.46
	14,368		10,954,570	42,133.0	100.00

(3) *Olifants river.* Area available: 420 sq. miles.

Species	Number	Average bodyweight	Total biomass in lbs.	Biomass per sq. mile	Differential percentage of total biomass
Hippo	829	2,440	2,022,760	4,816 lbs.	29.71%
Elephant	152	7,000	1,064,000	2,533.3	15.63
Buffalo	800	1,100	880,000	2,095.2	12.92
Waterbuck ...	600	450	270,000	642.9	3.97
Kudu	500	380	190,000	452.4	2.79
Impala	20,000	90	1,800,000	4,285.7	26.43
Giraffe	200	1,500	300,000	714.3	4.41
Zebra	500	475	237,500	565.3	3.48
Others	900	50	45,000	107.1	0.66
	24,481		6,809,260	16,212.5	100.00

(4) *Sabi river.* Area available: 216 sq. miles.

Species	Number	Average bodyweight	Total biomass in lbs.	Biomass per sq. mile	Differential percentage of total biomass
Hippo	747	2,440	1,822,680	8,438.3 lbs.	16.29%
Elephant	170	7,000	1,190,000	5,509.3	10.64
Buffalo	1,576	1,100	1,733,600	8,025.9	15.48
Waterbuck ...	150	450	67,500	312.5	0.60
Kudu	350	380	133,000	615.7	1.19
Zebra	1,500	475	712,500	3,298.6	6.38
Wildebeest ...	2,000	400	800,000	3,703.7	7.15
Impala	50,000	90	4,500,000	20,833.3	40.22
Giraffe	120	1,500	180,000	833.3	1.60
Others	1,000	50	50,000	231.5	0.45
	57,613		11,189,280	51.802.2	100.00

(5) *Crocodile river.*

Area available: 150 sq. miles.

Species	Number	Average bodyweight	Total biomass in lbs.	Biomass per sq. mile	Differential percentage of total biomass
Hippo	501	2,440	1,222,440	8,149 lbs.	19.91%
Elephant	22	7,000	154,000	1,026	2.51
Buffalo	843	1,100	924,000	6,160	15.05
Waterbuck ...	130	450	58,500	390	0.95
Kudu	350	380	133,000	886	2.16
Wildebeest ...	200	400	80,000	533	1.30
Impala	35,000	90	3,150,000	21,000	51.30
Giraffe	125	1,500	187,500	1,250	3.05
Zebra	380	475	180,500	1,203	2.94
Others	1,000	50	50,000	333	0.81
	38,548		6,139,940	40,933	99.98

The Queen Elizabeth Park supports, in terms of hippo alone, a higher biomass than the total biomass on the riverine grazing along any of the above-mentioned rivers of the Kruger National Park.

This comparison does not hold much value on account of the radical difference in quality and virility of the grass cover of these two parks. Yet it would appear that the riverine grazing areas of the Kruger National Park retain a potential surplus even during poor years. (cf. Total stomach content of 343 lbs., moisture content 75% ∴ 86 lbs. dry material in the Queen Eliabeth Park, with the local total of 459 lbs. (with moisture content of 81.3%) ∴ 86 lbs. dry matter during the *extremely poor* conditions during the time of the experiment.)

We are dealing here with grazing animals which utilise practically only monocotyledonous plants. It would, therefore, be more realistic to use as a basis of comparison agricultural standards on grazing areas similar to that along our rivers.

The relatively meagre grazing found in most of the areas along the Letaba and Olifants rivers would probably not support more than one head of cattle per 15 morgen when allowing for the prolonged dry periods which are sometimes experienced in these regions.

On this basis an estimation of the carrying capacity of the Letaba river area (260 sq. miles), would be *5,234.6* cattle units.

This would represent a total biomass of 4,187,680 lbs. if 800 lbs. is regarded as the average bodyweight of cattle (i.e. 16,106 lbs./sq. mile).

In view of the greater variety of fodder plants utilised by a mixed wild animal community and the relative absence of selective and regional grazing, it is a well-known fact that any portion of natural veld may support double and even three times the biomass in terms of wild herbivores than domestic stock. (Dasmann, 1962; Talbot & Talbot, 1963a; Talbot, 1964, and others).

