AERIAL SURVEY OF NORTH-EASTERN NAMIBIA –
ELEPHANTS & OTHER WILDLIFE IN ZAMBEZI REGION
SEPTEMBER/OCTOBER 2019

G.C. Craig & D. St.C. Gibson
The 2019 aerial survey of wildlife in Zambezi Region, Namibia was commissioned by KfW on behalf of the Ministry of Environment and Tourism (MET), Government of Namibia as part of the survey of elephants in north-eastern Namibia.

Funding: Funding for the aerial survey was provided by KfW

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Photo: Elephants from the air in Namibia – M. Brassine
AERIAL SURVEY OF NORTH-EAST NAMIBIA – ELEPHANTS & OTHER WILDLIFE IN ZAMBEZI REGION, SEPTEMBER/OCTOBER 2019

SUMMARY

An aerial survey of wildlife and domestic livestock took place in Zambezi Region from 25th September to 4th October 2019 as part of a wider survey including Khaudum National Park and its neighbouring conservancies. A total area of 17 380 km$^2$ was sampled at intensities between 10 and 40%.

The estimates of numbers of each species are tabulated below. The estimated number of elephants is lower than that from the 2015 survey, but the change is not statistically significant. There were considerably fewer elephant carcasses seen in 2019. However as a result of the policy of MET to remove carcasses from the field, mortality can no longer be estimated from the aerial survey results. Illegal hunting of elephants continues to take place in the area.

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>Population estimate</th>
<th>95% Confidence Range</th>
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<tr>
<td>Sheep/goats</td>
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</table>
# TABLE OF CONTENTS

1. **INTRODUCTION** .......................................................... 1  
   1.1. Objectives ........................................................................ 1  
   1.2. General ........................................................................... 1  
   1.3. Reporting format ............................................................. 3  
2. **RESULTS** .......................................................................... 4  
   2.1. Elephant numbers ............................................................ 4  
   2.2. Elephant distribution ......................................................... 5  
   2.3. Elephant population trends ................................................. 7  
   2.4. Elephants – carcass numbers ............................................. 8  
   2.5. Elephants – herd sizes ....................................................... 11  
   2.6. Buffalo ........................................................................... 12  
   2.7. Baboon ........................................................................... 13  
   2.8. Duiker ............................................................................ 14  
   2.9. Eland .............................................................................. 15  
   2.10. Giraffe ........................................................................... 16  
   2.11. Hippopotamus ............................................................... 17  
   2.12. Impala .......................................................................... 18  
   2.13. Kudu ............................................................................ 19  
   2.14. Lechwe .......................................................................... 20  
   2.15. Reedbuck ...................................................................... 21  
   2.16. Roan antelope ............................................................... 22  
   2.17. Sable antelope ............................................................... 23  
   2.18. Steenbok ...................................................................... 24  
   2.19. Tsessebe ...................................................................... 25  
   2.20. Warthog ........................................................................ 26  
   2.21. Waterbuck .................................................................... 27  
   2.22. Wildebeest ................................................................... 28  
   2.23. Zebra ........................................................................... 29  
   2.24. Carnivores .................................................................... 30  
   2.25. Crocodiles .................................................................... 30  
   2.26. Carcasses of species other than elephant ......................... 31  
   2.27. Ground Hornbill ............................................................. 32  
   2.28. Ostrich .......................................................................... 33  
   2.29. Observations of Domestic Livestock ................................ 34  
   2.30. Other Observations – human activity and settlement ............ 35  
   2.31. Other Observations – fishing activities .............................. 35  
   2.32. Other Observations – fire ................................................ 35  
3. **RECOMMENDATIONS FOR SURVEY** ................................ 36  
   3.1. General Recommendations ............................................... 36  
   3.2. Precision .......................................................................... 36  
   3.3. Frequency of Surveys ....................................................... 36  
4. **REFERENCES** .................................................................... 37  
   a. Survey design ...................................................................... 38  
   b. Sampling intensity .............................................................. 38  
   c. Selection of transects .......................................................... 38  
   d. Calibration .......................................................................... 40  
   e. Data collection .................................................................... 40  
   f. Searching rate ..................................................................... 41  

**APPENDIX I: METHODS** ...................................................... 38  

---

**APPENDIX II: METHODS** ...................................................... 38  

---

**APPENDIX III: METHODS** ...................................................... 39  

---

**APPENDIX IV: METHODS** ...................................................... 39  

---

**APPENDIX V: METHODS** ...................................................... 40  

---

**APPENDIX VI: METHODS** ...................................................... 41
g. Data analysis .................................................................................................................. 41
h. Calculation of heights above ground level .................................................................. 42
i. Elephant sightings, carcass classification and ratios .................................................. 43
j. Mapping wildlife distribution ....................................................................................... 43

APPENDIX II: GENERAL SURVEY INFORMATION .......................................................... 44
a. Transect track logs ...................................................................................................... 45
b. Stratum statistics ......................................................................................................... 46
c. Calculation of strip width ............................................................................................ 47
d. Maintenance of height ................................................................................................ 50
e. Flight speeds ................................................................................................................ 51
f. Comparison of observers .............................................................................................. 52

APPENDIX III: RESULTS BY STRATUM ......................................................................... 54

Estimates of numbers, densities and confidence limits .................................................. 54
| Figure 1 | 2019 strata (additional strata in lower case) .................................................. | 2 |
| Figure 2 | Boundaries of management zones, protected areas and conservancies (green type) .......... | 2 |
| Figure 3 | Sightings of elephants in bull groups 2019 ......................................................... | 5 |
| Figure 4 | Sightings of elephants in family groups 2019 ....................................................... | 5 |
| Figure 5 | Sightings of elephant carcasses 2013 - 2019 ....................................................... | 5 |
| Figure 6 | Density distribution of elephants in Zambezi Region 2019 ..................................... | 6 |
| Figure 7 | Density distribution of elephants in Zambezi Region 2015 ..................................... | 6 |
| Figure 8 | Population trend of elephants in Zambezi region .................................................. | 8 |
| Figure 9 | Sightings of carcasses during aerial surveys 2013 to 2019 ................................... | 10 |
| Figure 10 | Location of carcasses removed from the field by MET in 2017 and 2019 (i.e. not available for observation from the air during the survey) ............................................... | 11 |
| Figure 11 | Sightings of buffalo 2019 ....................................................................................... | 12 |
| Figure 12 | Sightings of baboons 2019 ..................................................................................... | 13 |
| Figure 13 | Sightings of duiker 2019 ....................................................................................... | 14 |
| Figure 14 | Sightings of eland 2019 ......................................................................................... | 15 |
| Figure 15 | Sightings of giraffe 2019 ....................................................................................... | 16 |
| Figure 16 | Sightings of hippopotamus 2019 .......................................................................... | 17 |
| Figure 17 | Sightings of impala 2019 ...................................................................................... | 18 |
| Figure 18 | Sightings of kudu 2019 ......................................................................................... | 19 |
| Figure 19 | Sightings of lechwe 2019 ....................................................................................... | 20 |
| Figure 20 | Sightings of reedbuck 2019 .................................................................................. | 21 |
| Figure 21 | Sightings of roan 2019 ......................................................................................... | 22 |
| Figure 22 | Sightings of sable 2019 ....................................................................................... | 23 |
| Figure 23 | Sightings of steenbok 2019 .................................................................................. | 24 |
| Figure 24 | Sightings of tsessebe 2019 .................................................................................. | 25 |
| Figure 25 | Sightings of warthog 2019 ................................................................................... | 26 |
| Figure 26 | Sightings of waterbuck 2019 .............................................................................. | 27 |
| Figure 27 | Sightings of wildebeest 2019 ............................................................................. | 28 |
| Figure 28 | Sightings of zebra 2019 ..................................................................................... | 29 |
| Figure 29 | Sightings of zebra 2015 ...................................................................................... | 30 |
| Figure 30 | Sightings of crocodile 2019 .............................................................................. | 30 |
| Figure 31 | Sightings of carcasses (other than elephants) 2019 .......................................... | 31 |
| Figure 32 | Sightings of ground hornbills 2019 ................................................................. | 32 |
| Figure 33 | Sightings of ostrich 2019 .................................................................................. | 33 |
| Figure 34 | Sightings of domestic livestock 2019 .............................................................. | 34 |
| Figure 35 | Sightings of villages, cultivation and cattle posts 2019 .................................. | 35 |
| Figure 36 | Sightings of activities relevant to fishing 2019 ............................................. | 35 |
| Figure 37 | Sightings of active fires 2019 ......................................................................... | 35 |
| Figure 38 | Transects selected for the 2019 survey .......................................................... | 39 |
| Figure 39 | Calibration of observation strips .................................................................... | 40 |
| Figure 40 | Installation of laser rangefinders in the aircraft wing ..................................... | 40 |
| Figure 41 | Flightlogger display of height a.g.l. (pilot's GPS mounted on the control yoke) ...... | 41 |
| Figure 42 | Crew in action ..................................................................................................... | 44 |
| Figure 43 | Tracks flown on the 2019 Zambezi survey ....................................................... | 45 |
| Figure 44 | Calibration of observers ................................................................................ | 49 |
| Figure 45 | Relationship of laser altimeter and pressure altimeter (ft. a.g.l.) ...................... | 49 |
1. INTRODUCTION

1.1. Objectives

The survey was intended to obtain the best overall estimates of elephant numbers and distributions within the limits of available resources. The focus was on live elephants and elephant carcasses, but other species including domestic livestock were included in the survey and sightings of human settlements and cultivation were recorded.

1.2. General

The 2019 aerial survey of elephants and other species in Zambezi Region was conducted between 25 September and 6 October 2019.

The survey was conducted according to the internationally accepted MIKE standard practices (Craig 2012) in a light aircraft (a Cessna 182) using stratified systematic transect sampling (Norton Griffiths, 1978).

To facilitate comparisons with previous surveys, basic stratification of the survey area (Fig. 1) was the same as for previous surveys (Craig & Gibson 2013; Gibson & Craig 2015). These were designed to maximise precision and do not follow the boundaries of management zones, protected areas or conservancies (Fig. 2). Similarly, the names are those given in previous surveys.

The Rooikat Trust, a Namibian conservation NGO, that has a special interest in wildlife in eastern Zambezi Region supported additional survey effort with the aim of improving the precision of estimates in the area. To do this, “super-strata” were overlaid on east Zambezi strata to provide higher sampling intensities than in previous surveys (Fig. 1). The results were combined with the data from the “original” strata to provide overall estimates.

The survey strata are listed in Table 1.
Aerial survey of elephants & other wildlife in Zambezi Region

Figure 1 2019 strata (additional strata in lower case)
Note: Stratum names follow those of previous surveys and are not the same as those of management zones, parks or conservancies

Figure 2 Boundaries of management zones, protected areas and conservancies (green type)
Table 1. Survey strata

<table>
<thead>
<tr>
<th>Stratum Name</th>
<th>Stratum code</th>
<th>Area km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Bwabwata</td>
<td>BAB</td>
<td>3 789</td>
</tr>
<tr>
<td>2  Buffalo/Mahango (A, B &amp; C)</td>
<td>BUF</td>
<td>1 162</td>
</tr>
<tr>
<td>3  E Zambezi North</td>
<td>EZN</td>
<td>4 772</td>
</tr>
<tr>
<td>4  E Zambezi South</td>
<td>EYS</td>
<td>3 099</td>
</tr>
<tr>
<td>5  Kwando (A &amp; B)</td>
<td>KW</td>
<td>1 513</td>
</tr>
<tr>
<td>6  Kwando N</td>
<td>KN</td>
<td>666</td>
</tr>
<tr>
<td>7  Salambala/Impalila (A &amp; B)</td>
<td>SAL</td>
<td>1 245</td>
</tr>
<tr>
<td>8  Susuwe (A, B &amp; C)</td>
<td>SUS</td>
<td>1 134</td>
</tr>
<tr>
<td>9  Rooikat N (A &amp; B)</td>
<td>RN</td>
<td>(774)</td>
</tr>
<tr>
<td>10 Rooikat S (A &amp; B)</td>
<td>RS</td>
<td>(1 959)</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>17 380</td>
</tr>
</tbody>
</table>

Those strata numbered 1 to 8 are the same as previous surveys, while the “Rooikat” strata, numbers 9 and 10 are the overlaid super-strata.

