

VOLUME 1

WILDLIFE AND BIRDS

TITLE	Specialist Report Wildlife and Birds
AUTHOR	S. Ferreira
PROJECT NAME	Consulting Services for the Establishment and Monitoring of the Instream Flow Requirements for River Courses Downstream of LHWP Dams
REPORT STATUS	Final
REPORT NO	LHDA 648-F-19 (Vol. 1)
DATE	10.11.1999

EXECUTIVE SUMMARY

Wildlife species contribute primarily indirectly to the dynamics of river and riparian ecosystems. Furthermore, the wildlife associated with the Lesotho rivers has an extensive history of human use and disturbance, which has resulted in a depauperate wildlife community compared to some other large river catchments in Africa. The bird and mammal communities at the IFR sites therefore appear to consist of species prone to inhabiting disturbed areas. The study also illustrates that the mammal and bird communities are dominated by a few relatively common species. Some differences exist between IFR sites for the mammalian fauna while none were recorded for the avifauna. Of more importance were differences recorded in certain features of mammal and bird communities between three zones likely to be most affected by instream flow changes. These zones include the aquatic, lower and back dynamic zones.

In the aquatic zone, direct short term effects are likely to influence the population dynamics of the 12 water dependent bird species and the one water dependent mammal recorded, all of which utilise the aquatic zone primarily as a foraging area. IFR requirements should therefore address the needs of these species. These needs can be assessed by using predictive models developed during the present study. The models use changes in habitat features, linked with changes in flow regimes, to predict species-specific population changes at an IFR site.

Most of the other bird and mammal species are indirectly affected by flow changes through changes in available habitat in the lower and back dynamic zones because these habitats and resources represent only a subset of their requirements, i.e. these species are not totally dependent on these habitats. Regular seasonal flood events determine most of the habitat features and geomorphological characteristics of the lower dynamic zone in such a way that this zone and the species utilising these are likely to be affected in the medium term by changes in flow regimes. IFR requirements should therefore incorporate changes in species richness in the lower dynamic zone. These can be predicted using multiple regression habitat models developed in the present study.

Longer term changes as a result of instream flow alteration are likely to be reflected in changes in species richness of the back dynamic zone because habitat features and river geomorphology here are largely determined by irregular high floods. IFR requirements should therefore incorporate the potential effects that reduced frequency or exclusion of high flows (irregular high floods) may have on species richness of the back dynamic zone.

Finally, it is suggested that monitoring should be directed at assessing the short-term direct effects of flow manipulations on water dependent species (including those not recorded during the present study), medium-term effects on the species richness in lower dynamic zone) and long-term effects (species richness in back dynamic zone).

TABLE OF CONTENTS

EXECUTIVE SUMMARY	(Vol.1) i
TABLE OF CONTENTS	(Vol.1) iii
LIST OF TABLES AND FIGURES	(Vol.1) x
PART 1: INTRODUCTION	(Vol.1) 1
1 INTRODUCTION	(Vol.1) 1
2 OVERVIEW OF THE STUDY	(Vol.1) 1
2.1 Terms of reference	(Vol.1) 1
2.2 Dates of the study	(Vol.1) 2
2.3 Limitations of the study	(Vol.1) 2
PART 2: LITERATURE REVIEWS	(Vol.1) 3
3 INTERNATIONAL REVIEW OF THE KINDS OF DATA USED AS INPUT TO INSTREAM FLOW ASSESSMENTS	(Vol.1) 3
3.1 Role of wildlife ecology in river structure and functioning	(Vol.1) 3
3.2 Roles of wildlife ecology in instream flow requirements	(Vol.1) 3
3.3 Kinds of data used in instream flow assessments	(Vol.1) 3
4 THE HISTORIC NATURAL CONDITION OF LESOTHO RIVERS WITH RESPECT TO WILDLIFE ECOLOGY	(Vol.1) 4
PART 3: STUDY AREA	(Vol.1) 5
5 GENERAL DESCRIPTION OF WILDLIFE ECOLOGY IN THE STUDY AREA	(Vol.1) 5
5.1 Purpose of the IFR sites	(Vol.1) 5
5.2 Location of IFR sites	(Vol.1) 5
5.3 Extrapolation of data from IFR sites to the rest of the study area	(Vol.1) 5
PART 4: STUDY PROGRAMME	(Vol.1) 7
6 OVERALL PLAN	(Vol.1) 7
6.1 Objectives	(Vol.1) 7
6.2 Conceptual model	(Vol.1) 7
6.3 Timetable	(Vol.1) 7
6.4 Overview of activities	(Vol.1) 7
7 ACTIVITIES	(Vol.1) 8
7.1 Small mammal trapping	(Vol.1) 9
7.2 Intensive search for larger mammal signs	(Vol.1) 9
7.3 Bird counts	(Vol.1) 9
7.4 Intensive search for bird signs and nests	(Vol.1) 9
7.5 Night survey for presence/absence of nocturnal species	(Vol.1) 10
7.6 Gross structural vegetation characterisation	(Vol.1) 10
7.7 Gross characterisation of geomorphological features of the river	(Vol.1) 10
PART 5: DATA PRESENTATION FOR WILDLIFE ECOLOGY	(Vol.1) 13
8 IFR SITE 1	(Vol.1) 13
8.1 General overview of the characteristics of IFR Site 1	(Vol.1) 13
8.2 Description of wildlife ecology at IFR Site 1	(Vol.1) 13
8.3 Reach represented by IFR Site 1	(Vol.1) 13

8.4	Results	(Vol.1) 14
8.5	Identification of key species/features, with reasons	(Vol.1) 15
9	IFR SITE 2	(Vol.1) 16
9.1	General overview of the characteristics of IFR Site 2	(Vol.1) 16
9.2	Description of wildlife ecology at IFR Site 2	(Vol.1) 16
9.3	Reach represented by IFR Site 2	(Vol.1) 17
9.4	Results	(Vol.1) 17
9.5	Identification of key species/features, with reasons	(Vol.1) 18
10	IFR SITE 3	(Vol.1) 19
10.1	General overview of the characteristics of IFR Site 3	(Vol.1) 19
10.2	Description of wildlife ecology at IFR Site 3	(Vol.1) 20
10.3	Reach represented by IFR Site 3	(Vol.1) 20
10.4	Results	(Vol.1) 20
10.5	Identification of key species/features, with reasons	(Vol.1) 20
11	IFR SITE 4	(Vol.1) 22
11.1	General overview of the characteristics of IFR Site 4	(Vol.1) 22
11.2	Description of wildlife ecology at IFR Site 4	(Vol.1) 23
11.3	Reach represented by IFR Site 4	(Vol.1) 23
11.4	Results	(Vol.1) 23
11.5	Identification of key species/features, with reasons	(Vol.1) 25
12	IFR SITE 5	(Vol.1) 25
12.1	General overview of the characteristics of IFR Site 5	(Vol.1) 25
12.2	Description of wildlife ecology at IFR Site 5	(Vol.1) 26
12.3	Reach represented by IFR Site 5	(Vol.1) 26
12.4	Results	(Vol.1) 26
12.5	Identification of key species/features, with reasons	(Vol.1) 28
13	IFR SITE 6	(Vol.1) 28
13.1	General overview of the characteristics of IFR Site 6	(Vol.1) 28
13.2	Description of wildlife ecology at IFR Site 6	(Vol.1) 29
13.3	Reach represented by IFR Site 6	(Vol.1) 29
13.4	Results	(Vol.1) 29
13.5	Identification of key species/features, with reasons	(Vol.1) 31
14	IFR SITE 7	(Vol.1) 31
14.1	General overview of the characteristics of IFR Site 7	(Vol.1) 31
14.2	Description of wildlife ecology at IFR Site 7	(Vol.1) 32
14.3	Reach represented by IFR Site 7	(Vol.1) 32
14.4	Results	(Vol.1) 32
14.5	Identification of key species/features, with reasons	(Vol.1) 33
15	IFR SITE 8	(Vol.1) 34
15.1	General overview of the characteristics of IFR Site 8	(Vol.1) 34
15.2	Description of wildlife ecology at IFR Site 8	(Vol.1) 35
15.3	Reach represented by IFR Site 8	(Vol.1) 35
15.4	Results	(Vol.1) 35
15.5	Identification of key species/features, with reasons	(Vol.1) 35
16	SUMMARY OF THE PRESENT-DAY CONDITION OF THE LESOTHO RIVERS RELATIVE TO THE NATURAL CONDITION WITH RESPECT TO WILDLIFE ECOLOGY	(Vol.1) 37
16.1	Introduction	(Vol.1) 37
16.2	Species list	(Vol.1) 37
16.3	Variation in communities comprising the wildlife component	(Vol.1) 40
16.4	Multiple regression relationships for species and key features	(Vol.1) 51