The Letaba river area could, therefore, safely carry throughout the year, a total mixed mammalian community representing a biomass of about 48,000 lbs./sq. mile. At present it carries a maximum biomass of 42,133 lbs./sq. mile for the few driest months. The Olifants river area likewise carries a maximum biomass of 16,212.5 lbs./sq. mile.

A hippo with an average bodyweight of 2,440 lbs. has a total food consumption of ± 59 lbs. (dry weight) over a 24 hour cycle. This would be about three times the amount that one adult head of cattle would consume during the same period. The riverine grazing of the Letaba river would thus carry, in terms of hippo only, 5,234.6 ÷ 3 = 1,744 animals over a period of 12 months. This is a purely theoretical state however, and would never be realised in practice.

To determine a safe and realistic maximum population figure for hippos in each of the river systems, each system should be judged on merit and in the light of prevailing conditions.

(1) *The Letaba River.*

The respective contributions to the total biomass are dominated by elephant in this region. These animals only make use of the riverine grazing for part of the year, and even then utilise a much larger area than is possible for hippo.

This also applies in a lesser degree to buffalo, zebra and kudu in this area.

In view of the fact that the population level of elephant is shortly to be stabilised in this area, this will leave room for the other associated species (i.e. hippos) to reproduce undisturbed for a while.

The Letaba river has already, under favourable conditions (2 years ago) harboured as many as 1,000+ hippos. In view of the limited number of permanent water-holes and hippo pools, and also of the fact that the river flows but rarely above the sandy bed during normal dry seasons, this population level cannot be sustained during drought conditions without serious harm either to the animals or to the habitat.

During cropping operations about 120 hippos were destroyed in the Letaba this year. This caused considerable disturbance in the population west of the Letaba causeway. Many animals left the Park at Mahlangene and nearly 200 were counted along the first few miles west of this point.

A similar exodus was experienced from the Olifants river and the Letaba river east of the Nwanedzi mouth (where no control measures were taken), which points to the fact that a lack of food, rather than the disturbance, was probably the main factor causing this mass emigration.

It would not be advisable to allow more than 800 residential hippos in this river, particularly with the present low ebb of the river. This figure will have to be checked annually to determine the results of culling operations, and to provide an indication of possible increased emigration.

(2) *The Olifants River.*

During the 1962 census, the hippo population in this river had reached an all-time peak of 1,567 for a normal dry season. During this year's (1964) intense drought, the population had been nearly halved to 829.

Before these animals were forced to migrate as a result of the low ebb of the river, heavy concentrations in the limited deep pools remaining, resulted in continuous savage fighting, particularly amongst the males. Many were killed during these fights. A further 20 carcasses were found along the Olifants river where death could be ascribed either directly or indirectly to an unknown virus infection. It may be accepted though, that during this dry period, large numbers of hippo had to leave the Park eventually, to find sanctuary in Mozambique. Others migrated westwards as far as Mica. As

soon as conditions improve, many of these animals will probably return, and this should not put undue pressure on the recovered grazing.

The question does arise however, whether it is advisable to allow this extensive, uncontrollable fluctuation in numbers. It would be desirable to stabilise the population and prevent mass emigrations.

This would involve safeguarding the water supply in the river, possibly by means of a series of strategically placed weirs. The population level should then be fixed at a number that will easily survive a period of prolonged drought.

There are definite indications, however, that the Olifants river has already reached a saturation level for hippos, not in respect of grazing, but in terms of available "lebensraum". This position is reflected in the increased colonisation of suitable pools in the seasonal tributaries of the Olifants river, such as the Bangu, Timbavati and Shishakashangondzo rivers, as well as by increased emigration during periods of drought. Hippos were even found at the proposed dam site in the Hlanganine watercourse and in a mud hole at the Bulweni windmill.

The Hlangene water-hole in the Timbavati river accommodated a herd of about 30 hippos, which normally reside in the Olifants river at the Timbavati mouth, during the whole dry season.

This process continues, and is also the salvation of the riverine vegetation and instrumental in limiting soil erosion along the river banks.

To allow a larger number of hippos than can safely utilise the available grazing in the vicinity of their permanent habitats during drought conditions, would be decidedly unwise, particularly where the resident hippos are to be discouraged from emigrating.