1.3. Reporting format

This report follows the format used for previous surveys of wildlife in Namibia. For each species, a table provides the estimated number per stratum with its 95% confidence range. This “range” refers to the range within which there is a 95% probability that the true number falls (i.e. it is the 95% confidence interval). The PRP% (Percentage Relative Precision) is half the 95% confidence interval expressed as a percentage of the estimate. It is what most people understand as a statement of the reliability of the estimate. For example, 4000 ± 50% indicates the real number is likely to be between 2000 and 6000. It is the same thing as the 95% range (given in the tables), but is a more compact way of saying it.

Strictly, for most species, the 95% confidence range is actually the range within which 95% of independent estimates made by the same method would fall. The true value is likely to be higher on average because of undercounting bias.

The numbers actually seen by the observers are also provided. “No. in” is the number of animals seen within sampling strips and “No. out” is the number seen outside of the sampling strips. Where animals were seen only outside of the sampling strips no estimate can be given but the information can be used to show that the species occurs and where it occurred.

Wildlife species in this section are arranged in alphabetical order of their common names with the exception of elephants and elephant carcasses, which are placed first and second respectively. At the end of the wildlife section, the carcasses of species other than elephant are reported.

The report describes wildlife populations, human activities and other attributes in the section entitled Results and Discussion.

Details of the design and methods are given in Appendix I while details of results per stratum are given in Appendix II.
## 2. RESULTS

### 2.1. Elephant numbers

#### Table 2. Estimates of Elephants in Family Groups

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>3546</td>
<td>1107</td>
<td>1562</td>
<td>43.8</td>
<td>1992 - 5100</td>
<td>305.16</td>
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<tr>
<td>Bwabwata</td>
<td>95</td>
<td>10</td>
<td>14</td>
<td>197.1</td>
<td>10 - 283</td>
<td>2.52</td>
</tr>
<tr>
<td>Susuwe</td>
<td>2336</td>
<td>617</td>
<td>822</td>
<td>58.4</td>
<td>972 - 3701</td>
<td>206.04</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>3093</td>
<td>618</td>
<td>656</td>
<td>43.1</td>
<td>1739 - 4446</td>
<td>204.4</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambesi South</td>
<td>1315</td>
<td>169</td>
<td>241</td>
<td>72.5</td>
<td>362 - 2267</td>
<td>42.42</td>
</tr>
<tr>
<td>Salambala</td>
<td>477</td>
<td>198</td>
<td>181</td>
<td>91.4</td>
<td>198 - 912</td>
<td>38.29</td>
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<td><strong>Overall</strong></td>
<td><strong>10862</strong></td>
<td><strong>2719</strong></td>
<td><strong>3476</strong></td>
<td><strong>23.7</strong></td>
<td><strong>8283 - 13440</strong></td>
<td><strong>62.5</strong></td>
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</table>

#### Table 3. Estimates of Elephant Bulls

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>540</td>
<td>168</td>
<td>202</td>
<td>45.0</td>
<td>297 - 783</td>
<td>46.44</td>
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<tr>
<td>Bwabwata</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0 - 0</td>
<td>0</td>
</tr>
<tr>
<td>Susuwe</td>
<td>186</td>
<td>67</td>
<td>78</td>
<td>61.8</td>
<td>71 - 301</td>
<td>16.39</td>
</tr>
<tr>
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<tr>
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<td>362</td>
<td>75</td>
<td>113</td>
<td>41.5</td>
<td>209 - 514</td>
<td>23.92</td>
</tr>
<tr>
<td>East Zambezi North</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambesi South</td>
<td>29</td>
<td>3</td>
<td>1</td>
<td>137.3</td>
<td>3 - 68</td>
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<tr>
<td>Salambala</td>
<td>30</td>
<td>13</td>
<td>6</td>
<td>76.4</td>
<td>13 - 53</td>
<td>2.43</td>
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<tr>
<td><strong>Overall</strong></td>
<td><strong>1146</strong></td>
<td><strong>326</strong></td>
<td><strong>406</strong></td>
<td><strong>25.9</strong></td>
<td><strong>849 - 1443</strong></td>
<td><strong>6.59</strong></td>
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</tbody>
</table>

#### Table 4. Estimates of All Elephants

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>4086</td>
<td>1275</td>
<td>1764</td>
<td>37.5</td>
<td>2552 - 5619</td>
<td>351.6</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>95</td>
<td>10</td>
<td>20</td>
<td>197.1</td>
<td>10 - 283</td>
<td>2.52</td>
</tr>
<tr>
<td>Susuwe</td>
<td>2522</td>
<td>684</td>
<td>900</td>
<td>55.2</td>
<td>1130 - 3915</td>
<td>222.43</td>
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<tr>
<td>Kwando North</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>3455</td>
<td>693</td>
<td>769</td>
<td>39.5</td>
<td>2072 - 4838</td>
<td>228.32</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>East Zambesi South</td>
<td>1343</td>
<td>172</td>
<td>242</td>
<td>71.4</td>
<td>385 - 2302</td>
<td>43.34</td>
</tr>
<tr>
<td>Salambala</td>
<td>507</td>
<td>211</td>
<td>187</td>
<td>86.6</td>
<td>211 - 946</td>
<td>40.71</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>12008</strong></td>
<td><strong>3045</strong></td>
<td><strong>3882</strong></td>
<td><strong>21.6</strong></td>
<td><strong>9410 - 14606</strong></td>
<td><strong>69.09</strong></td>
</tr>
</tbody>
</table>
2.2. Elephant distribution

In the Zambezi survey area, elephants were found mainly in protected areas (Figs 3 & 4). This was the case in previous surveys which were also conducted in the dry season. There are no survey data to show wet season distributions, but the combined evidence from carcasses (Fig 5) suggests that elephants are more widespread than shown by dry season surveys and are found in areas that have no water during the dry season. Distributions of elephants were very similar to those in 2015 (see Figs 6 and 7). This is clearly typical of distribution during dry seasons.

Figure 3 Sightings of elephants in bull groups 2019

Figure 4 Sightings of elephants in family groups 2019

Figure 5 Sightings of elephant carcasses 2013 - 2019
Figure 6 Density distribution of elephants in Zambezi Region 2019

Figure 7 Density distribution of elephants in Zambezi Region 2015
2.3. Elephant population trends

As reported previously (Craig & Gibson 2013, Craig & Gibson 2014, Gibson & Craig 2015), estimates from previous surveys are difficult to compare because of differences in overall areas surveyed and differences in the methods used. Survey methods from 1994 onwards were broadly similar apart from total counts of wetlands. Table 5 provides information from surveys between 1994 and 2019.

Table 5. Results of aerial surveys of elephants in Zambezi Region (Caprivi) since 1994

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate/no counted</th>
<th>%PRP</th>
<th>95% range</th>
<th>Survey type</th>
<th>Source of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>low</td>
<td>high</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>7950</td>
<td>59.00</td>
<td>3255</td>
<td>12645</td>
<td>Sample</td>
</tr>
<tr>
<td>1994</td>
<td>5556</td>
<td>0.00</td>
<td></td>
<td></td>
<td>Sample</td>
</tr>
<tr>
<td>1995</td>
<td>4883</td>
<td>25.56</td>
<td>3635</td>
<td>6130</td>
<td>Sample</td>
</tr>
<tr>
<td>1998</td>
<td>4576</td>
<td>27.30</td>
<td>3328</td>
<td>5824</td>
<td>Sample</td>
</tr>
<tr>
<td>2004</td>
<td>8725</td>
<td>28.28</td>
<td>6258</td>
<td>14983</td>
<td>Sample</td>
</tr>
<tr>
<td>2005</td>
<td>6474</td>
<td>37.77</td>
<td>4035</td>
<td>8912</td>
<td>Sample</td>
</tr>
<tr>
<td>2007</td>
<td>3062</td>
<td>0.00</td>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>2007</td>
<td>11339</td>
<td>*10.18</td>
<td>*10185</td>
<td>*12493</td>
<td>Sample + total**</td>
</tr>
<tr>
<td>2009</td>
<td>3450</td>
<td>0.00</td>
<td></td>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>2011</td>
<td>10847</td>
<td>32.70</td>
<td>7300</td>
<td>14394</td>
<td>Sample</td>
</tr>
<tr>
<td>2013</td>
<td>9165</td>
<td>21.46</td>
<td>7198</td>
<td>11132</td>
<td>Sample</td>
</tr>
<tr>
<td>2014</td>
<td>14097</td>
<td>18.7</td>
<td>11462</td>
<td>16732</td>
<td>Sample</td>
</tr>
<tr>
<td>2015</td>
<td>13136</td>
<td>26.1</td>
<td>9701</td>
<td>16570</td>
<td>Sample</td>
</tr>
<tr>
<td>2019</td>
<td>12008</td>
<td>21.6</td>
<td>9410</td>
<td>14606</td>
<td>Sample</td>
</tr>
</tbody>
</table>

* the 95% confidence limits provided above have been calculated independently. Statistics presented in Chase 2008 are incorrect
** a sample survey except for Mamili NP surveyed as a total count
The overall rate of change from 1998 averages an increase of 4.74% (2.74% - 6.82%) and is statistically significant (F=29.7, p = 0.0006***) (Fig. 8).

Estimates have decreased over the past 3 surveys, but the decline is not significant. It is possible that such a decrease is real: some decline might be expected as a result of the illegal hunting that took place from before 2013 (Craig & Gibson 2013) but this cannot be shown by the available population data. Additional evidence on the level of illegal hunting might be provided by the data from carcass estimates (see below).

2.4. Elephants – carcass numbers

Change in carcass numbers and carcass ratios can be more sensitive indicators of excess mortality than change in population size (Craig & Gibson 2013). Table 6 gives estimates of numbers of elephant carcasses in the four decay stages (Douglas-Hamilton & Burril 1991) which are described in Appendix Ic.

The MET has a policy of removing carcasses from the field. This renders the current carcass ratio invalid as an index of population status. Comparing numbers of carcasses in the light of numbers removed is another option. That is, there were an estimated 733 carcasses within protected areas (Bwabwata, Mahango, Mudumu and Nkasa Rupara National Parks) in 2015. Since then, 400 carcasses have been removed from these areas (location of these were provided by MET and shown in Fig. 10) by MET. The present estimate in the areas is 343. One interpretation would be that the present number represents those of the 733 original carcasses that were not picked up, there having been very little mortality since 2015. Conversely, all the 2015 carcasses may have been collected or deteriorated beyond recognition, so that the 343 present carcasses have all accumulated since 2017. One thing that
may be said with confidence is that 94 carcasses (of stages 1, 2 or 3) have accumulated in the area in the last two years, which suggests poaching is continuing, albeit at a reduced rate.

In the areas where carcasses were not removed (see Fig. 10), the number of carcasses estimated has declined from 450 in 2015 to 175 in 2019, a highly significant difference (t=3, p<0.003***). Here the rate of accumulation from mortality has been outweighed by deterioration of the carcasses already present because here, at least, poaching has declined although the carcass ratio is still 9%, which is marginal for sustainability.

Maps of sightings of carcasses seen during successive surveys (Fig. 9) suggest that there were high levels of elephant poaching from 2013 to 2015 that have declined by 2019. The map (Fig.10) of carcasses that were removed in 2017 and 2019 show a substantial number of carcasses and the areas where removal took place.