PART 6: FLOW-RELATED INFORMATION		(Vol.1) 55
17	STRIPED-MOUSE (<i>RHABDOMYS PUMILIO</i>) (see Skinner & Smithers 1990)	(Vol.1) 55
17.1	Distributions	(Vol.1) 55
17.2	Conservation status	(Vol.1) 55
17.3	Habitat preference	(Vol.1) 55
17.4	Flow-related aspects of lifecycle	(Vol.1) 55
17.5	Breeding/reproduction biology	(Vol.1) 55
17.6	Flow-related physical habitat	(Vol.1) 55
17.7	Water quality and temperature tolerances ranges	(Vol.1) 55
18	GREATER RED MUSK SHREW (<i>CROCIDURA FLAVESCENS</i>)	(Vol.1) 55
18.1	Distributions	(Vol.1) 55
18.2	Conservation status	(Vol.1) 55
18.3	Habitat preference	(Vol.1) 55
18.4	Flow-related aspects of lifecycle	(Vol.1) 55
18.5	Breeding/reproduction biology	(Vol.1) 55
18.6	Flow-related physical habitat	(Vol.1) 55
18.7	Water quality and temperature tolerances ranges	(Vol.1) 55
19	MULTIMAMMATE MOUSE (<i>MASTOMYS NATALENSIS/COUCHA</i>)	(Vol.1) 56
19.1	Distribution	(Vol.1) 56
19.2	Conservation status	(Vol.1) 56
19.3	Habitat preference	(Vol.1) 56
19.4	Flow-related aspects of lifecycle	(Vol.1) 56
19.5	Breeding/reproduction biology	(Vol.1) 56
19.6	Flow-related physical habitat	(Vol.1) 56
19.7	Water quality and temperature tolerances ranges	(Vol.1) 56
20	WHITE-TAILED MOUSE (<i>MYSTROMYS ALBICAUDATA</i>)	(Vol.1) 56
20.1	Distributions	(Vol.1) 56
20.2	Conservation status	(Vol.1) 56
20.3	Habitat preference	(Vol.1) 56
20.4	Flow-related aspects of lifecycle	(Vol.1) 56
20.5	Breeding/reproduction biology	(Vol.1) 56
20.6	Flow-related physical habitat	(Vol.1) 56
20.7	Water quality and temperature tolerances ranges	(Vol.1) 56
21	CAPE CLAWLESS OTTER (<i>AONYX CAPENSIS</i>)	(Vol.1) 56
21.1	Distributions	(Vol.1) 56
21.2	Conservation status	(Vol.1) 56
21.3	Habitat preference	(Vol.1) 56
21.4	Flow-related aspects of lifecycle	(Vol.1) 57
21.5	Breeding/reproduction biology	(Vol.1) 57
21.6	Flow-related physical habitat	(Vol.1) 57
21.7	Water quality and temperature tolerances ranges	(Vol.1) 57
22	AFRICAN BLACK DUCK (<i>ANAS SPARSA</i>)	(Vol.1) 57
22.1	Distributions	(Vol.1) 57
22.2	Conservation status	(Vol.1) 57
22.3	Habitat preference	(Vol.1) 57
22.4	Flow-related aspects of lifecycle	(Vol.1) 57
22.5	Breeding/reproduction biology	(Vol.1) 57
22.6	Flow-related physical habitat	(Vol.1) 57
22.7	Water quality and temperature tolerances ranges	(Vol.1) 57

23	HAMERKOP (<i>SCOPUS UMBRETTA</i>)	(Vol.1) 57
23.1	Distributions	(Vol.1) 57
23.2	Conservation status	(Vol.1) 57
23.3	Habitat preference	(Vol.1) 57
23.4	Flow-related aspects of lifecycle	(Vol.1) 57
23.5	Breeding/reproduction biology	(Vol.1) 58
23.6	Flow-related physical habitat	(Vol.1) 58
23.7	Water quality and temperature tolerances ranges	(Vol.1) 58
24	GREY HERON (<i>ARDEA CINEREA</i>)	(Vol.1) 58
24.1	Distributions	(Vol.1) 58
24.2	Conservation status	(Vol.1) 58
24.3	Habitat preference	(Vol.1) 58
24.4	Flow-related aspects of lifecycle	(Vol.1) 58
24.5	Breeding/reproduction biology	(Vol.1) 58
24.6	Flow-related physical habitat	(Vol.1) 58
24.7	Water quality and temperature tolerances ranges	(Vol.1) 58
25	WHITE-BREASTED CORMORANT (<i>PHALOCROCORAX CARBO</i>)	(Vol.1) 58
25.1	Distributions	(Vol.1) 58
25.2	Conservation status	(Vol.1) 58
25.3	Habitat preference	(Vol.1) 58
25.4	Flow-related aspects of lifecycle	(Vol.1) 58
25.5	Breeding/reproduction biology	(Vol.1) 58
25.6	Flow-related physical habitat	(Vol.1) 58
25.7	Water quality and temperature tolerances ranges	(Vol.1) 59
26	CAPE TEAL (<i>ANAS CAPENSIS</i>)	(Vol.1) 59
26.1	Distributions	(Vol.1) 59
26.2	Conservation status	(Vol.1) 59
26.3	Habitat preference	(Vol.1) 59
26.4	Flow-related aspects of lifecycle	(Vol.1) 59
26.5	Breeding/reproduction biology	(Vol.1) 59
26.6	Flow-related physical habitat	(Vol.1) 59
26.7	Water quality and temperature tolerances ranges	(Vol.1) 59
27	DARTER (<i>ANHINGA MELANOGASTER</i>)	(Vol.1) 59
27.1	Distributions	(Vol.1) 59
27.2	Conservation status	(Vol.1) 59
27.3	Habitat preference	(Vol.1) 59
27.4	Flow-related aspects of lifecycle	(Vol.1) 59
27.5	Breeding/reproduction biology	(Vol.1) 59
27.6	Flow-related physical habitat	(Vol.1) 59
27.7	Water quality and temperature tolerances ranges	(Vol.1) 59
28	EGYPTIAN GOOSE (<i>ALOPOCHEN AEGYPTIACUS</i>)	(Vol.1) 60
28.1	Distributions	(Vol.1) 60
28.2	Conservation status	(Vol.1) 60
28.3	Habitat preference	(Vol.1) 60
28.4	Flow-related aspects of lifecycle	(Vol.1) 60
28.5	Breeding/reproduction biology	(Vol.1) 60
28.6	Flow-related physical habitat	(Vol.1) 60
28.7	Water quality and temperature tolerances ranges	(Vol.1) 60
29	GIANT KINGFISHER (<i>CERYLE MAXIMA</i>)	(Vol.1) 60
29.1	Distributions	(Vol.1) 60
29.2	Conservation status	(Vol.1) 60