We propose a maximum residential population of between 800 and 1,000 for the Olifants river.

(3) *The Sabi River.*

The riverine grazing is of a much better quality and more abundant along virtually the whole length of the Sabi river than that along the Olifants river. The flow of the Sabi river is also much stronger, and the whole river bed contains dense masses of reeds *(Phragmites communis).* The habitat encompassing this river is therefore infinitely more suitable for hippos than both the Letaba and Olifants rivers. The present population of some 370 hippos is therefore no cause for concern. The portion west of Skukuza should be watched though, in view of the fact that only one bank may be properly utilised, and increased agricultural activities on the opposite bank will have to be protected. The present number of 185 along this stretch of river, should not be allowed to increase at will.

(4) *The Crocodile River.*

Large tracts of the grazing strip along the south bank are cut off by the Snyman fence, as this river forms the southern boundary of the Park.

A serious shortage of grazing is already experienced along this river during times of stress, and hippos then often break the fence and raid the fodder and vegetable patches on the neighbouring farms.

Despite the fact that this river may support many more hippos during the summer months, the present population level of 501 should be regarded as an absolute maximum.

(5) *The Levubu River.*

The topography (mountainous and craggy, with little accessible riverine grazing), of this boundary river makes it for the most part an unsuitable habitat for hippos, and it could possibly not sustain more than its present number of 110 hippos.

This number has remained remarkably constant over the years, and here we probably have another case of a river that has reached a "natural" saturation point in terms of hippo. The surplus hippo probably emigrate or are disposed of by natural means such as fighting, anthrax outbreaks at Pafuri and so on.

No culling campaign is envisaged along this river, but the position at Pafuri itself will have to be carefully watched.

CONTROL OF SURPLUS HIPPOPOTAMI

Once each river has been allocated its quota of hippos with consideration of food and shelter, the Board and its executive officers will have a weighty problem on their hands.

Firstly, no population must be allowed to increase beyond the established quota, and yet, other decimating factors will have to be carefully considered, lest the culling rate exceeds the natural rate of reproduction. In this respect, particular notice should be taken of possible emigration and natural mortality factors amongst young and mature animals.

Some degree of emigration, resulting from animals seeking better pasture and shelter during periods of drought, will have to be accepted. Large numbers of hippos will probably be attracted to the big irrigation dam being built by the Portuguese authorities in the Olifants river. This phenomenon will have to be duly considered, as it would have a very real bearing on any culling ceiling that might be envisaged for the Olifants river.

To amend the numbers to be culled annually even further, the mortality rate amongst adults should also receive additional attention. Hippos in the Kruger National Park are susceptible to anthrax, particularly at Pafuri, where sporadic outbreaks occur. Fighting for leadership, territory and during the mating season is another important mortality factor. An unknown virus infection has caused a number of deaths amongst the starving hippos in the Olifants river during the recent severe drought.

Cantankerous adult bulls are responsible for a certain number of deaths amongst young animals and calves. Lions, always opportunistic, occasionally kill a calf and some of the very young calves die from exposure during severe winters.

The complement fixation test on blood sera of a number of adult hippo females gave a positive reaction for Brucellosis. The incidence of this disease could have an important bearing on population growth or decline.

It would be very necessary to continue with annual counting or censusses in the Letaba and Olifants rivers in view of the population fluctuation caused by prevailing conditions in these rivers. It will also be important to keep abreast continually with the exact position in respect of population numbers, so that culling operations may be amended accordingly.

The possibility of more accurate counts from the air will be investigated shortly. Preliminary surveys indicate that aerial counts will indeed be more successful.

Apart from controlling the numbers of the resident hippo populations, it will be our responsibility to provide in the basic needs (in respect of food and shelter) of the remaining hippos.

To ensure the continued existence of the allowable hippo quotas in

LIFE TABLE OF A GROUP OF 57 HIPPO FEMALES (36 ADULTS) IN THE LETABA RIVER (K.N.P.) OVER A PERIOD OF 20 YEARS.

AGE GROUPS IN YEARS.