### Table 6. Estimates of Elephant Carcasses

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carcass 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>188.2</td>
<td>1 - 14</td>
<td>0.31</td>
</tr>
<tr>
<td>Carcass 1 Overall</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>182.4</td>
<td>1 - 13</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Carcass 2:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo / Mahango</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>135.8</td>
<td>2 - 15</td>
<td>0.54</td>
</tr>
<tr>
<td>Kwando</td>
<td>10</td>
<td>2</td>
<td>0</td>
<td>128.7</td>
<td>2 - 24</td>
<td>0.68</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>188.8</td>
<td>1 - 27</td>
<td>0.31</td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
<td>0 - 0</td>
<td>0</td>
</tr>
<tr>
<td>Carcass 2 Overall</td>
<td>26</td>
<td>5</td>
<td>1</td>
<td>89.6</td>
<td>5 - 50</td>
<td>0.15</td>
</tr>
<tr>
<td><strong>Carcass 3:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo / Mahango</td>
<td>13</td>
<td>4</td>
<td>0</td>
<td>86.4</td>
<td>4 - 24</td>
<td>1.13</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>192.1</td>
<td>1 - 28</td>
<td>0.25</td>
</tr>
<tr>
<td>Susuwe</td>
<td>17</td>
<td>4</td>
<td>0</td>
<td>117.7</td>
<td>4 - 37</td>
<td>1.5</td>
</tr>
<tr>
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<td>33</td>
<td>7</td>
<td>0</td>
<td>93.8</td>
<td>7 - 65</td>
<td>2.21</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>38</td>
<td>4</td>
<td>0</td>
<td>91.8</td>
<td>4 - 73</td>
<td>0.8</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>22</td>
<td>3</td>
<td>0</td>
<td>116.5</td>
<td>3 - 48</td>
<td>0.72</td>
</tr>
<tr>
<td>Salambala</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>186.5</td>
<td>3 - 21</td>
<td>0.58</td>
</tr>
<tr>
<td>Carcass 3 Overall</td>
<td>141</td>
<td>26</td>
<td>1</td>
<td>43.5</td>
<td>79 - 202</td>
<td>0.81</td>
</tr>
<tr>
<td><strong>Carcass 4:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo / Mahango</td>
<td>13</td>
<td>4</td>
<td>0</td>
<td>83.4</td>
<td>4 - 24</td>
<td>1.15</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>67</td>
<td>7</td>
<td>1</td>
<td>64.4</td>
<td>24 - 110</td>
<td>1.76</td>
</tr>
<tr>
<td>Susuwe</td>
<td>74</td>
<td>25</td>
<td>0</td>
<td>41.2</td>
<td>44 - 105</td>
<td>6.53</td>
</tr>
<tr>
<td>Kwando</td>
<td>95</td>
<td>19</td>
<td>2</td>
<td>51.5</td>
<td>45 - 145</td>
<td>6.28</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>22</td>
<td>3</td>
<td>0</td>
<td>117.8</td>
<td>3 - 48</td>
<td>0.46</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>57</td>
<td>8</td>
<td>0</td>
<td>103.5</td>
<td>8 - 116</td>
<td>1.85</td>
</tr>
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<td>Salambala</td>
<td>19</td>
<td>8</td>
<td>0</td>
<td>73.4</td>
<td>8 - 32</td>
<td>1.5</td>
</tr>
<tr>
<td>Carcass 4 Overall</td>
<td>347</td>
<td>74</td>
<td>3</td>
<td>27.6</td>
<td>251 - 443</td>
<td>2</td>
</tr>
<tr>
<td><strong>All Carcasses</strong>:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo / Mahango</td>
<td>33</td>
<td>10</td>
<td>0</td>
<td>47.8</td>
<td>17 - 48</td>
<td>2.82</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>76</td>
<td>8</td>
<td>2</td>
<td>58.7</td>
<td>31 - 121</td>
<td>2.01</td>
</tr>
<tr>
<td>Susuwe</td>
<td>91</td>
<td>29</td>
<td>0</td>
<td>37.4</td>
<td>57 - 125</td>
<td>8.04</td>
</tr>
<tr>
<td>Kwando</td>
<td>143</td>
<td>29</td>
<td>2</td>
<td>37.5</td>
<td>89 - 198</td>
<td>9.48</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>60</td>
<td>7</td>
<td>0</td>
<td>82.5</td>
<td>11 - 110</td>
<td>1.26</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>89</td>
<td>12</td>
<td>0</td>
<td>88.4</td>
<td>12 - 168</td>
<td>2.87</td>
</tr>
<tr>
<td>Salambala</td>
<td>26</td>
<td>11</td>
<td>1</td>
<td>73.0</td>
<td>11 - 45</td>
<td>2.08</td>
</tr>
<tr>
<td>Carcasses Overall</td>
<td>519</td>
<td>106</td>
<td>5</td>
<td>23.4</td>
<td>398 - 640</td>
<td>2.98</td>
</tr>
</tbody>
</table>
Figure 9 Sightings of carcasses during aerial surveys 2013 to 2019
During positioning turns over Botswana between transects, the survey recorded a total of 68 carcasses in Botswana, 9 of which had been killed recently. Several of these were fresh, none had tusks and some had fallen together. The number is greater than seen in 2014 (53) and is evidence of a continuing poaching problem just across the border.

2.5. Elephants – herd sizes

Elephants that are under pressure tend to group into large herds and comparisons of herd sizes in 2014 and 2015 showed significantly increased herd sizes in Kwando and Susuwe (Table 7) (Gibson & Craig 2015). This trend appeared subsequently to be reversed and mean herd sizes in those strata decreased significantly (Table 8).

<table>
<thead>
<tr>
<th>STRATUM</th>
<th>Mean herd size 2014</th>
<th>Mean herd size 2015</th>
<th>t</th>
<th>p</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bwabwata</td>
<td>21</td>
<td>10</td>
<td>2.1331</td>
<td>0.0769</td>
<td>6</td>
</tr>
<tr>
<td>Buffalo/Mahango</td>
<td>16</td>
<td>11</td>
<td>3.5183</td>
<td>0.0005***</td>
<td>225</td>
</tr>
<tr>
<td>East Zambezi S</td>
<td>15</td>
<td>34</td>
<td>1.8049</td>
<td>0.0862</td>
<td>20</td>
</tr>
<tr>
<td>Kwando</td>
<td>13</td>
<td>19</td>
<td>2.9245</td>
<td>0.0036**</td>
<td>446</td>
</tr>
<tr>
<td>Kwando N</td>
<td>13</td>
<td>17</td>
<td>0.9091</td>
<td>0.4049</td>
<td>5</td>
</tr>
<tr>
<td>Salambala</td>
<td>20</td>
<td>13</td>
<td>1.2254</td>
<td>0.2294</td>
<td>32</td>
</tr>
<tr>
<td>Susuwe</td>
<td>14</td>
<td>25</td>
<td>3.3077</td>
<td>0.0011**</td>
<td>292</td>
</tr>
<tr>
<td>Overall Zambezi Region</td>
<td>14</td>
<td>18</td>
<td>1.4205</td>
<td>0.1558</td>
<td>1041</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STRATUM</th>
<th>Mean herd size 2015</th>
<th>Mean herd size 2019</th>
<th>t</th>
<th>p</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bwabwata</td>
<td>10</td>
<td>8</td>
<td>1.4569</td>
<td>0.1731</td>
<td>11</td>
</tr>
<tr>
<td>Buffalo/Mahango</td>
<td>11</td>
<td>13</td>
<td>1.5680</td>
<td>0.1178</td>
<td>328</td>
</tr>
<tr>
<td>East Zambezi S</td>
<td>34</td>
<td>17</td>
<td>1.7633</td>
<td>0.0863</td>
<td>36</td>
</tr>
<tr>
<td>Kwando</td>
<td>19</td>
<td>9</td>
<td>4.9373</td>
<td>1.1798E-06</td>
<td>387</td>
</tr>
<tr>
<td>Kwando N</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>37</td>
</tr>
<tr>
<td>Salambala</td>
<td>13</td>
<td>13</td>
<td>0</td>
<td>1</td>
<td>37</td>
</tr>
<tr>
<td>Susuwe</td>
<td>25</td>
<td>12</td>
<td>3.3758</td>
<td>0.000821***</td>
<td>340</td>
</tr>
<tr>
<td>Overall Zambezi Region</td>
<td>18</td>
<td>9</td>
<td>4.9057</td>
<td>1.0645E-06</td>
<td>1153</td>
</tr>
</tbody>
</table>

Figure 10 Location of carcasses removed from the field by MET in 2017 and 2019 (i.e. not available for observation from the air during the survey)
2.6. Buffalo

Table 9. Estimate of buffalo numbers

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>3370</td>
<td>1051</td>
<td>943</td>
<td>49.3</td>
<td>1709 - 5030</td>
<td>289.99</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susuwe</td>
<td>161</td>
<td>57</td>
<td>25</td>
<td>73.0</td>
<td>57 - 278</td>
<td>14.16</td>
</tr>
<tr>
<td>Kwando North</td>
<td>1495</td>
<td>301</td>
<td>507</td>
<td>132.1</td>
<td>301 - 3469</td>
<td>98.78</td>
</tr>
<tr>
<td>Kwando</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>2119</td>
<td>223</td>
<td>90</td>
<td>128.8</td>
<td>223 - 4849</td>
<td>68.38</td>
</tr>
<tr>
<td>Salambala</td>
<td>394</td>
<td>170</td>
<td>1118</td>
<td>135.2</td>
<td>170 - 926</td>
<td>31.62</td>
</tr>
<tr>
<td>Overall</td>
<td>7538</td>
<td>1802</td>
<td>2683</td>
<td>49.0</td>
<td>3844 - 11231</td>
<td>43.37</td>
</tr>
</tbody>
</table>

Although the population appears to have increased at around 7% *per annum* since 2013, the trend is not statistically significant.

Table 10. Estimates of buffalo numbers since 2013

<table>
<thead>
<tr>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>5339</td>
<td>43.80 Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>4512</td>
<td>46.80 Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>6538</td>
<td>42.50 Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>7538</td>
<td>49.00 This report</td>
</tr>
</tbody>
</table>

Figure 11 Sightings of buffalo 2019
2.7. Baboon

Table 11. Estimates of Baboon

<table>
<thead>
<tr>
<th>Location</th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>0</td>
<td>0 - 0</td>
<td>0</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susuwe</td>
<td>80</td>
<td>21</td>
<td>0</td>
<td>104.2</td>
<td>21 - 164</td>
<td>7.09</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>108</td>
<td>21</td>
<td>0</td>
<td>99.8</td>
<td>21 - 217</td>
<td>7.17</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambesi South</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>189</strong></td>
<td><strong>42</strong></td>
<td><strong>25</strong></td>
<td><strong>69.2</strong></td>
<td><strong>58 - 319</strong></td>
<td><strong>1.09</strong></td>
</tr>
</tbody>
</table>

Figure 12 Sightings of baboons 2019
2.8. Duiker

Table 12. Estimates of Duiker

<table>
<thead>
<tr>
<th>Location</th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>29</td>
<td>9</td>
<td>0</td>
<td>60.3</td>
<td>11 - 46</td>
<td>2.47</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>153</td>
<td>16</td>
<td>0</td>
<td>66.0</td>
<td>52 - 253</td>
<td>4.03</td>
</tr>
<tr>
<td>Susuwe</td>
<td>34</td>
<td>11</td>
<td>0</td>
<td>75.6</td>
<td>11 - 61</td>
<td>3.04</td>
</tr>
<tr>
<td>Kwando North</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>206.2</td>
<td>1 - 27</td>
<td>1.31</td>
</tr>
<tr>
<td>Kwando</td>
<td>20</td>
<td>4</td>
<td>0</td>
<td>91.0</td>
<td>4 - 38</td>
<td>1.31</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>38</td>
<td>4</td>
<td>0</td>
<td>87.3</td>
<td>5 - 71</td>
<td>0.8</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>29</td>
<td>3</td>
<td>0</td>
<td>105.8</td>
<td>3 - 59</td>
<td>0.92</td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>311</strong></td>
<td><strong>48</strong></td>
<td><strong>0</strong></td>
<td><strong>36.5</strong></td>
<td><strong>197 - 424</strong></td>
<td><strong>1.79</strong></td>
</tr>
</tbody>
</table>

Duiker are difficult to see from the air and estimates are likely to be inaccurate and imprecise. This is apparent from the series of estimates from successive surveys which do not show a significant trend.