29.3	Habitat preference	(Vol.1) 60
29.4	Flow-related aspects of lifecycle	(Vol.1) 60
29.5	Breeding/reproduction biology	(Vol.1) 60
29.6	Flow-related physical habitat	(Vol.1) 60
29.7	Water quality and temperature tolerances ranges	(Vol.1) 60
30	YELLOW-BILLED DUCK (<i>ANAS UNDULATA</i>)	(Vol.1) 60
30.1	Distributions	(Vol.1) 60
30.2	Conservation status	(Vol.1) 60
30.3	Habitat preference	(Vol.1) 61
30.4	Flow-related aspects of lifecycle	(Vol.1) 61
30.5	Breeding/reproduction biology	(Vol.1) 61
30.6	Flow-related physical habitat	(Vol.1) 61
30.7	Water quality and temperature tolerances ranges	(Vol.1) 61
31	LITTLE STINT (<i>CALIDRIS MINUTA</i>)	(Vol.1) 61
31.1	Distributions	(Vol.1) 61
31.2	Conservation status	(Vol.1) 61
31.3	Habitat preference	(Vol.1) 61
31.4	Flow-related aspects of lifecycle	(Vol.1) 61
31.5	Breeding/reproduction biology	(Vol.1) 61
31.6	Flow-related physical habitat	(Vol.1) 61
31.7	Water quality and temperature tolerances ranges	(Vol.1) 61
32	BLACK-HEADED HERON (<i>ARDEA MELANOCEPHALA</i>)	(Vol.1) 61
32.1	Distributions	(Vol.1) 61
32.2	Conservation status	(Vol.1) 61
32.3	Habitat preference	(Vol.1) 61
32.4	Flow-related aspects of lifecycle	(Vol.1) 62
32.5	Breeding/reproduction biology	(Vol.1) 62
32.6	Flow-related physical habitat	(Vol.1) 62
32.7	Water quality and temperature tolerances ranges	(Vol.1) 62
33	THREE-BANDED PLOVER (<i>CHARADRIUS TRICOLLARIS</i>)	(Vol.1) 62
33.1	Distributions	(Vol.1) 62
33.2	Conservation status	(Vol.1) 62
33.3	Habitat preference	(Vol.1) 62
33.4	Flow-related aspects of lifecycle	(Vol.1) 62
33.5	Breeding/reproduction biology	(Vol.1) 62
33.6	Flow-related physical habitat	(Vol.1) 62
33.7	Water quality and temperature tolerances ranges	(Vol.1) 62
34	BIRD SPECIES RICHNESS IN THE LOWER DYNAMIC ZONE	(Vol.1) 62
34.1	Natural range	(Vol.1) 62
34.2	Flow-related variations	(Vol.1) 62
35	BIRD SPECIES RICHNESS IN THE BACK DYNAMIC ZONE	(Vol.1) 62
35.1	Natural range	(Vol.1) 62
35.2	Flow-related variations	(Vol.1) 63
PART 7: ACKNOWLEDGEMENTS AND REFERENCES		(Vol.1) 65
36	ACKNOWLEDGEMENTS	(Vol.1) 65
37	REFERENCES	(Vol.1) 65

PART 8: APPENDICES**(Vol.1) 69**

APPENDIX 1: IFR SITE 1	(Vol.1) 69
38 IFR SITE 1	(Vol.1) 69
38.1 Mammal raw data	(Vol.1) 69
38.2 Bird raw data	(Vol.1) 69
38.3 Mammal presence/absence data summary	(Vol.1) 70
38.4 Bird presence/absence data summary	(Vol.1) 70
38.5 Gross vegetation structural raw data	(Vol.1) 70
38.6 Gross geomorphological raw data	(Vol.1) 70
APPENDIX 2: IFR SITE 2	(Vol.1) 71
39 IFR SITE 2	(Vol.1) 71
39.1 Mammal raw data	(Vol.1) 71
39.2 Bird raw data	(Vol.1) 71
39.3 Mammal presence/absence data summary	(Vol.1) 72
39.4 Bird presence/absence data summary	(Vol.1) 72
39.5 Gross vegetation structural raw data	(Vol.1) 72
39.6 Gross geomorphological raw data	(Vol.1) 72
APPENDIX 3: IFR SITE 3	(Vol.1) 73
40 IFR SITE 3	(Vol.1) 73
40.1 Mammal raw data	(Vol.1) 73
40.2 Bird raw data	(Vol.1) 73
40.3 Mammal presence/absence data summary	(Vol.1) 74
40.4 Bird presence/absence data summary	(Vol.1) 74
40.5 Gross vegetation structural raw data	(Vol.1) 74
40.6 Gross geomorphological raw data	(Vol.1) 75
APPENDIX 4: IFR SITE 4	(Vol.1) 76
41 IFR SITE 4	(Vol.1) 76
41.1 Mammal raw data	(Vol.1) 76
41.2 Bird raw data	(Vol.1) 76
41.3 Mammal presence/absence data summary	(Vol.1) 77
41.4 Bird presence/absence data summary	(Vol.1) 77
41.5 Gross vegetation structural raw data	(Vol.1) 77
41.6 Gross geomorphological raw data	(Vol.1) 77
APPENDIX 5: IFR SITE 5	(Vol.1) 78
42 IFR SITE 5	(Vol.1) 78
42.1 Mammal raw data	(Vol.1) 78
42.2 Bird raw data	(Vol.1) 78
42.3 Mammal presence/absence data summary	(Vol.1) 78
42.4 Bird presence/absence data summary	(Vol.1) 78
42.5 Gross vegetation structural raw data	(Vol.1) 79
42.6 Gross geomorphological raw data	(Vol.1) 79

APPENDIX 6: IFR SITE 6	(Vol.1) 80
43 IFR SITE 6	(Vol.1) 80
43.1 Mammal raw data	(Vol.1) 80
43.2 Bird raw data	(Vol.1) 80
43.3 Mammal presence/absence data summary	(Vol.1) 81
43.4 Bird presence/absence data summary	(Vol.1) 81
43.5 Gross vegetation structural raw data	(Vol.1) 81
43.6 Gross geomorphological raw data	(Vol.1) 81
APPENDIX 7: IFR SITE 7	(Vol.1) 82
44 IFR SITE 7	(Vol.1) 82
44.1 Mammal raw data	(Vol.1) 82
44.2 Bird raw data	(Vol.1) 82
44.3 Mammal presence/absence data summary	(Vol.1) 83
44.4 Bird presence/absence data summary	(Vol.1) 83
44.5 Gross vegetation structural raw data	(Vol.1) 83
44.6 Gross geomorphological raw data	(Vol.1) 83
APPENDIX 8: IFR SITE 8	(Vol.1) 84
45 IFR SITE 8	(Vol.1) 84
45.1 Mammal raw data	(Vol.1) 84
45.2 Bird raw data	(Vol.1) 84
45.3 Mammal presence/absence data summary	(Vol.1) 84
45.4 Bird presence/absence data summary	(Vol.1) 84
45.5 Gross vegetation structural raw data	(Vol.1) 85
45.6 Gross geomorphological raw data	(Vol.1) 85
APPENDIX 9	(Vol.1) 86
46 IUCN CATEGORIES AND CRITERIA	(Vol.1) 86
46.1 Summary of New IUCN Categories and Criteria (IUCN 1996)	(Vol.1) 86
47 CODES USED IN THE MULTIPLE REGRESSION MODELS	(Vol.1) 87