TIME LAPSE IN YEARS	Present season's calves	Immature calves			Adult Females																						Senile														Dead				Totale	
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45		
1964	6	5	5	5	**4**	4	4	**3**	3	3	**2**	2	2	**1**	1	1	**1**	1	1	**1**	1	1																									57	1964
65	8	5	5	5	**5**	4	4	**4**	3	3	**3**	2	2	**2**	1	1	**1**	1	1	**1**	1	1	**1**	1																							64	65
66	8	7	5	5	**5**	5	4	**4**	4	3	**3**	3	2	**2**	2	1	**1**	1	1	**1**	1	1	**1**	1																							71	66
67	8	7	7	5	**5**	5	5	**4**	4	4	**3**	3	3	**2**	2	2	**1**	1	1	**1**	1	1	**1**	1	1																						78	67
68	11	7	7	7	**5**	5	5	**5**	4	4	**4**	3	3	**3**	2	2	**2**	1	1	**1**	1	1	**1**	1	1	**1**																					88	68
69	12	10	7	7	**7**	5	5	**5**	5	4	**4**	4	3	**3**	3	2	**2**	2	1	**1**	1	1	**1**	1	1	**1**	1																				99	69
70	12	10	10	7	**7**	7	5	**5**	5	5	**4**	4	4	**3**	3	2	**2**	2	2	**1**	1	1	**1**	1	1	**1**	1	1																				109	70
71	14	10	10	10	**7**	7	7	**5**	5	5	**5**	4	4	**4**	3	3	**3**	2	2	**2**	1	1	**1**	1	1	**1**	1	1	**1**																			121	71
72	17	12	10	10	**10**	7	7	**7**	5	5	**5**	5	4	**4**	4	3	**3**	3	2	**2**	2	1	**1**	1	1	**1**	1	1	**1**	1																		136	72
73	17	15	12	10	**10**	10	7	**7**	7	5	**5**	5	5	**4**	4	4	**3**	3	3	**2**	2	2	**1**	1	1	**1**	1	1	**1**	1	1																	151	73
74	19	15	15	12	**10**	10	10	**7**	7	7	**5**	5	5	**5**	4	4	**4**	3	3	**3**	2	2	**2**	1	1	**1**	1	1	**1**	1	1	**1**																168	74
75	22	16	15	15	**12**	10	10	**10**	7	7	**7**	5	5	**5**	5	4	**4**	4	3	**3**	3	2	**2**	2	1	**1**	1	1	**1**	1	1	**1**	1															187	75
76	24	19	16	15	**15**	12	10	**10**	10	7	**7**	7	5	**5**	5	5	**4**	4	4	**3**	3	3	**2**	2	2	**1**	1	1	**1**	1	1	**1**	1	1														208	76
77	27	20	19	16	**15**	15	12	**10**	10	10	**7**	7	7	**5**	5	5	**5**	4	4	**4**	3	3	**3**	2	2	**2**	1	1	**1**	1	1	**1**	1	1	**1**													231	77
78	31	23	20	19	**16**	15	15	**12**	10	10	**10**	7	7	**7**	5	5	**5**	5	4	**4**	4	3	**3**	3	2	**2**	2	1	**1**	1	1	**1**	1	1	**1**	1												258	78
79	34	26	23	20	**19**	16	15	**15**	12	10	**10**	10	7	**7**	7	5	**5**	5	5	**4**	4	4	**3**	3	3	**2**	2	2	**1**	1	1	**1**	1	1	**1**	1	1											287	79
80	36	29	26	23	**20**	19	16	**15**	15	12	**10**	10	10	**7**	7	7	**5**	5	5	**5**	4	4	**4**	3	3	**3**	2	2	**2**	1	1	**1**	1	1	**1**	1	1	1									318	80
81	42	30	29	26	**23**	20	19	**16**	15	15	**12**	10	10	**10**	7	7	**7**	5	5	**5**	5	4	**4**	4	3	**3**	3	2	**2**	2	1	**1**	1	1	**1**	1	1	1	1								354	81
82	46	35	30	29	**26**	23	20	**19**	16	15	**15**	12	10	**10**	10	7	**7**	7	5	**5**	5	5	**4**	4	4	**3**	3	3	**2**	2	2	**1**	1	1	**1**	1	1	1	1	1							393	82
83	50	39	35	30	**29**	26	23	**20**	19	16	**15**	15	12	**10**	10	10	**7**	7	7	**5**	5	5	**5**	4	4	**4**	3	3	**3**	2	2	**2**	1	1	**1**	1	1	1	1	1	1						436	83
1984	56	42	39	35	**30**	29	26	**23**	20	19	**16**	15	15	**12**	10	10	**10**	7	7	**7**	5	5	**5**	5	4	**4**	4	3	**3**	3	2	**2**	2	1	**1**	1	1	1	1	1	1	1					484	1984
Percentage after 20 years	11.57%	8.67%	8.06%	7.23%											64.46%																																