Table 13. Estimates of duiker numbers since 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>221</td>
<td>57.60</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>125</td>
<td>84.90</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>79</td>
<td>69.70</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>311</td>
<td>36.50</td>
<td>This report</td>
</tr>
</tbody>
</table>

Figure 13 Sightings of duiker 2019
2.9. Eland

Table 14. Estimates of Eland

<table>
<thead>
<tr>
<th>Area</th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>113</td>
<td>36</td>
<td>5</td>
<td>136.3</td>
<td>36 - 266</td>
<td>9.7</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>114</td>
<td>12</td>
<td>0</td>
<td>99.6</td>
<td>12 - 228</td>
<td>3.02</td>
</tr>
<tr>
<td>Susuwe</td>
<td>127</td>
<td>33</td>
<td>10</td>
<td>130.1</td>
<td>33 - 292</td>
<td>11.2</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>77</td>
<td>15</td>
<td>0</td>
<td>145.4</td>
<td>15 - 188</td>
<td>5.06</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambesi South</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>431</strong></td>
<td><strong>96</strong></td>
<td><strong>15</strong></td>
<td><strong>61.2</strong></td>
<td><strong>167 - 694</strong></td>
<td><strong>2.48</strong></td>
</tr>
</tbody>
</table>

The population trend since 2013 is not statistically significant.

Table 15. Estimates of eland numbers since 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>259</td>
<td>108.80</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>342</td>
<td>137.60</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>187</td>
<td>118.60</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>431</td>
<td>61.20</td>
<td>This report</td>
</tr>
</tbody>
</table>

Figure 14. Sightings of eland 2019
### 2.10. Giraffe

#### Table 16. Estimates of Giraffe

<table>
<thead>
<tr>
<th>Area</th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>22</td>
<td>7</td>
<td>0</td>
<td>93.3</td>
<td>7 - 43</td>
<td>1.94</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0 - 0</td>
<td>0</td>
</tr>
<tr>
<td>Susuwe</td>
<td>250</td>
<td>67</td>
<td>37</td>
<td>75.0</td>
<td>67 - 437</td>
<td>22</td>
</tr>
<tr>
<td>Kwando North</td>
<td>17</td>
<td>2</td>
<td>0</td>
<td>146.6</td>
<td>2 - 53</td>
<td>2.61</td>
</tr>
<tr>
<td>Kwando</td>
<td>59</td>
<td>12</td>
<td>0</td>
<td>91.5</td>
<td>12 - 113</td>
<td>3.92</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>29</td>
<td>3</td>
<td>0</td>
<td>192.4</td>
<td>3 - 84</td>
<td>0.6</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>26</td>
<td>8</td>
<td>1</td>
<td>106.9</td>
<td>8 - 53</td>
<td>0.83</td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>403</strong></td>
<td><strong>99</strong></td>
<td><strong>42</strong></td>
<td><strong>49.4</strong></td>
<td><strong>204 - 602</strong></td>
<td><strong>2.32</strong></td>
</tr>
</tbody>
</table>

The population trend since 2013 is not statistically significant.

#### Table 17. Estimates of giraffe numbers since 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>324</td>
<td>85.30</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>123</td>
<td>59.50</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>129</td>
<td>56.30</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>403</td>
<td>49.40</td>
<td>This report</td>
</tr>
</tbody>
</table>

*Figure 15* Sightings of giraffe 2019
## 2.11. Hippopotamus

### Table 18. Estimates of Hippos

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>205</td>
<td>64</td>
<td>15</td>
<td>67.4</td>
<td>67 - 343</td>
<td>17.65</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susuwe</td>
<td>760</td>
<td>237</td>
<td>9</td>
<td>49.3</td>
<td>385 - 1135</td>
<td>67.05</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>1197</td>
<td>241</td>
<td>30</td>
<td>76.6</td>
<td>280 - 2114</td>
<td>79.14</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>127</td>
<td>31</td>
<td>11</td>
<td>107.7</td>
<td>31 - 263</td>
<td>2.65</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>48</td>
<td>15</td>
<td>0</td>
<td>180.4</td>
<td>15 - 135</td>
<td>1.55</td>
</tr>
<tr>
<td>Salambala</td>
<td>98</td>
<td>41</td>
<td>0</td>
<td>68.7</td>
<td>41 - 165</td>
<td>7.83</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>2435</strong></td>
<td><strong>629</strong></td>
<td><strong>65</strong></td>
<td><strong>39.9</strong></td>
<td><strong>1464 - 3406</strong></td>
<td><strong>14.01</strong></td>
</tr>
</tbody>
</table>

The population of hippos appear to have declined at a rate of 4% per annum since 2013. This trend is not statistically significant. This survey method is not ideal for the species and estimates may not be accurate.

### Table 19. Estimates of hippo numbers since 2013

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>3252</td>
<td>25.20</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>2773</td>
<td>30.30</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>2692</td>
<td>31.80</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>2435</td>
<td>39.90</td>
<td>This report</td>
</tr>
</tbody>
</table>

![Figure 16 Sightings of hippos 2019](image)
### 2.12. Impala

#### Table 20. Estimates of Impala

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>157</td>
<td>48</td>
<td>0</td>
<td>114.8</td>
<td>48 - 336</td>
<td>13.48</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susuwe</td>
<td>908</td>
<td>277</td>
<td>9</td>
<td>49.1</td>
<td>463 - 1354</td>
<td>80.11</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>2008</td>
<td>406</td>
<td>64</td>
<td>61.8</td>
<td>767 - 3250</td>
<td>132.73</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>185.1</td>
<td>1 - 9</td>
<td>0.07</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>269</td>
<td>84</td>
<td>0</td>
<td>98.0</td>
<td>84 - 533</td>
<td>8.69</td>
</tr>
<tr>
<td>Salambala</td>
<td>141</td>
<td>58</td>
<td>80</td>
<td>135.8</td>
<td>58 - 332</td>
<td>11.3</td>
</tr>
<tr>
<td>Overall</td>
<td>3486</td>
<td>874</td>
<td>153</td>
<td>37.6</td>
<td>2175 - 4798</td>
<td>20.06</td>
</tr>
</tbody>
</table>

**Figure 17** Sightings of impala 2019

Impala have increased at a rate of 12.6% per annum since 2013. Although the trend is not statistically significant, it may be real.

#### Table 21. Estimates of impala numbers since 2013

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>1743</td>
<td>33.00</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>1616</td>
<td>36.40</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>2458</td>
<td>48.50</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>3486</td>
<td>37.60</td>
<td>This report</td>
</tr>
</tbody>
</table>
2.13.  Kudu

Table 22. Estimates of Kudu

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>392</td>
<td>119</td>
<td>11</td>
<td>46.0</td>
<td>212 - 573</td>
<td>33.75</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>143</td>
<td>15</td>
<td>1</td>
<td>129.8</td>
<td>15 - 329</td>
<td>3.78</td>
</tr>
<tr>
<td>Susuwe</td>
<td>200</td>
<td>71</td>
<td>9</td>
<td>52.8</td>
<td>95 - 306</td>
<td>17.67</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>224</td>
<td>45</td>
<td>0</td>
<td>70.9</td>
<td>65 - 383</td>
<td>14.82</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>36</td>
<td>11</td>
<td>0</td>
<td>92.1</td>
<td>11 - 68</td>
<td>1.15</td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>995</td>
<td>261</td>
<td>21</td>
<td>31.1</td>
<td>686 - 1305</td>
<td>5.73</td>
</tr>
</tbody>
</table>

The population trend since 2013 is not statistically significant.

Table 23. Estimates of kudu numbers since 2013

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>893</td>
<td>48.30</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>619</td>
<td>47.80</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>1056</td>
<td>56.70</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>995</td>
<td>31.10</td>
<td>This report</td>
</tr>
</tbody>
</table>

Figure 18 Sightings of kudu 2019
2.14. **Lechwe**

**Table 24. Estimates of Lechwe**

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>925</td>
<td>281</td>
<td>0</td>
<td>76.2</td>
<td>281 - 1629</td>
<td>79.57</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susuwe</td>
<td>2434</td>
<td>689</td>
<td>172</td>
<td>37.1</td>
<td>1531 - 3336</td>
<td>214.63</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>1526</td>
<td>301</td>
<td>25</td>
<td>94.9</td>
<td>301 - 2975</td>
<td>100.88</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salambala</td>
<td>46</td>
<td>20</td>
<td>0</td>
<td>149.3</td>
<td>20 - 114</td>
<td>3.69</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>4931</td>
<td>1291</td>
<td>197</td>
<td>35.8</td>
<td>3168 - 6694</td>
<td>28.37</td>
</tr>
</tbody>
</table>

**Figure 19** Sightings of lechwe 2019

Lechwe appear to have increased at a rate of 9.5% per annum since 2013. This trend is not significant.

**Table 25. Estimates lechwe numbers since 2013**

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>2515</td>
<td>25.00</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>3717</td>
<td>28.00</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>3305</td>
<td>46.60</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>4931</td>
<td>35.80</td>
<td>This report</td>
</tr>
</tbody>
</table>
2.15. Reedbuck

Table 26. Estimates of Reedbuck

<table>
<thead>
<tr>
<th>Area</th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>15</td>
<td>5</td>
<td>0</td>
<td>185.5</td>
<td>5 - 44</td>
<td>1.33</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susuwe</td>
<td>48</td>
<td>19</td>
<td>0</td>
<td>98.7</td>
<td>19 - 95</td>
<td>4.2</td>
</tr>
<tr>
<td>Kwando North</td>
<td>17</td>
<td>2</td>
<td>0</td>
<td>146.6</td>
<td>2 - 43</td>
<td>2.61</td>
</tr>
<tr>
<td>Kwando</td>
<td>95</td>
<td>19</td>
<td>0</td>
<td>102.1</td>
<td>19 - 193</td>
<td>6.31</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>135.4</td>
<td>3 - 23</td>
<td>0.21</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>89</td>
<td>10</td>
<td>0</td>
<td>110.5</td>
<td>10 - 187</td>
<td>2.87</td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>275</strong></td>
<td><strong>58</strong></td>
<td><strong>0</strong></td>
<td><strong>53.4</strong></td>
<td><strong>128 - 421</strong></td>
<td><strong>1.58</strong></td>
</tr>
</tbody>
</table>

Reedbuck appear to have increased at a rate of 18.5% per annum since 2013. This trend is not significant.

Figure 20 Sightings of reedbuck 2019

Table 27. Estimates of reedbuck numbers since 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>78</td>
<td>123.10</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>142</td>
<td>47.90</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>135</td>
<td>61.10</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>275</td>
<td>53.40</td>
<td>This report</td>
</tr>
</tbody>
</table>
2.16. Roan antelope

Table 28. Estimates of Roan Antelope

<table>
<thead>
<tr>
<th>Location</th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>77</td>
<td>24</td>
<td>4</td>
<td>60.2</td>
<td>31 - 123</td>
<td>6.63</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susuwe</td>
<td>99</td>
<td>31</td>
<td>2</td>
<td>80.5</td>
<td>31 - 178</td>
<td>8.7</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>149</td>
<td>29</td>
<td>2</td>
<td>88.1</td>
<td>29 - 280</td>
<td>9.84</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>325</strong></td>
<td><strong>84</strong></td>
<td><strong>8</strong></td>
<td><strong>47.1</strong></td>
<td><strong>172 - 477</strong></td>
<td><strong>1.87</strong></td>
</tr>
</tbody>
</table>

Figure 21 Sightings of roan 2019

The population trend since 2013 is not statistically significant.