LIST OF TABLES AND FIGURES

TABLES

Table 2.1	Time allocations for Wildlife Ecologist.	(Vol.1) 2
Table 2.2	Dates of task completion for Wildlife Ecologist.	(Vol.1) 2
Table 5.1	Description of IFR site localities used in the wildlife ecology component.	(Vol.1) 5
Table 6.1.	Timetable for Wildlife Ecologist.	(Vol.1) 8
Table 8.1	Mammals and signs of mammals recorded at IFR Site 1	(Vol.1) 14
Table 8.2	Habitat features characterising capture localities of small mammal species at IFR Site 1.	(Vol.1) 14
Table 8.3	Indices of bird densities at IFR Site 1.	(Vol.1) 15
Table 8.4	Gross vegetation structure at IFR Site 1.	(Vol.1) 15
Table 8.5	Gross geomorphological features at IFR Site 1.	(Vol.1) 16
Table 9.1	Mammals and signs of mammals recorded at IFR Site 2.	(Vol.1) 17
Table 9.2	Habitat features characterising capture localities of small mammal species at IFR Site 2.	(Vol.1) 17
Table 9.3	Indices of bird densities at IFR Site 2.	(Vol.1) 18
Table 9.4	Gross vegetation structure at IFR Site 2.	(Vol.1) 19
Table 9.5	Gross geomorphological features at IFR Site 2.	(Vol.1) 19
Table 10.1	Mammals and signs of mammals recorded at IFR Site 3.	(Vol.1) 21
Table 10.2	Indices of bird densities at IFR Site 3	(Vol.1) 21
Table 10.3	Gross vegetation structure at IFR Site 3.	(Vol.1) 22
Table 10.4	Gross geomorphological features at IFR Site 3.	(Vol.1) 22
Table 11.1	Mammals and signs of mammals recorded at IFR Site 4.	(Vol.1) 23
Table 11.2	Habitat features characterising capture localities of small mammal species at IFR Site 4.	(Vol.1) 24
Table 11.3	Indices of bird densities at IFR Site 4	(Vol.1) 24
Table 11.4	Gross vegetation structure at IFR Site 4.	(Vol.1) 25
Table 11.5	Gross geomorphological features at IFR Site 4.	(Vol.1) 25
Table 12.1	Mammals and signs of mammals recorded at IFR Site 5.	(Vol.1) 27
Table 12.2.	Habitat features characterising capture localities of small mammal species at IFR Site 5.	(Vol.1) 27
Table 12.3	Indices of bird densities at IFR Site 5.	(Vol.1) 27
Table 12.4	Gross vegetation structure at IFR Site 5.	(Vol.1) 28
Table 12.5	Gross geomorphological features at IFR Site 5.	(Vol.1) 28
Table 13.1	Mammals and signs of mammals recorded at IFR Site 6.	(Vol.1) 30
Table 13.2	Habitat features characterising capture localities of small mammal species at IFR Site 6.	(Vol.1) 30
Table 13.3	Indices of bird densities at IFR Site 6.	(Vol.1) 30
Table 13.4	Gross vegetation structure at IFR Site 6.	(Vol.1) 31
Table 13.5	Gross geomorphological features at IFR Site 6.	(Vol.1) 31
Table 14.1	Mammals and signs of mammals recorded at IFR Site 7.	(Vol.1) 32
Table 14.2	Indices of bird densities at IFR Site 7.	(Vol.1) 33
Table 14.3	Gross vegetation structure at IFR Site 7.	(Vol.1) 34
Table 14.4	Gross geomorphological features at IFR Site 7.	(Vol.1) 34
Table 15.1	Mammals and signs of mammals recorded at IFR Site 8.	(Vol.1) 36
Table 15.2	Indices of bird densities at IFR Site 8.	(Vol.1) 36
Table 15.3	Gross vegetation structure at IFR Site 8.	(Vol.1) 36
Table 15.4	Gross geomorphological features at IFR Site 8.	(Vol.1) 37
Table 16.1	Key species and features identified for IFR sites comprising the present study.	(Vol.1) 38
Table 16.2	Checklist of mammals that may occur or are likely to occur in the study area.	(Vol.1) 41
Table 16.3	Checklist of bird species are likely to occur in the study area.	(Vol.1) 44
Table 16.4	Multiple regression models developed for mammals captured during the present study.	(Vol.1) 51
Table 16.5	Multiple regression models developed for birds recorded during the present study	(Vol.1) 52

APPENDIX TABLES

38	IFR SITE 1	(Vol.1) 69
38.1	Mammal raw data	(Vol.1) 69
38.2	Bird raw data	(Vol.1) 69
38.5	Gross vegetation structural raw data	(Vol.1) 70
38.6	Gross geomorphological raw data	(Vol.1) 70
39	IFR SITE 2	(Vol.1) 71
39.1	Mammal raw data	(Vol.1) 71
39.2	Bird raw data	(Vol.1) 71
39.5	Gross vegetation structural raw data	(Vol.1) 72
39.6	Gross geomorphological raw data	(Vol.1) 72
40	IFR SITE 3	(Vol.1) 73
40.1	Mammal raw data	(Vol.1) 73
40.2	Bird raw data	(Vol.1) 73
40.5	Gross vegetation structural raw data	(Vol.1) 74
40.6	Gross geomorphological raw data	(Vol.1) 75
41	IFR SITE 4	(Vol.1) 76
41.1	Mammal raw data	(Vol.1) 76
41.2	Bird raw data	(Vol.1) 76
41.5	Gross vegetation structural raw data	(Vol.1) 77
41.6	Gross geomorphological raw data	(Vol.1) 77
42	IFR SITE 5	(Vol.1) 78
42.1	Mammal raw data	(Vol.1) 78
42.2	Bird raw data	(Vol.1) 78
42.5	Gross vegetation structural raw data	(Vol.1) 79
42.6	Gross geomorphological raw data	(Vol.1) 79
43	IFR SITE 6	(Vol.1) 80
43.1	Mammal raw data	(Vol.1) 80
43.2	Bird raw data	(Vol.1) 80
43.5	Gross vegetation structural raw data	(Vol.1) 81
43.6	Gross geomorphological raw data	(Vol.1) 81
44	IFR SITE 7	(Vol.1) 82
44.1	Mammal raw data	(Vol.1) 82
44.2	Bird raw data	(Vol.1) 82
44.5	Gross vegetation structural raw data	(Vol.1) 83
44.6	Gross geomorphological raw data	(Vol.1) 83
45	IFR SITE 8	(Vol.1) 84
45.1	Mammal raw data	(Vol.1) 84
45.2	Bird raw data	(Vol.1) 84
45.5	Gross vegetation structural raw data	(Vol.1) 85
45.6	Gross geomorphological raw data	(Vol.1) 85
46	IUCN CATEGORIES AND CRITERIA	(Vol.1) 86
46.1	Summary of New IUCN Categories and Criteria (IUCN 1996)	(Vol.1) 86
47	CODES USED IN THE MULTIPLE REGRESSION MODELS	(Vol.1) 87

PART 1: INTRODUCTION**1 INTRODUCTION**

Contract LHDA 648: **The establishment and monitoring of instream flow requirements (IFR) for river courses downstream of LHWP dams** was awarded to Metsi Consultants, a joint venture between Southern Waters of South Africa and SMEC International of Australia. The wildlife ecology component is directed at providing information on past and present distributions of semi-aquatic and terrestrial mammals and birds associated with, and dependent on, rivers in the study area.

Many mammals are dependent on riverine ecosystems to some extent. Although not dependent on rivers to provide habitat, many of the larger mammals are drawn to rivers because they provide drinking water but are not dependent on habitat provided by riverine ecosystems. However, many smaller mammals also utilise the habitats provided by rivers. This is also true of most other terrestrial vertebrates, including birds, amphibians and reptiles. An alteration in flow characteristics of rivers affected by dam construction could therefore lead to potential negative consequences for some species with associated degradation of ecosystem function as a result of alteration in flow regimes.

2 OVERVIEW OF THE STUDY**2.1 Terms of reference**

The Terms of Reference for the study were as follows:

- 1 Design a methodology that will inform, to the extent possible within the time, budget and literature limitations, on the past and present distributions of semi-aquatic and terrestrial animals (revised to include only mammals and birds) that use the study rivers, and specific information on their life cycles, life styles and other attributes that are relevant to instream flow assessments as per, but not necessarily restricted to, the tasks outlined below.
- 2 Review the available international literature on the habitat requirements of the terrestrial and semi-aquatic animals (revised to include only mammals and birds) that are likely to be present in the study area, and dependent on rivers.
- 3 Attend a Planning Meeting in April 1998 to report on the proposed methodology for wildlife ecology of the IFR Study including presenting and providing a written description of the methods to be used, for discussion with the IFR Team.
- 4 Undertake a data collection trip to the study area to collect relevant data on semi-aquatic and terrestrial animals (revised to include only mammals and birds) utilising the river.
- 5 Provide a general characterisation of the semi-aquatic and terrestrial animals (revised to include only mammals and birds) associated with the river and riparian corridor in the study area, using data collected and available information.
- 6 Where possible, make an assessment of historical changes in the state of biota, e.g. information on species that once occurred naturally but are now absent, and an identification of the possible cause for any changes observed.
- 7 Select key species for further study, explaining and justifying criteria for selecting key species. Key species include rare and endangered species, species that are dominant in an assemblage, pest species or species that have an economic importance.
- 8 Compile summary information on key species, including a description of the species, their distribution, abundance and extent, timing and purpose of their use of the rivers (i.e. for drinking, food, nesting etc.) using field observations and experience, collected data and international literature regarding aspects of the autecology of different species that are related in any way to certain attributes of the river (e.g. vegetation, substrate).
- 9 Provide a report for the IFR Workshop Starter Document.

- 10 Attend the IFR Workshop in April 1999 and use the information from 1-9 to make recommendations on the flow requirements of the semi-aquatic and terrestrial animals (revised to include only mammals and birds) that depend on the rivers.
- 11 Adhere to standard formatting, font and layout specifications provided by the consultant for written submissions.
- 12 Submit copies of raw data, as and when they become available, to the Project Manager for archiving.