Of a total of 36 adult cows, 12 calved this year (1964) (i.e. 6 female and 6 male calves). Sex ratio=1:1. Twelve calves born last year (1963) are still suckling periodically (mammary glands of their mothers are still active).

The remaining 12 females will probably calve during the next season (1965), together with the three year olds of this season.

The mortality rate amongst newly born calves is calculated at 1 in 6, i.e. 16.6%. Mortality amongst older calves and adults is negligible and is not considered.

The numbers in heavy print indicate adult cows which calved during that particular year.
Gestation period=8 months.

Period of culling operation=25.5.1964 - 20.8.1964.

Twenty of the 36 adult females destroyed, were in lactation (24 for the purpose of this table). Only two were pregnant (one on 8th July and one on 20th July). The balance were neither pregnant nor lactating. Mating was observed from time to time during the period of June to August.

50% of the total number of hippos=Number of females (x).

64.5% of (x)=number of adult females (y).

33.3% of (y)=number of young per annum (z).

(z)—16.6%=expected annual increase.

This is also the number (including all age groups) that will have to be cropped annually to keep the population static.

Time lapse between births= plus-minus 3 years.

Suckling period=more than a year, and the mammary glands remain active for the best part of another year. During this time the female does not come into oestrus, therefore no mating normally takes place. It can be reasonably assumed that a female who has lost her calf, will mate again during the following season, although this is not definitely known.

all our perennial rivers, it has become very necessary that authoritative steps be taken to prevent the ever-increasing drain (especially during the winter months) on the normal flow of our rivers by the increased agricultural and industrial activities outside the boundaries of the Park. If this cannot be guaranteed, then suitable habitats will have to be provided by the building of weirs (such as those along the Crocodile river) at strategic sites along the whole length of the river concerned (for the time being only the Letaba and Olifants rivers).

Culling can still be effected by means of rifles, but care will have to be exercised not to disturb the animals unduly. The campaign will have to cover the whole length of the river, and only a few individuals should be culled from each herd. Skinning and other activities at each hippo pool should be accomplished in the shortest possible time. The possibility of using the crossbow and drugs can, nevertheless, be investigated.

The number to be cropped annually can be calculated from the life table, with the necessary adjustments for mortality and emigration. The natural ratios of each age group should be accurately represented in the final quota to be destroyed. Newly born calves should, therefore, represent 11.2% of the total; one-, two- and three year olds each about 8.4% and adults 63.6%. Males and females are to be shot in equal proportions.

The accompanying comparative index of weight groups may be used as a norm for estimating age classes. This might not always be feasible, however, and body measurements can also be used to determine the relevant age groups.

For determining the age of young, immature hippos, the chest girth appears to be the most reliable measurement:

Suckling calves under 6 months: 3 ft. — 5 ft. 2 in.

Calves 6-18 months: 5 ft. 2 in. — 6 ft. 9 in.

Juveniles 18-30 months: 6 ft. 9 in. — 7 ft. 6 in.

Sub-adults 30-42 months: 7 ft. 6 in. — 8 ft. 1 in.

Adult cows measure from 8 ft. 1 in — 9 ft. 8 in. (10 ft. 1 in. being the exception) and adult bulls 8 ft. 1 in — 10 ft. 4 in. (cf. accompanying tables) around the chest.

Length is not always an accurate indication of age and weight group, as this depends to a certain extent on shoulder height.

Animals shot during lean periods may be abnormally light, therefore, weight is not always an accurate guide either (cf. 1,200 lb. hippo heifer).

Carcasses that are not excessively bloated, should always be weighed and measured.

All carcasses should be removed from the water as speedily as possible to allow enough time for the proper processing of meat, hides, bones and other by-products, to ensure the best possible financial benefit on disposal.