Table 29. Estimates of roan numbers since 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>364</td>
<td>63.40</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>345</td>
<td>84.80</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>662</td>
<td>46.60</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>325</td>
<td>47.10</td>
<td>This report</td>
</tr>
</tbody>
</table>
2.17. Sable antelope

Table 30. Estimates of Sable Antelope

<table>
<thead>
<tr>
<th>Area</th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>852</td>
<td>263</td>
<td>157</td>
<td>51.6</td>
<td>412 - 1292</td>
<td>73.31</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>19</td>
<td>2</td>
<td>0</td>
<td>195.0</td>
<td>2 - 56</td>
<td>0.5</td>
</tr>
<tr>
<td>Susuwe</td>
<td>839</td>
<td>239</td>
<td>55</td>
<td>39.3</td>
<td>509 - 1169</td>
<td>73.98</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>220</td>
<td>45</td>
<td>18</td>
<td>111.2</td>
<td>45 - 465</td>
<td>14.55</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>181</td>
<td>19</td>
<td>0</td>
<td>188.3</td>
<td>19 - 522</td>
<td>3.8</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>26</td>
<td>8</td>
<td>0</td>
<td>180.4</td>
<td>8 - 72</td>
<td>0.83</td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>2137</strong></td>
<td><strong>576</strong></td>
<td><strong>230</strong></td>
<td><strong>31.2</strong></td>
<td><strong>1470 - 2803</strong></td>
<td><strong>12.29</strong></td>
</tr>
</tbody>
</table>

The population trend since 2013 is not statistically significant.

Table 31. Estimates of sable numbers since 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>690</td>
<td>48.40</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>1970</td>
<td>45.40</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>1458</td>
<td>32.50</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>2137</td>
<td>31.20</td>
<td>This report</td>
</tr>
</tbody>
</table>

Figure 22 Sightings of sable 2019
### 2.18. Steenbok

**Table 32. Estimates of Steenbok**

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>100.3</td>
<td>3 - 20</td>
<td>0.85</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>29</td>
<td>3</td>
<td>0</td>
<td>109.6</td>
<td>3 - 60</td>
<td>0.76</td>
</tr>
<tr>
<td>Susuwe</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>145.3</td>
<td>2 - 18</td>
<td>0.65</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>190.2</td>
<td>1 - 28</td>
<td>0.2</td>
</tr>
<tr>
<td>East Zambesi South</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>187.0</td>
<td>1 - 27</td>
<td>0.31</td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td>65</td>
<td>10</td>
<td>0</td>
<td>64.3</td>
<td>23 - 107</td>
<td>0.37</td>
</tr>
</tbody>
</table>

**Figure 23** Sightings of steenbok 2019
2.19. Tsessebe

Table 33. Estimates of Tsessebe

<table>
<thead>
<tr>
<th>Location</th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>22</td>
<td>7</td>
<td>0</td>
<td>188.3</td>
<td>7 - 62</td>
<td>1.86</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>48</td>
<td>5</td>
<td>0</td>
<td>192.2</td>
<td>5 - 139</td>
<td>1.26</td>
</tr>
<tr>
<td>Susuwe</td>
<td>39</td>
<td>11</td>
<td>1</td>
<td>132.8</td>
<td>11 - 91</td>
<td>3.45</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>108</strong></td>
<td><strong>23</strong></td>
<td><strong>1</strong></td>
<td><strong>100.1</strong></td>
<td><strong>23 - 217</strong></td>
<td><strong>0.62</strong></td>
</tr>
</tbody>
</table>

The population trend since 2013 is not statistically significant.

Table 34. Estimates of tsessebe numbers since 2013

<table>
<thead>
<tr>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>275</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>87</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>36</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>108</td>
<td>This report</td>
</tr>
</tbody>
</table>

Figure 24 Sightings of tsessebe 2019
### 2.20. Warthog

The number of warthog estimated in 2019 was almost identical to the 2015 estimate.

**Table 35. Estimates of Warthog**

<table>
<thead>
<tr>
<th>Area</th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>235</td>
<td>72</td>
<td>5</td>
<td>60.9</td>
<td>92 - 379</td>
<td>20.25</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>48</td>
<td>5</td>
<td>0</td>
<td>192.2</td>
<td>5 - 139</td>
<td>1.26</td>
</tr>
<tr>
<td>Susuwe</td>
<td>187</td>
<td>56</td>
<td>0</td>
<td>35.1</td>
<td>121 - 252</td>
<td>16.46</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>537</td>
<td>108</td>
<td>2</td>
<td>65.5</td>
<td>185 - 889</td>
<td>35.48</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>56</td>
<td>17</td>
<td>0</td>
<td>145.3</td>
<td>17 - 137</td>
<td>1.17</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>60</td>
<td>13</td>
<td>0</td>
<td>114.3</td>
<td>13 - 130</td>
<td>1.95</td>
</tr>
<tr>
<td>Salambala</td>
<td>12</td>
<td>5</td>
<td>0</td>
<td>187.1</td>
<td>5 - 35</td>
<td>0.99</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>1135</strong></td>
<td><strong>276</strong></td>
<td><strong>7</strong></td>
<td><strong>34.7</strong></td>
<td><strong>742 - 1529</strong></td>
<td><strong>6.53</strong></td>
</tr>
</tbody>
</table>

The population trend since 2013 is not statistically significant.

**Table 36. Estimates of warthog numbers since 2013**

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>1385</td>
<td>35.80</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>800</td>
<td>30.20</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>1124</td>
<td>43.40</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>1135</td>
<td>34.70</td>
<td>This report</td>
</tr>
</tbody>
</table>

**Figure 25** Sightings of warthog 2019
### 2.21. Waterbuck

#### Table 37. Estimates of Waterbuck

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>72</td>
<td>22</td>
<td>0</td>
<td>98.3</td>
<td>22 - 142</td>
<td>6.16</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susiwe</td>
<td>27</td>
<td>6</td>
<td>0</td>
<td>176.7</td>
<td>6 - 74</td>
<td>2.35</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>66</td>
<td>14</td>
<td>28</td>
<td>120.2</td>
<td>14 - 145</td>
<td>4.36</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salambala</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>186.8</td>
<td>3 - 21</td>
<td>0.58</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>171</strong></td>
<td><strong>45</strong></td>
<td><strong>28</strong></td>
<td><strong>64.9</strong></td>
<td><strong>60 - 283</strong></td>
<td><strong>0.99</strong></td>
</tr>
</tbody>
</table>

The population trend since 2013 is not statistically significant.

#### Table 38. Estimates of Waterbuck numbers since 2013

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>20</td>
<td>174.10</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>58</td>
<td>101.00</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>344</td>
<td>113.40</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>171</td>
<td>64.90</td>
<td>This report</td>
</tr>
</tbody>
</table>

**Figure 26** Sightings of waterbuck 2019
2.22. Wildebeest

Table 39. Estimates of Wildebeest

<table>
<thead>
<tr>
<th>Location</th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>93</td>
<td>30</td>
<td>0</td>
<td>183.4</td>
<td>30 - 263</td>
<td>7.98</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susuwe</td>
<td>56</td>
<td>16</td>
<td>4</td>
<td>114.9</td>
<td>16 - 121</td>
<td>4.98</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>265</td>
<td>55</td>
<td>20</td>
<td>127.9</td>
<td>55 - 605</td>
<td>17.54</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>171</td>
<td>55</td>
<td>4</td>
<td>188.8</td>
<td>55 - 495</td>
<td>3.59</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>792</td>
<td>248</td>
<td>126</td>
<td>118.9</td>
<td>248 - 1733</td>
<td>25.55</td>
</tr>
<tr>
<td>Salambala</td>
<td>105</td>
<td>45</td>
<td>0</td>
<td>136.8</td>
<td>45 - 249</td>
<td>8.44</td>
</tr>
<tr>
<td>Overall</td>
<td>1483</td>
<td>449</td>
<td>154</td>
<td>71.6</td>
<td>449 - 2545</td>
<td>8.53</td>
</tr>
</tbody>
</table>

The population trend since 2013 is not statistically significant.

Table 40. Estimates of wildebeest numbers since 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>317</td>
<td>72.60</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>1554</td>
<td>74.20</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>1687</td>
<td>85.60</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>1483</td>
<td>71.60</td>
<td>This report</td>
</tr>
</tbody>
</table>
2.23. Zebra

Zebra numbers in 2019 were double the 2015 estimates (4856 ± 81.8) and they were more widely distributed (Figs 28 & 29). They were seen in grasslands near water but appear to avoid human habitation. In 2013 there were no zebra seen along the Chobe river or any of the eastern Zambezi floodplains which were flooded and the estimated number was very low.

Table 41. Estimates of Zebra

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>192</td>
<td>58</td>
<td>28</td>
<td>64.9</td>
<td>67 - 316</td>
<td>16.48</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>29</td>
<td>3</td>
<td>0</td>
<td>192.1</td>
<td>3 - 84</td>
<td>0.76</td>
</tr>
<tr>
<td>Susuwe</td>
<td>731</td>
<td>210</td>
<td>68</td>
<td>56.0</td>
<td>322 - 1140</td>
<td>64.47</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>957</td>
<td>194</td>
<td>59</td>
<td>74.4</td>
<td>245 - 1669</td>
<td>63.25</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>1412</td>
<td>433</td>
<td>250</td>
<td>96.7</td>
<td>433 - 2778</td>
<td>29.6</td>
</tr>
<tr>
<td>East Zambesi South</td>
<td>4864</td>
<td>867</td>
<td>897</td>
<td>78.2</td>
<td>1058 - 8669</td>
<td>156.95</td>
</tr>
<tr>
<td>Salambala</td>
<td>2582</td>
<td>1079</td>
<td>1563</td>
<td>48.6</td>
<td>1326 - 3838</td>
<td>207.42</td>
</tr>
<tr>
<td>Overall</td>
<td>10767</td>
<td>2844</td>
<td>2865</td>
<td>39.6</td>
<td>6501 - 15032</td>
<td>61.95</td>
</tr>
</tbody>
</table>

Figure 28 Sightings of zebra 2019

Table 42. Estimates of zebra numbers since 2013

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>1421</td>
<td>44.50</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>5435</td>
<td>61.20</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>4856</td>
<td>81.80</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>10767</td>
<td>39.60</td>
<td>This report</td>
</tr>
</tbody>
</table>

Although the trend is not statistically significant, the zebra population appears to have increased at a rate of 16.7% since 2014. They were increasingly widespread from 2014.
2.24. Carnivores

Too few carnivores were seen to provide population estimates. 4 hyaena, 4 black-backed jackal and 2 lions were observed during the survey.

2.25. Crocodiles

Table 43. Estimates of Crocodile

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>215</td>
<td>67</td>
<td>0</td>
<td>45.5</td>
<td>117 - 313</td>
<td>18.53</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susuwe</td>
<td>91</td>
<td>29</td>
<td>0</td>
<td>47.1</td>
<td>48 - 134</td>
<td>8.04</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>45</td>
<td>9</td>
<td>3</td>
<td>153.6</td>
<td>9 - 114</td>
<td>2.98</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>184.6</td>
<td>1 - 9</td>
<td>0.07</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salambala</td>
<td>48</td>
<td>20</td>
<td>4</td>
<td>65.9</td>
<td>20 - 79</td>
<td>3.84</td>
</tr>
<tr>
<td>Overall</td>
<td>403</td>
<td>126</td>
<td>7</td>
<td>31.1</td>
<td>277 - 528</td>
<td>2.32</td>
</tr>
</tbody>
</table>

Crocodiles were seen in most water bodies. Sample counts are not suitable for estimating numbers of crocodiles, which are underestimated. However precision is reasonable so estimates, which are given despite the counting bias, could be useful indices of numbers. The trend in estimated numbers since 2013 is not statistically significant.