A number of tasks are operational and logistic of nature and have been completed in the ongoing conduct of the wildlife component. The focus of this report is thus tasks 1, 2 and 4-9.

2.2 Dates of the study

2.2.1 Date of Appointment

30 April 1997 (Contract signed 14 April 1998).

2.2.2 Dates of Tasks

See Table 2.2.

2.3 Limitations of the study

The availability of relevant data on habitat requirements, population densities and life-history features of most bird and mammal species in the Lesotho region limits the study. The study therefore relies heavily on findings from other regions and on the limited field data collected as part of the present study.

Table 2.2 Dates of task completion for Wildlife Ecologist.

Task	Dates
Workplan preparation	28 February 1998
Planning meeting	6-7 April 1998
Report back meeting	14 April 1998
Field data collection	8-13 April 1998 15-20 April 1998
Published data survey	May 1998
Field data input and exploratory analyses	June 1998
Extensive literature survey	July - September 1998
Literature data input	October 1998
Literature review, data analysis and write-up	November 1998 - January 1999
Preparation of starter document	January - February 1999
IFR Workshop	12-19 April 1999

PART 2: LITERATURE REVIEWS**3 INTERNATIONAL REVIEW OF THE KINDS OF DATA USED AS INPUT TO INSTREAM FLOW ASSESSMENTS****3.1 Role of wildlife ecology in river structure and functioning**

Mammals and birds have a significant influence on river ecosystem functioning. Apart from totally aquatic species, such as otters, most mammals and birds utilise river ecosystems (including the riparian zones) as part of a suite of resources and as such have both direct and indirect effects on river ecosystem functioning. Direct effects include water dependent species feeding on aquatic invertebrates or fish altering biomass levels in aquatic zones, whereas indirect effects entail predation on, for example, totally water dependent vertebrate species by other mammals or birds which normally do not use the river ecosystem at all.

Some terrestrial species such as the larger mammals may also affect physical features of rivers (e.g. hippo's, *Hippopotamus amphibius*, affect sediment loadings and river-bank morphology, Skinner & Smithers 1990). In the context of the present study, influences on structural features of the river are likely to be restricted to those imposed by domestic mammals.

3.2 Roles of wildlife ecology in instream flow requirements

Although several studies have been conducted to evaluate the effect of instream flow characteristics on wildlife (see Kadlec 1976; Mosley 1983), wildlife ecology has received relatively little attention compared with other components. The little attention that it has received has focused on bird fauna (see Kadlec 1976; Mosley 1983; Jourdonnais, Stanford, Hauer & Hall 1990), although IFR studies have included mammals (e.g. Bissell & Yde 1985 in Jourdonais *at al.* 1990; Bissell & Brown 1987 in Jourdonais *at al.* 1990; Gore, Layzer & Russel 1990) and their incorporation into IFR studies have been increasing.

The relatively low incidence of wildlife ecology as part of instream flow assessments is partly a result of lack of appropriate methodologies. Approaches have primarily relied on combining existing instream flow

methodologies, such as Instream Flow Incremental Methodology (Mosley 1983; Gore *et al.* 1990), and predictive wildlife models (Kadlec 1976; Bissell & Yde 1985 in Jourdonais *at al.* 1990; Bissell & Brown 1987 in Jourdonais *at al.* 1990; Casey, Wood & Ball 1987 in Jourdonais *at al.* 1990).

Kadlec (1976) provided a conceptual framework within which instream flows for wildlife should be considered. These include :

Removal of water: Direct effect predominantly as result of consumptive requirement (permanent alteration of food and habitat availability).

Altered flow patterns or volumes of water: Direct affect also as result of consumptive requirements primarily through alteration of temporal patterns of food availability and habitat changes.

Lowered water tables: Indirect effect through alteration of riparian vegetation, eliminating essential elements of habitat requirements for some wildlife species.

Changed patterns of flooding: Indirect affect through changes in river physical morphology, habitats maintained by flooding (wetlands and floodplains) and the subsequent changes in habitat and food availability.

Kadlec (1976) considered lowering of the water table and changes in the patterns of flooding as having the largest effects. Since altered flow patterns and reductions in the water table could have severe impacts on riparian habitats, these are considered particularly important habitats for birds and mammals in semi-arid and arid regions of Southern Africa (Oliver 1974 in Kadlec 1976; Carothers & Johnson 1975 in Kadlec 1976). They are thus likely to be the most important impacts in Lesotho.

3.3 Kinds of data used in instream flow assessments

The limited literature available illustrate that at present the majority of studies deal only with possible approaches for assessing IFR for wildlife and provide little guidance

on the types of data to include (see Jourdonnais *et al.* 1990). There are however some notable exceptions. Mosley (1983) developed a habitat-discharge approach that requires the identification of precise microhabitats used by birds, their characteristics and the range of factors that may influence these. The main factor being the extent of different types of habitat. Gore *et al.* (1990) used a similar technique to predict changes in semi-aquatic mammals.

These examples suggest that it might be appropriate to use detailed habitat requirements of a range of species for an IFR. However, data on these are likely to be limited for many species and the degrees of dependence of all species on riverine habitats are often difficult to quantify. Thus, the effects of change in habitats are difficult to predict.

Conceptual solutions to this problem incorporate the use of indicator species or assessment of wildlife by groups

rather than individual species, where criteria may include organism size, mobility and seasonal dependence on habitat (see Jourdonnais *et al.* 1990). However, it may be problematic to predict changes for species or groups of species where riverine habitats are only one component of the suite of habitat characteristics required by a species.

Estimates of wildlife population numbers are usually too variable (partly as a result of limited time available for assessment) to be useful indicators of changes in instream flow. Densities of species that are solely or near-solely dependent on riverine resources directly affected by flow may serve as better indicators for IFRs. This suggests that data on a combination of habitat characteristics, population densities and life-history features of suites of species should be included in IFR assessments.

4 THE HISTORIC NATURAL CONDITION OF LESOTHO RIVERS WITH RESPECT TO WILDLIFE ECOLOGY

The highlands of Lesotho are characterised by relatively few species of birds and mammals compared with other areas in southern Africa. As such, the bird and mammal species compositions associated with rivers in Lesotho have also been relatively species poor (Jacot-Guillarmod 1963; du Plessis 1969). Historical accounts of birds and mammals are sparse and restricted to some archaeological studies (du Plessis 1969) and relatively recent studies on bird and mammal distributions (Staples & Hudson 1938; Jacot-Guillarmod 1963; Bonde 1981; Bonde 1984; Meakins *et al.* 1988; Osborne & Tigar 1989;

Osborne & Tigar 1990; Osborne & Tigar 1992a; Lynch & Watson 1990; Lynch 1993). These studies shed little light on historic distribution and population sizes of mammals or birds associated with Lesotho rivers. Nonetheless, it can be assumed that high levels of anthropogenic disturbance that characterises Lesotho rivers at present has substantially altered the composition of bird and mammal communities in the area. The present day characteristics of wildlife fauna are therefore likely to represent a depleted fauna relative to earlier times.

PART 3: STUDY AREA**5 GENERAL DESCRIPTION OF WILDLIFE ECOLOGY IN THE STUDY AREA****5.1 Purpose of the IFR sites**

IFR sites were selected by the IFR Biophysical Team to represent reaches of the river system that are, or will be, affected by the Lesotho Highlands Water Project (see Inception Report, Metsi Consultants 1997). The Matsoku River will be affected by a diversion gravity weir under construction in the Matsoku River (IFR Site 1 will be used for assessment of the Matsoku River below the weir). IFR Site 2, below Katse Bridge, will provide assessment of wildlife values affected by the existing Katse Dam on the Malibatso River upstream of the confluence with the Matsoku River. IFR Site 3 represents wildlife characteristics of the Malibatso River downstream of the confluence with the Matsoku River. IFR Site 7 will be used to provide information on wildlife ecology to be affected by the Mohale Dam under construction in the Sengunyane River. A number of smaller rivers contribute to the volume of water likely to flow in the lower parts of the Sengunyane River and these potential effects on wildlife will be assessed at IFR Site 8 upstream from the confluence with the Senqu River. The remaining three IFR sites (4, 5, and 6) are located at various stages in the Senqu River following confluences with the Malibatso, Tsoelike and Sengunyane Rivers, respectively.