MEASUREMENTS AND WEIGHTS (IMMATURE HIPPOS)

Age Group	Weight	Length (Head to base of tail)	Shoulder height	Chest girth
Present season's calves	70-600 lbs.	3 ft.—6 ft.	1 ft. 6 inches —3 ft.	3 ft.—5 ft. 2 in.
'One year olds' (6-18 months)	600-1,200 lbs.	6 ft.—7 ft. 3 inches	3 ft.—3 ft. 9 inches	5 ft. 2 in— 6 ft. 9 in.
'Two year olds' (18-30 months)	1,200-1,700 lbs.	7 ft. 3 inches— 8 ft. 3 inches.	3 ft. 9 inches —4 ft. 3 inches	6 ft. 9 in. — 7 ft. 6 in.
'Three year olds' (30-42 months)	1,700-2,100 lbs.	8 ft. 3 inches —9 ft. 3 inches	4 ft. 3 inches— 4 ft. 8 inches	7 ft. 6 in. — 8 ft. 1 in.

The lower canines are cut at about four months and attain a length of about 1-1½ inches during the following twelve months. At two years these canines measure ± 2½ inches in females and from 4-4½ inches in males. At three years they are about 4-4½ inches in females and 5-5½ inches in males.

MEASUREMENTS AND WEIGHTS (ADULT HIPPOS)

1. MALES

Weight	Length from head to the base of the tail	Shoulder height	Chest girth	Length of lower canine
2144	9 ft. 6 inches	4 ft. 3 inches	8 ft. 1½ inch	5 inches
2372	9 3	4 4	8 ½	7
2447	9 9	4 4	8 8	5½
2498	9 10	4 8	8	6¼
2612	10	5 1	8 11	8
2620	9 7½	4 6	8 4½	8
2678	10 6	4 7	8 3½	8¼
2820	10 6	5 2	8 4	9½
2832	10 3½	4 6	9 5	8¾
2844	10 1	5 3½	8 8½	7½
2862	10 3	4 6	9	7¼
2880	10 1	4 7	8 11	7¼
2948	10 7	4 3	9 2	8½
2952	10 4	5 4	9 5	6
2954	9 10	5	8 11	7½
3248	11 1½	5 6	8 9	9½
3364	10 7	5 2	9 2	9
3398	10 10	5 2	9 2	10½
3434	10 11	4 3	9 6	9
3516	11 5	5 5	8 11	10¼
3570	11 4	4 7	9 2	12¼
3754	11 3	5 0	9 4½	10
3814	11 3½	5 6	9 6	9½
3815	11 5½	5 7	9 5	10¾
3824	10 10½	4 7	9 5	11¾
3934	11 2	5 1½	9 10½	9
4022	11 7	4 5	9 8	10½
4104	11 7	5 8	9 8	10½
4112	11	5 6	9 7	10½
4196	11 9	5 4¼	10 4	11
4280	11 4	5 1	10 3	11
4412	12	4 11	10	11¼

Longest canine (i.e. visible portion) measured: 12¼ inch. (5 inches—12¼ inches).

Length from the head to the base of the tail: 9 ft. 3 inches — 12 ft.

Shoulder height: 4 ft. 3 inches — 5 ft. 8 inches.

Chest girth: 8 ft. — 10 ft. 4 inches. (Remarkably constant in males of different weight groups).

2. FEMALES

Weight	Length from head to the base of the tail	Shoulder height	Chest girth	Length of lower canine
2196	9 ft. 5 inches	3 ft. 8 inches	8 ft. 1 inches	6 inches
2222	10	4 2	8 3	3
2276	9 6	4	8 5	4½
2468	9 10	4 9	8 10	4
2498	9 9	4 9	8 10	5¼
2546	10 3	4 11	8 5	6½
2594	9 11	4 6	9 2	5
2668	10 1	4 5	8 10	5½
2716	10 8	5 1	8 5	6
2728	10 3½	4 5	8 8½	4½
2740	10 10	4 2	9 5	5
2778	9 11	4 2	8 5	6
2872	10 5	4 7	9 1	6½
2890	10 1	4 9	9 2	4½
2904	10 5	4 11½	8 6½	5½
2908	11	4 10	9 5	6
2960	11 2½	4 5	8 5	5
2974	11 ½	5 1½	8 8½	5½
2976	9 10	5	8 9½	6½
3000	10 6½	4 8	8 8	6¾
3010	10 11	4 11	8 8½	5½
3010	10 10	4 7	8 11	5
3034	10 4½	5 1	8 4½	6½
3040	10 11½	4 11	8 8	5
3064	10 6	4 10	8 8	5½
3085	10 4	4 10	8 9	8
3128	10 7	4 11	9 3½	6
3154	10 7½	5	9 3	6
3176	10 9	5	8 6	5
3205	10 11½	5 3½	9 1	5¾
3252	11 1	5 2	8 7	5½
3265	10 4	5	9 6	5
3292	10 5½	5	8 11	6
3310	10 7	5 1	9 1½	5
3352	10 11	5 3	9 7½	6
3696	11 3	4 11	10 1	6½