Table 44. Estimates of crocodiles numbers since 2013

<table>
<thead>
<tr>
<th></th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>557</td>
<td>47.10</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>651</td>
<td>29.70</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>707</td>
<td>35.40</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>403</td>
<td>31.10</td>
<td>This report</td>
</tr>
</tbody>
</table>

Figure 30 Sightings of crocodile 2019

Figure 29 Sightings of zebra 2015
2.26. Carcasses of species other than elephant

Decay stages of carcasses described for elephants in Appendix II below were used to classify carcasses of other species. It isn’t possible to identify the species of many of these carcasses and some may be elephants.

Table 45. Estimates of carcasses of species other than elephants

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcass 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo / Mahango</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>130.0</td>
<td>2 - 15</td>
<td>0.56</td>
</tr>
<tr>
<td>Kwando</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>198.7</td>
<td>1 - 15</td>
<td>0.34</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>191.0</td>
<td>1 - 9</td>
<td>0.07</td>
</tr>
<tr>
<td>Salambala</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>141.7</td>
<td>3 - 18</td>
<td>0.58</td>
</tr>
<tr>
<td>Carcass 1 Overall</td>
<td>22</td>
<td>7</td>
<td>0</td>
<td>78.3</td>
<td>7 - 39</td>
<td>0.13</td>
</tr>
<tr>
<td>Carcass 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo / Mahango</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>138.0</td>
<td>3 - 24</td>
<td>0.85</td>
</tr>
<tr>
<td>Susuwe</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>144.5</td>
<td>3 - 18</td>
<td>0.66</td>
</tr>
<tr>
<td>Kwando</td>
<td>35</td>
<td>7</td>
<td>0</td>
<td>99.0</td>
<td>7 - 70</td>
<td>2.33</td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>22</td>
<td>3</td>
<td>0</td>
<td>116.2</td>
<td>3 - 48</td>
<td>0.72</td>
</tr>
<tr>
<td>Salambala</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>134.6</td>
<td>2 - 11</td>
<td>0.38</td>
</tr>
<tr>
<td>Carcass 2 Overall</td>
<td>80</td>
<td>18</td>
<td>0</td>
<td>57.3</td>
<td>34 - 125</td>
<td>0.46</td>
</tr>
<tr>
<td>Carcass 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo / Mahango</td>
<td>13</td>
<td>4</td>
<td>0</td>
<td>79.3</td>
<td>4 - 23</td>
<td>1.10</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>10</td>
<td>1</td>
<td>0</td>
<td>192.1</td>
<td>1 - 28</td>
<td>0.25</td>
</tr>
<tr>
<td>Susuwe</td>
<td>15</td>
<td>4</td>
<td>0</td>
<td>94.9</td>
<td>4 - 29</td>
<td>1.30</td>
</tr>
<tr>
<td>Kwando</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>188.7</td>
<td>1 - 14</td>
<td>0.31</td>
</tr>
<tr>
<td>Salambala</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>133.6</td>
<td>2 - 11</td>
<td>0.37</td>
</tr>
<tr>
<td>Carcass 3 Overall</td>
<td>46</td>
<td>12</td>
<td>0</td>
<td>56.8</td>
<td>20 - 73</td>
<td>0.27</td>
</tr>
<tr>
<td>Carcass 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo / Mahango</td>
<td>29</td>
<td>9</td>
<td>0</td>
<td>84.2</td>
<td>10 - 48</td>
<td>2.48</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>29</td>
<td>3</td>
<td>0</td>
<td>106.7</td>
<td>3 - 59</td>
<td>0.76</td>
</tr>
<tr>
<td>Susuwe</td>
<td>47</td>
<td>15</td>
<td>1</td>
<td>44.0</td>
<td>26 - 67</td>
<td>4.13</td>
</tr>
<tr>
<td>Kwando</td>
<td>60</td>
<td>12</td>
<td>0</td>
<td>63.1</td>
<td>22 - 98</td>
<td>3.98</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>13</td>
<td>2</td>
<td>0</td>
<td>148.9</td>
<td>2 - 32</td>
<td>0.27</td>
</tr>
<tr>
<td>Salambala</td>
<td>14</td>
<td>6</td>
<td>0</td>
<td>75.8</td>
<td>6 - 25</td>
<td>1.13</td>
</tr>
<tr>
<td>Overall</td>
<td>191</td>
<td>47</td>
<td>1</td>
<td>30.3</td>
<td>133 - 249</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Figure 31 Sightings of carcasses (other than elephants) 2019
2.27. Ground Hornbill

Ground hornbills were only seen in the east of the region in small numbers. The estimated number was small, much lower than in 2015 and imprecise. The sighting mapped in Bwabwata was casual, i.e. not on a transect.

Table 46. Estimates of ground hornbill

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bwabwata</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Susuwe</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi South</td>
<td>29</td>
<td>3</td>
<td>0</td>
<td>188.1</td>
<td>3 - 82</td>
<td>0.92</td>
</tr>
<tr>
<td>Salambala</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>189.2</td>
<td>1 - 7</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>31</strong></td>
<td><strong>4</strong></td>
<td><strong>0</strong></td>
<td><strong>172.1</strong></td>
<td><strong>4 - 84</strong></td>
<td><strong>0.18</strong></td>
</tr>
</tbody>
</table>

The trend in estimated numbers since 2013 is not statistically significant.

Table 47. Estimates of ground hornbill numbers since 2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>PRP%</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>95</td>
<td>89.60</td>
<td>Craig &amp; Gibson 2014</td>
</tr>
<tr>
<td>2014</td>
<td>5</td>
<td>49.70</td>
<td>Craig &amp; Gibson 2015</td>
</tr>
<tr>
<td>2015</td>
<td>207</td>
<td>64.80</td>
<td>Gibson &amp; Craig 2015</td>
</tr>
<tr>
<td>2019</td>
<td>31</td>
<td>172.10</td>
<td>This report</td>
</tr>
</tbody>
</table>
## 2.28. Ostrich

### Table 48. Estimates of ostrich

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo / Mahango</td>
<td>36</td>
<td>11</td>
<td>14</td>
<td>105.4</td>
<td>11 - 74</td>
<td>3.12</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>38</td>
<td>4</td>
<td>0</td>
<td>150.3</td>
<td>4 - 95</td>
<td>1.01</td>
</tr>
<tr>
<td>Susuwe</td>
<td>12</td>
<td>4</td>
<td>2</td>
<td>141.1</td>
<td>4 - 30</td>
<td>1.09</td>
</tr>
<tr>
<td>Kwando North</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>189.1</td>
<td>1 - 10</td>
<td>0.07</td>
</tr>
<tr>
<td>East Zambesi South</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0 - 0</td>
<td>0</td>
</tr>
<tr>
<td>Salambala</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>90</strong></td>
<td><strong>20</strong></td>
<td><strong>17</strong></td>
<td><strong>76.1</strong></td>
<td><strong>22 - 159</strong></td>
<td><strong>0.52</strong></td>
</tr>
</tbody>
</table>

*Figure 33* Sightings of ostrich 2019
2.29. Observations of Domestic Livestock

The estimated number of cattle was almost identical to the 2015 estimate. Numbers of sheep/goats were not significantly different from 2015. No donkeys were seen. Lack of livestock and human activities pick out areas with conservation potential, e.g. the wildlife management zone of Salambala conservancy.

Table 49. Estimates of domestic livestock

<table>
<thead>
<tr>
<th></th>
<th>Pop. Est.</th>
<th>No. in</th>
<th>No. out</th>
<th>PRP%</th>
<th>95% Range</th>
<th>No./100 km²</th>
</tr>
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<tbody>
<tr>
<td>Domestic Pig</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>100</td>
<td>31</td>
<td>0</td>
<td>138.8</td>
<td>31 - 239</td>
<td>2.09</td>
</tr>
<tr>
<td>Salambala</td>
<td>33</td>
<td>14</td>
<td>0</td>
<td>134.5</td>
<td>14 - 77</td>
<td>2.63</td>
</tr>
<tr>
<td><strong>Pigs Overall</strong></td>
<td>133</td>
<td>45</td>
<td>0</td>
<td>108.2</td>
<td>45 - 276</td>
<td>0.76</td>
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<td>Horses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bwabwata</td>
<td>29</td>
<td>3</td>
<td>0</td>
<td>192.1</td>
<td>3 - 84</td>
<td>0.76</td>
</tr>
<tr>
<td>East Zambesi South</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>180.5</td>
<td>1 - 9</td>
<td>0.11</td>
</tr>
<tr>
<td><strong>Horses Overall</strong></td>
<td>32</td>
<td>4</td>
<td>0</td>
<td>167.6</td>
<td>4 - 85</td>
<td>0.18</td>
</tr>
<tr>
<td>Sheep and/or Goats</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo / Mahango</td>
<td>338</td>
<td>108</td>
<td>0</td>
<td>177.8</td>
<td>108 - 939</td>
<td>29.08</td>
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<tr>
<td>Bwabwata</td>
<td>315</td>
<td>33</td>
<td>0</td>
<td>128.6</td>
<td>33 - 719</td>
<td>8.31</td>
</tr>
<tr>
<td>Kwando</td>
<td>374</td>
<td>77</td>
<td>0</td>
<td>101.5</td>
<td>77 - 753</td>
<td>24.69</td>
</tr>
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<td>East Zambezi North</td>
<td>2274</td>
<td>277</td>
<td>0</td>
<td>51.2</td>
<td>1111 - 3438</td>
<td>47.66</td>
</tr>
<tr>
<td>East Zambesi South</td>
<td>3211</td>
<td>482</td>
<td>38</td>
<td>43.6</td>
<td>1810 - 4611</td>
<td>103.61</td>
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<tr>
<td>Salambala</td>
<td>327</td>
<td>137</td>
<td>18</td>
<td>71.8</td>
<td>137 - 562</td>
<td>26.28</td>
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<tr>
<td><strong>Shoats Overall</strong></td>
<td>6838</td>
<td>1114</td>
<td>56</td>
<td>28.9</td>
<td>4862 - 8815</td>
<td>39.35</td>
</tr>
<tr>
<td>Cattle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo / Mahango</td>
<td>383</td>
<td>115</td>
<td>73</td>
<td>87.6</td>
<td>115 - 719</td>
<td>32.96</td>
</tr>
<tr>
<td>Bwabwata</td>
<td>1679</td>
<td>176</td>
<td>47</td>
<td>128.6</td>
<td>176 - 3838</td>
<td>44.3</td>
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<tr>
<td>Susuwe</td>
<td>891</td>
<td>284</td>
<td>20</td>
<td>54.8</td>
<td>403 - 1379</td>
<td>78.59</td>
</tr>
<tr>
<td>Kwando North</td>
<td>4748</td>
<td>546</td>
<td>0</td>
<td>64.9</td>
<td>1667 - 7829</td>
<td>712.93</td>
</tr>
<tr>
<td>Kwando</td>
<td>5839</td>
<td>1194</td>
<td>210</td>
<td>57.9</td>
<td>2460 - 9218</td>
<td>385.95</td>
</tr>
<tr>
<td>East Zambezi North</td>
<td>55292</td>
<td>11102</td>
<td>4981</td>
<td>13.9</td>
<td>47605 - 62980</td>
<td>1158.69</td>
</tr>
<tr>
<td>East Zambesi South</td>
<td>41695</td>
<td>6307</td>
<td>2879</td>
<td>30.1</td>
<td>29132 - 54258</td>
<td>1345.42</td>
</tr>
<tr>
<td>Salambala</td>
<td>25350</td>
<td>10680</td>
<td>8346</td>
<td>21.6</td>
<td>19877 - 30824</td>
<td>2036.17</td>
</tr>
<tr>
<td><strong>Cattle Overall</strong></td>
<td>135878</td>
<td>30404</td>
<td>16556</td>
<td>12.0</td>
<td>119628 - 152127</td>
<td>781.8</td>
</tr>
</tbody>
</table>

Figure 34 Sightings of domestic livestock 2019
2.30. Other Observations – human activity and settlement

![Map of villages, cultivation and cattle posts 2019](image)

**Figure 35** Sightings of villages, cultivation and cattle posts 2019

2.31. Other Observations – fishing activities

As usual, canoes, fish traps and nets and fishing camps were seen on all water bodies of eastern Zambezi region. Many of the canoes were lying on dry land in seasonally flooded areas.