5.2 Location of IFR sites

Eight IFR sites were selected (Table 5.1). A study area stretching three kilometres upstream and three kilometres downstream of each IFR site was designated as the representative area for the wildlife component of that IFR site for the present IFR assessment.

5.3 Extrapolation of data from IFR sites to the rest of the study area

The locations of the IFR sites were deliberately selected to represent river reaches identified by the Metsi Biophysical Team. For the purpose of this study it was assumed *a priori* that wildlife characteristics measured at a particular IFR site will reflect that for a river reach represented by each IFR site. In some instances the assumption may not reflect field conditions as alteration in flow regimes and associated effects on wildlife populations progressively diminish along the river as tributaries not effected by the proposed development contribute to flow volumes and regimes. However, due to the generalist characteristics of most mammal and bird species likely to be affected, the relevant site-specific wildlife characteristics may be considered representative of a particular river reach and appropriate for incorporation in the BBM and IFR assessment.

Table 5.1 Description of IFR site localities used in the wildlife ecology component.

Site 1	Matsoku River at Ha Seshote	29°16'S	28°33'E
Site 2	Malibatso River below Katse Dam	29°22'S	28°34'E
Site 3	Malibatso River at Paray	29°31'S	28°40'E
Site 4	Senqu River at Sehonghong	29°44'S	28°46'E
Site 5	Senqu River at Whitehills	30°04'S	28°26'E
Site 6	Senqu River at Seaka Bridge	30°23'S	27°33'E
Site 7	Sengunyane River at Ha Marakabei	29°34'S	28°03'E
Site 8	Sengunyane River upstream of confluence with Senqu River	30°02'S	28°12'E

PART 4: STUDY PROGRAMME**6 OVERALL PLAN****6.1 Objectives**

- 1 Investigate present and past distribution patterns, habitat requirements, life-history characteristics and indices of population sizes of mammals and birds by collecting field data at eight IFR sites distributed along the affected river systems and reviewing the available literature.
- 2 Identify key species/features/aspects for monitoring the efficacy of future instream flow releases using the results obtained.

6.2 Conceptual model

The framework proposed by Metsi (1999) relies on identifying levels, termed flow bands, of water in the river that are of significance to various components and how reducing flow through various levels affects river and associated riverine ecosystems. The model should produce a range of river conditions related to flow at various degrees.

To contribute to the conceptual IFR process developed by Metsi Consultants, the wildlife ecology component will utilise data on extant species at each IFR site to develop predictive models of selected species-specific densities and selected features of the wildlife component. Present flow variation has resulted in the characteristics of wildlife measured during the present study. By incorporating variation in flow-associated habitat and structural features between IFR sites recorded in the present study, multiple regression models can be developed that explain species-specific densities and/or community characteristics. From these models, changes in species-specific densities and wildlife component features can be predicted for a flow band or flow regime (seasonal variation) at each IFR site.

The predictive approach suggested here relies on information provided by other specialists. For instance, the proposed method for determining minimum degradation levels for lowflows identify the upper range of lowflows, which are sequentially reduced. In this instance such a reduction is likely to result in a change in habitat

features at a particular IFR site. The botanical specialist may indicate a 10% reduction in grass cover and a 10% increase in shrubs while the geomorphologists identify an increase in sediment loadings resulting in larger areas covered in sand for each sequential reduction. Incorporating this change in habitat features in the multiple regression models will result in the prediction of the likely response of a variety of species and/or community characteristics. From these predictions, the point of discharge at which minimum degradation will occur can be determined by identifying when particular key species reach critically low densities and/or some community characteristic change substantially.

6.3 Timetable

Refer to table 6.1

6.4 Overview of activities

The eight IFR sites distributed along the affected rivers were surveyed for birds and mammals during April 1998 following the IFR Planning meeting. At each IFR site, five locations, situated 1500 m apart, along the riverbank were selected. Thus, at each IFR site, c. 6 km of the river was surveyed. At each location a number of activities were completed including:

- Small mammal trapping
- Intensive search for larger mammal signs
- Bird counts
- Intensive search for bird signs and nests
- Night survey for presence/absence of nocturnal species
- Gross structural vegetation characterisation
- Gross characterisation of geomorphological features of the river

A literature survey was conducted to augment information on distribution and habitat associations for birds and mammals.

Table 6.1 Timetable for Wildlife Ecologist.

Task	Dates
Workplan preparation	February 1998
Planning meeting	April 1998
Field data collection	April/May 1998
Published data survey	May 1998
Field data input and exploratory analyses	June 1998
Extensive literature survey	July - September 1998
Literature data input	October 1998
Literature review, data analysis and write-up	November 1998 - January 1999
Preparation of starter document	January - February 1999
IFR Workshop	April 1999

The products of these activities were used to construct a data-matrix for birds, mammals, and associated vegetation and geomorphological structure. The data collected were also used to provide a presence/absence data summary for birds and mammals. From these, an

assessment of bird and mammal association with vegetation and geomorphological structure was conducted, followed by an assessment of suitable species to be designated as key species at various sections of the affected rivers.

7 ACTIVITIES

7.1 Small mammal trapping

7.1.1 Purpose

To obtain a density index and index of habitat association of small mammals utilising the riparian zones of the rivers investigated.

7.1.2 Field equipment and methods

At each of the five localities representing a IFR site, 12 Sherman-like livetraps and 24 snaptraps were set in a trapping grid with 6X6 configuration and 20 m between traps. Raisins were used as bait. Traps were set at midday and checked during the last hour of daylight. Live-captured individuals were identified to species level and released. Traps were checked again and removed at dawn, and captured individuals identified to species level. Once again, all live-captured individuals were released at the site of capture.

Gross habitat characteristics within 2-m radius from the capture point were described for each capture using

similar approaches as those described in Chapters 7.6 and 7.7.

7.1.3 Storage and processing of samples

Not relevant to this activity.

7.1.4 Data analysis methods

Field data collection was directed primarily at abundant species and thus did not serve to indicate rare species. Trapping programs rarely provide reliable information on rare species. However, abundant small mammal species often reflect on disturbances and how systems are responding to these disturbances. From the capture data a density index was calculated as the number of individuals per trap for each species (Caughley 1977) and these compared between localities using non-parametric statistics where appropriate (Sokal & Rohlf 1983).

Observed features of habitats at which captures were recorded were used to provide a summary of localised

habitat preferences for each species. However, to assess variation in density indices in relation to gross vegetational and geomorphological features, multiple linear regression analyses (Sokal & Rohlf 1983) were used to develop a multifactor linear model for each species, which predicts changes in species density indices as a function of changing gross vegetational and geomorphological characteristics.

7.2 Intensive search for larger mammal signs

7.2.1 Purpose

To obtain an indication of larger mammals that are present at the rivers investigated.

7.2.2 Field equipment and methods

Intensive search for signs of mammals within a radius of 200 m of each locality at an IFR site was used to augment the trapping data and to construct a presence/absence data summary for all locations and IFR sites. Any encounters with mammals during other activities of fieldwork were also noted and added to the database.

7.2.3 Storage and processing of samples

Not relevant to this activity.

7.2.4 Data analysis methods

The presence/absence data were summarised and species richness (number of species) values were obtained for each locality. These were compared between localities and sampling sites using non-parametric statistics where appropriate (Sokal & Rohlf 1983).

7.3 Bird counts

7.3.1 Purpose

To obtain a density index of birds utilising the aquatic and riparian zones of the rivers investigated.

7.3.2 Field equipment and methods

Bird species were recorded using a point sampling method. The 200 m radius from the centre of the trapping grid each locality at an IFR site was used as a sampling area, selecting the best point allowing an observer to scan the total area. Observations were conducted for 45

minutes during which each bird observed was identified to species level. The numbers of birds in large, fast moving flocks were estimated.

All birds observed between localities at each IFR site were also recorded and added to the database for consideration in constructing a presence/absence data summary.

7.3.3 Storage and processing of samples

Not relevant to this activity.

7.3.4 Data analysis methods

A density index was calculated for each species as the number of sightings per hour and this was compared between localities using non-parametric statistics (Sokal & Rohlf 1983). As for mammals, variation in density indices in relation to gross vegetational and geomorphological features was assessed using multiple linear regression analyses (Sokal & Rohlf 1983). This was used to develop a multifactor linear model for each species, which predicts changes in species density indices as a function of changing gross vegetational and geomorphological characteristics.