Longest canine (visible portion) measured: 8 inches (3 inches — 8 inches). Mostly from 5-6½ inches.

Length from the head to the base of the tail: 9 ft. 5 inches — 11 ft. 3 inches.

Shoulder height: 3 ft. 8 inches — 5 ft. 3½ inches.

Chest girth: 8 ft. 1 inch — 10 ft. 1 inch. (Varies much more than in males).

AGE STRUCTURE OF HIPPO POPULATION USING WEIGHT GROUPS AS BASIS

Age Groups	Weight Groups	Number	Percentage of Total	
Present season's calves	Less than 100 lbs.	1	0.98	8.8%
	100—200 lbs.	1	0.98	
	200—400 lbs.	2	1.96	
	400—600 lbs.	5	4.90	
6-18 months old calves	600—800 lbs.	1	0.98	8.8%
	800—1,000 lbs.	3	2.94	
	1,000—1,200 lbs.	5	4.90	
18-30 months old juveniles	1,200—1,400 lbs.	2	1.96	8.8%
	1,400—1,600 lbs.	6	5.88	
	1,600—1,700 lbs.	1	0.98	
30-42 months old sub-adults	1,700—1,900 lbs.	4	3.92	8.8%
	1,900—2,100 lbs.	5	4.90	
Adults	2,100—2,300 lbs.	4	3.92	64.7%
	2,300—2,500	5	4.90	
	2,500—2,700	6	5.88	
	2,700—2,900*	11	10.78	
	2,900—3,100**	15	14.72	
	3,100—3,300	8	7.84	
	3,300—3,500	5	4.90	
	3,500—3,700 (Mainly bulls)	2	1.96	
	3,700—3,900 (Mainly bulls)	4	3.92	
	3,900—4,100 (Mainly bulls)	2	1.96	
	More than 4,100 (Mainly bulls)	4	3.92	
		102	99.98	99.9%

* 16.67% of adult cows fall in this weight group.
** 33.34% of adult cows fall in this weight group.

RESUMÉ

In retrospect and with the above treatise as basis, it is possible to summarise our views as follows:—

1. Where the number of hippo in populations is the cause for concern, a lack of adequate shelter and 'lebensraum' is more often the limiting factor than a lack of adequate food resources.
2. Authoritative steps should be taken to ensure the conservation of sufficient natural shelter, or alternatively, to supply artificial habitats for the established quotas of hippo in the Kruger National Park.
3. No control measures should be instituted against hippo in the Levubu and Sabi rivers, but the position at Pafuri and the area west of Skukuza in the Sabi river should be carefully watched.

4. Subject to alterations, the following quotas may be allocated to the remaining three perennial rivers:
Letaba river 800; Olifants river 800-1,000; Crocodile river 500 (maximum).

5. The annual increase, as per the life table, i.e. natural increase minus mortality, and subject to factors such as emigration, should be assiduously culled to ensure the continued existence of the survivors.

6. Control should be according to plan and a proportionate number representative of each age group must be destroyed. Males and females should be shot in equal numbers.

7. Animals may be culled by means of a rifle and culling activity should incorporate the entire length of the river, so as to cause the minimum disturbance to the survivors. Control by means of the crossbow and drugs should also be investigated.

8. The results of the annual cropping campaign should be checked by subsequent counts. Aerial censusing should be the technique of choice.

9. The carcasses of destroyed animals should be processed in such a way as to ensure the maximum gain, financial or otherwise, for the Board.

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