![Map of fishing activities 2019](image)

**Figure 36** Sightings of activities relevant to fishing 2019

2.32. Other Observations – fire

![Map of active fires 2019](image)

**Figure 37** Sightings of active fires 2019
3. RECOMMENDATIONS FOR SURVEY

3.1. General Recommendations

1. To enable monitoring of carcass numbers and carcass ratios from aerial surveys, carcasses should not be removed from the field. It is unnecessary and can be replaced by recording the exact location of carcasses on GPS. Carcasses could be stained/marked with paint as a backup.

2. Prior to any survey, information should be obtained from field staff/safari operators/tour operators and radio telemetry about likely distributions of animals, sources of disturbance etc.

3. MET should provide information about revised boundaries/land use etc prior to the planning of a survey.

4. MET should provide information about introduction of animals, particularly of species new to the area.

5. MET should provide information about issues of concern (eg dry water holes, possible declines of important species etc).

3.2. Precision

The survey area is stratified to optimise precision by allocating higher sampling intensities to areas with higher densities of elephants. Precision can be improved in future surveys by reviewing stratum boundaries and sampling intensities prior to each survey which should be revised based on previous results and local knowledge.

3.3. Frequency of Surveys

Confidence in the result of a survey does not just derive from the precision and accuracy of the current estimate but from the trend derived from this and previous surveys. Frequent surveys are essential to the success of a monitoring programme because:

- they enable earlier detection of any meaningful changes;
- regularity embeds routine surveys in the wider work programme and funding cycle and
- they provide results from which precise trends may be calculated and which improve cumulatively.

It is therefore recommended that surveys are carried out as often as possible. Frequent intensive surveys are more effective than infrequent intensive ones in achieving the desired results.
4. REFERENCES


APPENDIX I: METHODS


a. Survey design

As mentioned above, the same strata were used as those in previous surveys (eg Gibson & Craig 2015). Additional strata were added in the eastern Zambezi with the aim of improving the precision of estimates of zebra and other species (Fig.1).

b. Sampling intensity

Strata were sampled at intensities of 10%, 20% or 30%. Higher precision was required particularly for the core areas and for the eastern Zambezi region. In order to achieve sampling intensities of up to 30% for such areas, it would be necessary to space transects as little as 1.33 km apart. With strip widths of 200m per side and a 100m dead zone under the aircraft, this would leave a distance between transects of 833m outside the strip markers. Any deviation from track could cause double counting, as well as disturbing animals on adjacent transects and assumptions made in the calculation of precision would be violated. Transects in these strata (eg Susuwe) were therefore divided into interleaved sets (eg Susuwe A, B & C), each representing a separate 10% coverage, the results of which were combined in the final analysis. This had the additional advantage that in the event of the survey not being completed, a full coverage might still be available, albeit at a lower sampling intensity.

To accommodate the overlap between the Rooikat south and East Zambezi South, the south-eastern and south-western strata were flown together but separated for analysis (see Table 50). Where the estimated numbers of animals were calculated as a mean of the individual estimates, the combined variances were calculated as \( V = \frac{\Sigma v}{n} \) (\( n \) is the number of surveys).

c. Selection of transects

Transects were evenly spaced according to the required sampling intensity from a randomly chosen start point and oriented at right angles to major features (eg rivers) in each stratum, as far as possible (Fig. 38).
Figure 38 Transects selected for the 2019 survey
d. **Calibration**

Sampling strips were demarcated by rods attached to the lift struts on each side of the aircraft.

These were calibrated for each observer by flying at varying heights across numbers marked 10m apart on a level airstrip (Fig 39).

![Figure 39 Calibration of observation strips](image)

The observers called the inner and outer numbers seen between the rods. The difference + 10 between these numbers gave a distance that was adjusted for 300 ft a.g.l. and the mean used as the calibrated strip width for each observer.

e. **Data collection**

The aircraft, a Cessna 182 was flown at a nominal height of 300 feet above ground level along the transects. Height was maintained using a Lightware SF11 laser rangefinder fitted in the starboard wing of the aircraft (Fig. 40). A backup SF30 laser rangefinder was also installed in the wing in case of equipment failure.

![Figure 40 Installation of laser rangefinders in the aircraft wing](image)
Data from the rangefinder were streamed to a tablet in which the Vulcan Flightlogger App was installed to interpret and display it (Fig 41).

All incoming heights, speeds and location information were recorded at 1 second intervals for use in later analyses along with a time-stamp for each record.

Accurate navigation along each transect was achieved using an up-loaded display of transect coordinates using the Forelight App on an ipad. Tracklogs of all flights were recorded in both the Garmin GPS and the Vulcan Flightlogger. The observers called out animals and other parameters seen from their fixed positions in the rear seats. They distinguished between sightings within and outside the sampling rods. This information was recorded by the front seat observer on paper datasheets. The position of each sighting was “marked” in a Garmin 64S GPS.

**f. Searching rate**

The searching rate (km²/min) was calculated for each transect and the mean for each stratum provided as an objective indication the survey quality.

**g. Data analysis**

Jolly’s (1969) method for blocks of unequal size was used to calculate estimates of density and variance for each species in each stratum as follows:

\[
R = \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} z_i}
\]

\[
\hat{Y} = Z \cdot R
\]

\[
V_Y = \frac{N(N-n)}{n} \cdot (s_Y^2 - 2Rs_Ys_Y + R^2s_Y^2)
\]
where:

\[ R \] = density of animals
\[ Y \] = total number estimated
\[ Z \] = total area of stratum
\[ y_i \] = number of animals counted in transect \( i \)
\[ z_i \] = area of transect \( i \)
\[ n \] = number of transects
\[ N \] = number of transects possible in stratum where \( N = n.Z/\Sigma z \)
\[ s_y^2 \] = variance of number seen per transect
\[ s_z^2 \] = variance of transect areas
\[ s_{zy} \] = covariance between number seen per transect and transect area
\[ V_y \] = variance of estimated number in stratum (i.e. variance of \( Y \))

The standard error (SE) of the estimate is the square root of the variance and the 95% confidence limits of the estimate is \( Y \pm t \cdot SE \), where \( t \) is Student’s \( t \) for a two-tailed probability of 0.05 and \( n-1 \) degrees of freedom.

Overall estimates and variances were obtained from the sums of the stratum estimates and their variances. In the analysis the results of different strata were added to give estimates for higher units. Table 50, Appendix IIb, shows how stratum estimates were combined.

The term \( N(N-n)/n \) approaches zero as sampling intensity approaches 100%. Its application makes the assumption that all animals in the sample are seen once. This is violated if animals can move between transects during the survey, as can happen if transects are closely spaced or the survey cannot be completed in one flight. This is why some strata have repeated samples at 10%, rather than a single coverage at a higher intensity (see below). For example three 10% samples are the equivalent of a 30% sampling intensity to produce an overall estimate from the mean of the three resultant estimates. When merging separate coverages to give a mean estimate, the estimated numbers of animals were calculated as a mean of the individual estimates. Combined variances were calculated as \( V= \Sigma v/n^2 \) where \( n \) is the number of surveys.

**h. Calculation of heights above ground level**

Data streamed from the laser rangefinder was captured by the Flightlogger app. A height record was acquired every second along with a date/time stamp and GPS location. These data were downloaded into MS Excel for analysis.
i. **Elephant sightings, carcass classification and ratios**

Elephants were recorded as being in family groups or bull groups, defined as follows:

- **Family groups** - herds in which females and young are present. Any bulls in the group are counted as part of the group.
- **Bull groups** - single bulls or herds which contain no females or juveniles.

Carcasses were classified into four categories according to their estimated time since death (Douglas-Hamilton & Hillman 1981; Douglas-Hamilton & Burril 1991).

The four classes are:

- **Carcass 1** - Fresh (<1 month): skin covered, with flesh present giving the body a rounded appearance; vultures often present; ground still moist from body fluids.
- **Carcass 2** - Recent (<1 year): rot patch still visible; hide still attached to carcass; bones not scattered.
- **Carcass 3** - Old (>1 year): skin absent; bones not scattered; vegetation re-grown in rot patch.
- **Carcass 4** - Very old (up to 10 years): bones bleached and scattered.

The estimated time since death of carcasses may vary between regions as the rate of decomposition depends on a number of factors such as moisture and temperature.

A “carcass ratio” defined as the ratio of dead elephants to all elephants (dead plus live animals). Douglas-Hamilton et al. (Douglas-Hamilton & Hillman 1981; Douglas-Hamilton & Burril 1991) suggest a carcass ratio of 2 - 8% as being normal for a stable or increasing population, while a ratio of over 9% indicates a declining population.

j. **Mapping wildlife distribution**

For most species, the positions of the sightings were simply plotted on a map of the area without accounting for the relative numbers of animals per sighting or the sampling intensity at which the sighting was made.

A contoured map was produced to show the distribution of elephant densities. This was done by calculating the density of animals in cells measuring 1/30 degrees. These cells were filtered using a moving average. Empty cells were filled using Voronoi polygons surrounding the nearest filled cells. Resolution was doubled four times, filtering each time and cell values were converted to integer values of $\log_2$ density. Contours were produced by shading according to $\log_2$ density. This results in density doubling for each contour.
APPENDIX II: GENERAL SURVEY INFORMATION

The survey crew comprised R. Odendaal (pilot), C. Craig (front-seat recorder/coordinator), N. Chitemamuswe (left hand observer) and F. Muroki (right hand observer), M. Brassine (data capture/alternative right hand observer/driver), T. Sirika (ground support/cook/driver).

Supporting data indicating survey quality are given below.
a. *Transect track logs*

Flight paths (track logs) are shown in Fig 43.