7.4 Intensive search for bird signs and nests

7.4.1 Purpose

To obtain an indication of other birds that are present at the rivers investigated.

7.4.2 Field equipment and methods

Following 7.3, the area incorporated within the 200-m radius was intensely searched for signs of bird nests or any other undetected species. This, together with rare sightings of birds recorded at any time during the fieldwork period was used to augment presence/absence data.

7.4.3 Storage and processing of samples

Not relevant to this activity.

7.4.4 Data analysis methods

The presence/absence data were summarised and species richness (number of species) values were obtained for each locality. These were compared

between localities using non-parametric statistics where appropriate (Sokal & Rohlf 1983).

7.5 Night survey for presence/absence of nocturnal species

7.5.1 Purpose

To obtain an indication of nocturnal larger mammals and birds that are present at or near the rivers investigated.

7.5.2 Field equipment and methods

A 30-minute night survey at each locality for IFR sites using a spotlight was used to obtain presence/absence data on nocturnal species not encountered during the diurnal search.

7.5.3 Storage and processing of samples

Not relevant to this activity.

7.5.4 Data analysis methods

Information was used to augment the presence/absence data summary in Chapter 7.2 and 7.4.

7.6 Gross structural vegetation characterisation

7.6.1 Purpose

To obtain gross vegetational characteristics of localities at each IFR Site. This was needed to assess potential influences of changes in these features with change in instream flow characteristics.

7.6.2 Field equipment and methods

A brief description of gross vegetation features, such as percentage cover of grass, shrubs and trees, characterising the location was performed. Each locality was divided in four zones:

7.6.2.1 Aquatic zone

The wetted area with associated rocks, pebbles, cobbles, boulders and sand.

7.6.2.2 The lower dynamic zone

Comprising primarily the regularly flooded zones incorporating the wet bank and associated moss, sedge and shrub zones. A distinction was made between the side of the river on which data were recorded so that two sets of data were generated for each zone at each locality.

7.6.2.3 The back dynamic zone

Comprising the dry stable bank, incorporating the tree zone and lower slopes of the river valley. As for 7.6.2.2, distinction was made between the side of the river that data were recorded so that two sets of data were generated for each zone at each locality.

7.6.3.4 Islands

Vegetated islands located within the aquatic zone. For each zone the dominant vegetation structural features and percentage cover for each feature were recorded.

7.6.3 Storage and processing of samples

Not relevant to this activity.

7.6.4 Data analysis methods

A vegetational structural matrix was constructed. Mammal and bird species comprising communities at each locality were related to these vegetational structural variables using multiple linear regression analyses (Sokal & Rohlf 1983) (see Chapters 7.1 and 7.3). In addition, to obtain an indication of how bird and mammal communities are associated with the vegetation structure a simulation procedure, RELATE (Clarke & Green 1988), designed to compare two similarity matrices constructed from different databases (e.g., mammal community and vegetation structure), was used.

7.7 Gross characterisation of geomorphological features of the river

7.7.1 Purpose

To obtain gross geomorphological characteristics of localities at each IFR site. This was needed to assess potential influences of changes in these features with change in instream flow characteristics.

7.7.2 Field equipment and methods

A brief description of gross geomorphological features characterising the location was performed. Each locality was divided in four zones similar to that described in Chapter 7.6.2 and the data recorded accordingly.

7.7.3 Storage and processing of samples

Not relevant to this activity.

7.7.4 Data analysis methods

A geomorphological structural matrix was constructed and data analysed in a manner similar to that explained in Chapter 7.6.4 .

PART 5: DATA PRESENTATION FOR WILDLIFE ECOLOGY

8 IFR SITE 1 - Matsoku River at Seshote

8.1 General overview of the characteristics of IFR Site 1

8.1.1 Locality A (29 14'S 28 33'E)

Slow flowing river in south-eastern direction. The south-western bank comprised trees in the lower dynamic zone with the back dynamic zone under cultivation. Some large rocks lined the bank in the aquatic zone. The north-eastern bank was characterised by a narrow lower dynamic zone and steep rocky cliffs in the back dynamic zone. The small mammal trapping grid was located on south-western bank from the water's edge across both the lower and back dynamic zones.

8.1.2 Locality B (29 15'S 28 33'E)

Fast flowing river in southern direction, which consisted of a rapid and large rocks adjacent to the rapid. The western bank comprised a few trees and some grazed grass in the lower dynamic zone with the back dynamic zone under cultivation. The eastern bank was characterised by a narrow lower dynamic zone and steep rocky cliffs in the back dynamic zone. The small mammal trapping grid was located on western bank from the water's edge across both the lower and back dynamic zones.

8.1.3 Locality C (29 16'S 28 33'E)

Slow flowing river in south-western direction with some cobbles in the aquatic zone. The north-western bank comprised trees lining the waters' edge in the lower dynamic zone with the back dynamic zone under cultivation. The south-eastern bank was characterised by a narrow lower dynamic zone and steep rocky cliffs in the back dynamic zone. The small mammal trapping grid was located on north-western bank from the waters' edge across both the lower and back dynamic zones.

8.1.4 Locality D (29 17'S 28 33'E)

Slow river flowing in a southern direction. Both dynamic zones were heavily grazed. The western bank comprised trees in the lower dynamic zone with the back dynamic

zone under cultivation. The eastern bank was characterised by a narrow lower dynamic zone and a back dynamic zone under cultivation. The small mammal trapping grid was located on western bank from the waters' edge across both the lower and back dynamic zones.

8.1.5 Locality E (29 18'S 28 33'E)

Fast flowing river in south-eastern direction with two rapids. North-eastern bank comprised trees in the lower dynamic zone with the back dynamic zone under cultivation. The south-western bank was characterised by a narrow lower dynamic zone with lots of trees and steep rocky cliffs in the back dynamic zone. The small mammal trapping grid was located on north-eastern bank from the water's edge across both the lower and back dynamic zones.

The characteristics of these localities represent an IFR site characterised by a narrow slow flowing river, few rapids, parts of the upper dynamic zone being cultivated, a lower dynamic zone lined with predominantly scattered trees and some grazed grass.

8.2 Description of wildlife ecology at IFR Site 1

See Chapter 8.4.

8.3 Reach represented by IFR Site 1

The wildlife component is characterised by primarily generalists species. It is therefore likely that the wildlife features measured at IFR Site 1 will be representative of the reach of river from the site of the proposed Matsoku Weir to the confluence with the Malibatso River. One notable exception is the occurrence of a bald ibis breeding colony, approximately 10 km downstream of the IFR site. However, this colony breeds on high cliffs in the back dynamics zone and is unlikely to be affected by changes in flow regimes.

8.4 Results

8.4.1 Mammals

Three small mammal species were recorded as part of the trapping programme and there were signs of three other mammals (Table 8.1). All three species occurred in higher densities in the back dynamic zone but not significantly so (multimammate mouse: Mann-Whitney U-test, $Z = -0.39$, $p=0.70$; striped mouse: Mann-Whitney U-test, $Z = -1.62$, $p=0.11$; greater red musk shrew: Mann-Whitney U-test, $Z = -0.15$, $p=0.88$).

All three species were recorded on substrate comprising primarily soil and traps located within agricultural areas (Table 8.2). The striped mouse and the greater red musk shrew also seemed to prefer shrubs on sandy substrates.

8.4.2 Birds

Eighteen species were recorded at this site including three water-dependent or water-associated birds (grey heron, hamerkop and yellow-billed duck; Table 8.3). Cape wagtail was also recorded in the aquatic zone. Most birds were recorded in the lower dynamic zone, with Cape sparrow and red bishops occurring in high densities relative to other birds in the lower dynamic zone.

8.4.3 Vegetation

The lower dynamic zone was dominated by grass with interspersed bare patches, while the back dynamic zone was comprised of grass, agriculture and bare patches (Table 8.4).

Table 8.1 Mammals and signs of mammals recorded at IFR Site 1. Data are presented as number of individuals captured per 100 trapnights followed by one standard error of the mean ($n=5$), except where indicated otherwise.