**Figure 43** Tracks flown on the 2019 Zambezi survey
### Stratum statistics

#### Table 50. Stratum combinations for analysis, with sampling intensities and areas of strata

<table>
<thead>
<tr>
<th>STRATUM NAME</th>
<th>STRATUM CODES</th>
<th>Sampling intensity</th>
<th>Area km²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ZAMBEZI REGION OVERALL</strong></td>
<td></td>
<td></td>
<td>17380</td>
</tr>
<tr>
<td>Buffalo/Mahango Mean</td>
<td>(BUFA, BUFB, BUFC)</td>
<td></td>
<td>1162</td>
</tr>
<tr>
<td>Mahango + Buffalo A</td>
<td>BUFA</td>
<td>10.79%</td>
<td></td>
</tr>
<tr>
<td>Mahango + Buffalo B</td>
<td>BUFB</td>
<td>10.34%</td>
<td></td>
</tr>
<tr>
<td>Mahango + Buffalo C</td>
<td>BUFC</td>
<td>9.77%</td>
<td></td>
</tr>
<tr>
<td><strong>Bwabwata General Use Area</strong></td>
<td>BAB</td>
<td>10.48%</td>
<td>3789</td>
</tr>
<tr>
<td><strong>Kwando Core Area Mean</strong></td>
<td>(SUSA(Mean), SUSC)</td>
<td></td>
<td>1134</td>
</tr>
<tr>
<td>Kwando Core Area Mean</td>
<td>SUSA, SUSAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando Core Area</td>
<td>SUSA</td>
<td>9.97%</td>
<td></td>
</tr>
<tr>
<td>Kwando Core Area</td>
<td>SUSAR</td>
<td>10.13%</td>
<td></td>
</tr>
<tr>
<td>Kwando Core Area C</td>
<td>SUSC</td>
<td>10.32%</td>
<td></td>
</tr>
<tr>
<td><strong>Kwando Overall</strong></td>
<td>KW (Mean) + KWN</td>
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<td>2179</td>
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<tr>
<td>Kwando Mean</td>
<td>(KWA, KWB)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwando A</td>
<td>KWA</td>
<td>10.62%</td>
<td></td>
</tr>
<tr>
<td>Kwando B</td>
<td>KWB</td>
<td>9.68%</td>
<td></td>
</tr>
<tr>
<td>Kwando North</td>
<td>KWN</td>
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<td></td>
</tr>
<tr>
<td><strong>East Zambezi North</strong></td>
<td>(ECNW + RKN)</td>
<td></td>
<td>4772</td>
</tr>
<tr>
<td>East Zambezi North (West part)</td>
<td>ECNW</td>
<td>10.49%</td>
<td></td>
</tr>
<tr>
<td>Rooikat North Mean</td>
<td>(ECNE, RKNA, RKNB)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi North (East part)</td>
<td>ECNE</td>
<td>10.08%</td>
<td></td>
</tr>
<tr>
<td>Rooikat North A</td>
<td>RKNA</td>
<td>10.13%</td>
<td></td>
</tr>
<tr>
<td>Rooikat North B</td>
<td>RKNB</td>
<td>10.70%</td>
<td></td>
</tr>
<tr>
<td><strong>East Zambezi South</strong></td>
<td>(ECSW + Rooikat S Mean)</td>
<td></td>
<td>3099</td>
</tr>
<tr>
<td>East Zambezi South - W part</td>
<td>ECSW</td>
<td>10.52%</td>
<td></td>
</tr>
<tr>
<td>Rooikat South Mean</td>
<td>(ECSE, RKSAM, RKSBW)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Zambezi South - E part</td>
<td>ECSE</td>
<td>10.52%</td>
<td></td>
</tr>
<tr>
<td>Rooikat South A W part</td>
<td>RKSAM</td>
<td>10.42%</td>
<td></td>
</tr>
<tr>
<td>Rooikat South B W part</td>
<td>RKSBW</td>
<td>10.18%</td>
<td></td>
</tr>
<tr>
<td><strong>Salambala Mean</strong></td>
<td>(SALA, SALB, RKSAM, RKSBE)</td>
<td></td>
<td>1245</td>
</tr>
<tr>
<td>Rooikat South A - East Part</td>
<td>RKSAM</td>
<td>10.42%</td>
<td></td>
</tr>
<tr>
<td>Rooikat South B - East Part</td>
<td>RKSBE</td>
<td>10.18%</td>
<td></td>
</tr>
<tr>
<td>Salambala-Impalila A</td>
<td>SALA</td>
<td>10.63%</td>
<td></td>
</tr>
<tr>
<td>Salambala-Impalila B</td>
<td>SALB</td>
<td>10.99%</td>
<td></td>
</tr>
</tbody>
</table>
### Table 51. Stratum statistics:

Area = km² ; No. trans = number of transects in stratum; SI% = sampling intensity; trans time = total flight time on transects; length = total length of transects (km); GS=ground speed (knots); SR=search rate (km²/min)

Mean heights and speeds are calculated from the flight log (148549 records)

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Area</th>
<th>No. Trans</th>
<th>SI%</th>
<th>Trans time</th>
<th>Stratum time</th>
<th>Sample area</th>
<th>Length</th>
<th>GS</th>
<th>SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bwabwata</td>
<td>3789</td>
<td>33</td>
<td>10.4</td>
<td>5.55</td>
<td>6.05</td>
<td>394.5</td>
<td>965.06</td>
<td>93.91</td>
<td>1.18</td>
</tr>
<tr>
<td>Buffalo/Mahango A</td>
<td>1162</td>
<td>8</td>
<td></td>
<td>1.77</td>
<td>2.43</td>
<td>123.9</td>
<td>301.69</td>
<td>92.23</td>
<td>1.17</td>
</tr>
<tr>
<td>Buffalo/Mahango B</td>
<td>1162</td>
<td>9</td>
<td>30.5</td>
<td>1.65</td>
<td>2.13</td>
<td>118.7</td>
<td>289.01</td>
<td>94.88</td>
<td>1.20</td>
</tr>
<tr>
<td>Buffalo/Mahango C</td>
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c. **Calculation of strip width**

The results of the strip width calibration are given below. Messrs Muroki and Chitemamuswe were left and right observers respectively. Ms Brassine replaced Mr Muroki on the left for a few strata.

These calibrated strip widths were used for both the Zambezi Region and the Khaudum/Nyae Nyae surveys.
### Calibration (Team 1) V5 WOT (Left Muroki, Right Chitemamuswe)

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<th>out</th>
<th>in</th>
<th>out</th>
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<th>WIDTH CORRECTED</th>
<th>TOTAL WIDTH</th>
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Mean 201.23 209.48 410.72

Var 586.490838
Varmn 29.3245419
SEmn 5.41521393
t 2.09302405
PRP% 2.7596136

### Calibration (Team 2) V5 WOT (Left Brassine, Right Chitemamuswe)

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Mean 191.83 209.62 401.45

Var 479.102057
Varmn 36.8540044
SEmn 6.0707499
t 2.09302405
PRP% 3.16511099
Figure 44 Callibration of observers

Figure 45 Relationship of laser altimeter and pressure altimeter (ft. a.g.l.)
d. Maintenance of height

The target height was 300 feet above ground level (a.g.l.). Heights were calculated from individual heights recorded every second from the laser rangefinder. The mean height flown for the whole survey was 302.2 feet a.g.l. 95% of heights were within a predicted 30 feet of this value. The related statistics for the Zambezi survey are given in the table below and summarised in the following frequency histogram below.

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The true standard deviation in height must be less as there is variation due to instrument error that has not been allowed for.
e. **Flight speeds**

Flying speed was kept to below 103 knots (190km/hour). The mean speeds and related statistics are presented in the following table and frequency histogram.

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The outlying peak of high speeds to the right were due to increasing the speed for the final strata in order to finish on time.
### f. Comparison of observers

Comparisons of observers included data from both the Zambezi Region survey and the Khaudum/Nyae Nyae survey.

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<th>EXPECTED</th>
<th>CHI SQ</th>
<th>Prob</th>
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Aerial survey of elephants & other wildlife in Zambezi Region  
Sep/Oct 2019
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APPENDIX III: RESULTS BY STRATUM

Estimates of numbers, densities and confidence limits

The following tables give the results for each stratum based on the numbers seen in the sample. Results for all species and attributes counted are given. For species or attributes where no meaningful estimate can be given, only number seen is reported. “No. in” is the number of animals seen in the sampling strips. “No. out” is the number seen outside of them.

SI refers to the sampling intensity for the stratum. Column 6, labelled PRP (Percent Relative Precision), is the 95% confidence interval/2 expressed as a percentage of the estimate. Where the calculated lower limit of the confidence range is less than the number actually seen in the stratum (including all sightings, both in and out), the number seen is given as the lower limit of the range.

The individual stratum results and their combinations give higher level results as reported above (see Appendix II, Table 50). Where the overall result for a stratum is the result of separate coverages, the overall result follows the component coverages except for the overall result for the survey, which is presented first.
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### Aerial survey of elephants & other wildlife in Zambezi Region

#### Sep/Oct 2019

**BUFA : Mahango + Buffalo A**  
Area: 1162 km²  
Sampling Intensity: 10.78983%

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### Aerial survey of elephants & other wildlife in Zambezi Region

#### BUFB: Mahango + Buffalo B

- **Area:** 1162 km²
- **Sampling Intensity:** 10.34062%

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<th>Pop. est.</th>
<th>No. seen</th>
<th>No. Out</th>
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BUFC : Mahango + Buffalo C  
Area:  1162 km²  
Sampling Intensity: 9.766%  

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## Aerial survey of elephants & other wildlife in Zambezi Region
### Sep/Oct 2019

**Buffalo / Mahango Mean (BUFA,BUFB,BUFC)**  
**Area:** 1162 km²

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<th>No. seen</th>
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Aerial survey of elephants & other wildlife in Zambezi Region

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### Aerial survey of elephants & other wildlife in Zambezi Region

#### SUSAR:  Kwando Core Area
- **Area:** 1134 km²
- **Sampling Intensity:** 10.125%

#### Species and Population Estimates

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**Aerial survey of elephants & other wildlife in Zambezi Region**

**Sep/Oct 2019**
### Aerial survey of elephants & other wildlife in Zambezi Region

**Sep/Oct 2019**

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<th>No. seen</th>
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## Aerial survey of elephants & other wildlife in Zambezi Region

### Area: 1134 km²  Sampling Intensity: 10.322%

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## Aerial survey of elephants & other wildlife in Zambezi Region  
**Sep/Oct 2019**

**Kwando Core Area Mean (SUSA(Mn),SUSC) Area: 1134 km²**

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Aerial survey of elephants & other wildlife in Zambezi Region

KWA : Kwando A
Area: 1513 km²     Sampling Intensity: 10.615 %

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Area: 1513 km²

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### KWN : Kwando North  
Area: 666 km²  
Sampling Intensity: 11.499%

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**Aerial survey of elephants & other wildlife in Zambezi Region**  
**Sep/Oct 2019**
### Kwando Overall (Original MIKE site)

**Area:** 2179 km²

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### ECN: East Zambesi North (West part)
**Area:** 3984 km²  **Sampling Intensity:** 10.491%

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### ECNE: East Zambesi North (East part)
**Area:** 788 km²  **Sampling Intensity:** 10.075%

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<th>PRP%</th>
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### RKNA: Rooikat North A
**Area:** 788 km²  **Sampling Intensity:** 10.128%

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## Aerial survey of elephants & other wildlife in Zambezi Region

### Sep/Oct 2019

**RKNB : Rooikat North B**  
**Area:** 788 km²  
**Sampling Intensity:** 10.697%

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<th>No./100km²</th>
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**Rooikat North Mean (ECNE, RKNA,RKNB)  
Area: 788 km²**

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<th>Variance</th>
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<th>No./100km²</th>
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### East Zambezi North (ECNW + RKN) Area: 4772 km²

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### ECS : East Zambezi South - W part Area: 2381 km² Sampling Intensity: 10.523%

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Aerial survey of elephants & other wildlife in Zambezi Region Sep/Oct 2019
Aerial survey of elephants & other wildlife in Zambezi Region

**ECSE : East Zambesi South - E part**

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**RKSAW : Rooikat South A W part**

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Aerial survey of elephants & other wildlife in Zambezi Region  

**RKSBW : Rooikat South B  W part**  
**Area: 718 km²**  
**Sampling Intensity: 10.18%**

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**Rooikat South:  Mean (ECSE,RKSAW,RKSBW)**  
**Area: 718 km²**

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_Aerial survey of elephants & other wildlife in Zambezi Region  
Sep/Oct 2019_
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### RKSAE: Rooikat South A - East Part

**Area:** 1245 km²  
**Sampling Intensity:** 10.418%

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### RKSBME: Rooikat South B - East part

**Area:** 1245 km²  
**Sampling Intensity:** 10.18%

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<th>PRP%</th>
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### SALA: Salambala-Impalila A

Area: 1253 km²  
Sampling Intensity: 10.628 %

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### SALB: Salambala-Impalila B

Area: 1253 km²  
Sampling Intensity: 10.99%

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*Aerial survey of elephants & other wildlife in Zambezi Region  Sep/Oct 2019*
## Aerial survey of elephants & other wildlife in Zambezi Region

**Salambala Mean (SALA, SALB, RKSAE, RKSBE)**  
Area: 1245 km²

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>Pop. est.</th>
<th>No. seen</th>
<th>No. Out</th>
<th>Variance</th>
<th>PRP%</th>
<th>95%Range</th>
<th>No./100km²</th>
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