	Lower Zone	Back Zone	Aquatic Zone
Multimammate mouse	0.75±0.75	0.90±0.57	-
Striped mouse	2.18±2.18	4.36±0.49	-
Greater red musk shrew	0.49±0.49	1.15±1.15	-
<i>Cryptomys</i> spp. (Molerats)	4 mole heaps	25 mole-heaps	-
Viverid spp. (Slender mongoose)	2 sets of spoor	-	-
Rodent burrows	1	2	-

Table 8.2 Habitat features characterising capture localities of small mammal species at IFR Site 1.

	Multimammate mouse ($n=3$)	Striped mouse ($n=13$)	Greater red musk shrew ($n=3$)
Vegetation			
Agriculture (% cover)	58.33±30.05	69.23±10.26	66.67±16.67
Agriculture height (m)	56.67±34.80	86.92±14.27	70.00±40.00
Shrubs (% cover)	-	15.38±6.66	8.33±8.33
Shrub height (m)	-	25.38±11.56	25.00±25.00
Sedge(% cover)	16.67±16.67	-	-
Sedge height (m)	16.67±16.67	-	-
Grass(% cover)	16.67±16.67	11.53±6.08	25.00±14.43
Grass Height (m)	6.67±6.67	7.30±5.73	6.67±3.33
Geomorphology			
Bare ground (% cover)	8.33±8.33	5.00±2.53	-
Aspect (°)	10.00±0.01	11.69±1.83	13.33±3.33
Soil (% cover)	100.00±0.01	100±0.01	100.00±0.01
Rock (% cover)	-	-	-
Clay (% cover)	-	15.38±6.67	8.33±8.33
Sand (% cover)	-	25.38±11.56	25.00±25.00
Pebbles (% cover)	16.67±16.67	-	-
Boulder (% cover)	16.67±16.67	-	-

Table 8.3 Indices of bird densities (number of individuals per hour) followed by one standard error of the mean ($n=5$) in the lower, back and aquatic zone of IFR Site 1. IFR Count refers to the total number of individuals observed at this IFR Site including observations outside the localities.

	Lower Zone	Back Zone	Aquatic Zone	IFR Count
Total number of individuals	185	22	7	248
Cape bunting	1.07±1.07	0.53±0.53	-	6
Cape sparrow	13.86±8.35	0.27±0.27	-	65
Cape turtle dove	1.33±0.59	0.27±0.27	-	8
Cape weaver	3.47±1.16	-	-	21
Common waxbill	-	1.07±1.07	-	8
Cape white-eye	2.67±2.67	-	-	10
Cape wagtail	1.07±0.49	-	0.53±0.33	9
Drakensberg siskin	0.27±0.27	-	-	1
Grey Heron	-	-	0.53±0.53	3
Hamerkop	-	0.27±0.27	-	1
House martin	-	-	0.27±0.27	1
Neddicky	0.53±0.33	0.80±0.80	-	5
Red bishop	24.00±24.00	-	-	90
Rock bunting	-	1.07±0.65	-	4
Rock martin	-	0.27±0.27	-	1
Stone chat	0.27±0.27	1.33±1.03	-	8
Spotted prinia	0.80±0.53	-	-	5
Yellow-billed duck	-	-	0.53±0.53	2

Table 8.4 Gross vegetation structure at IFR Site 1. Data are presented as percentage cover followed by one standard error of the mean ($n=5$).

	Lower Zone	Back Zone
Trees	15.60±9.78	-
Shrubs	1.10±0.58	5.00±5.00
Reeds	-	-
Sedge	5.00±5.00	-
Grass	55.00±16.58	38.50±8.31
Bare ground	28.60±10.37	21.10±6.79
Agriculture	-	35.00±2.50
Island bare ground	-	-
Island shrubs	-	-
Island grass	-	-

8.4.4 Geomorphology

Both the lower dynamic and back dynamic zone were characteristically narrow (width) at this site with the substrates comprising primarily soil with some rock (Table 8.5). The lower dynamic zone also had some sandy patches. The aquatic zone was interspersed with rock, sand, cobbles and limited pebbles. Size classes of these follow that determined by the Metsi Biophysical Team.

8.5 Identification of key species/features, with reasons

The three mammals species recorded at this site are considered as key species. The striped mouse and multimammate mouse are both generalists and may reach plague densities on occasions (De Graaff 1981). The greater red musk shrew is considered vulnerable by the IUCN (IUCN 1996). Three water-dependent bird species (yellow-billed duck, grey heron and hamerkop) have been recorded here and are considered important key species for the bird fauna. Bird species richness in the lower dynamic zone is a key feature for this site.

Table 8.5 Gross geomorphological features at IFR Site 1. Width of zones are given in metres, aspect as degrees and the various components as percentage cover of a particular zone. $n=5$.

	Lower Zone	Back Zone		Aquatic Zone
Zone width	6.00±0.82	9.20±0.94	River width	27.00±2.00
Aspect	15.10±2.18	20.00±4.18		
Rock	17.50±9.35	18.50±10.50	River rock	8.20±4.27
Soil	63.00±18.12	83.00±10.52		
Sand	18.00±9.13	-	River sand	5.00±5.00
Cobble	3.50±2.91	0.50±0.50	River cobble	10.00±6.13
Pebble	-	-	River pebble	0.20±0.20
Boulder	-	-	River boulder	-
Clay	-	-		
Island length	-	-	Logs	-
Island width	-	-		
Island sand	-	-		
Island cobbles	-	-		
Island soil	-	-		

9 IFR SITE 2 – Malibatso River downstream of Katse Dam

9.1 General overview of the characteristics of IFR Site 2

9.1.1 Locality A (29 21'S 28 32'E)

The river was flowing slowly in south-east direction. The northern bank was comprised of a cornfield in back dynamic zone, with one large tree in the lower dynamic zone at the water's edge. The southern bank was lined with scattered trees in the lower dynamic zone. Low rock cliffs were apparent in the upper dynamic zone. The small mammal trapping grid was located on the southern bank and stretched from the water's edge across both the lower and back dynamic zones.

9.1.2 Locality B (29 21'S 28 33'E)

Slow flowing river in south-east direction. The northern bank comprised cornfield in back dynamic zone with two large trees in the lower dynamic zone at the water's edge. There was a large log in the aquatic zone. The southern bank was lined with scattered shrubs and trees in the lower dynamic zone. Low rock cliffs in the upper dynamic zone. The small mammal trapping grid was located on southern bank from the water's edge across both the lower and back dynamic zone.

9.1.3 Locality C (29 22'S 28 34'E)

Fast flowing river in south-east direction crossing a rapid. There was small stream entering the river from the south before the rapid. The northern bank comprised low rock cliffs delineating back dynamic zone. There were

boulders in the aquatic zone next to the southern bank. The small mammal trapping grid was located on southern bank from the water's edge across both the lower and back dynamic zone.

9.1.4 Locality D (29 22'S 28 34'E)

Slow flowing river in south-east direction. The northern bank was comprised of a cornfield in back dynamic zone. There were two large rocks in the aquatic zone. The small mammal trapping grid located on southern bank from the water's edge across both the lower and back dynamic zone.

9.1.5 Locality E (29 23'S 28 35'E)

Slow flowing river in south-east direction. The northern bank was comprised of cornfield in back dynamic zone. The small mammal trapping grid was located on southern bank from the water's edge across both the lower and back dynamic zone.

These localities represent an IFR site characterised by a slow flowing river, few rapids, with parts of the upper dynamic zone cultivated, a lower dynamic zone lined with scattered trees at the water's edge, and rocks, boulders and limited logs in the aquatic zone.

9.2 Description of wildlife ecology at IFR Site 2

See Chapter 9.4.

9.3 Reach represented by IFR Site 2

As for IFR Site 1, the wildlife component is characterised by primarily generalist species. It is therefore likely that the wildlife features measured at IFR Site 2 will be representative the Malibatso River from Katse Dam to the confluence with the Matsoku River.

9.4 Results

9.4.1 Mammals

Three small mammal species were recorded as part of the trapping program (see Table 9.1). The lower dynamic zone appeared to have the highest densities for two of the species, the striped mouse and the greater red musk shrew. However, large variations did not result in significant differences (striped mouse: Mann-Whitney U-test, $Z = -1.15$, $p = 0.18$ and greater red musk shrew: Mann-Whitney U-test, $Z = -1.00$, $p = 0.32$). Signs of mole-rats and mongoose were also recorded (Table 9.1).

The one specimen of multimammate mouse was recorded on rocky/sandy mixture of substrate with relatively sparse grass and shrub cover. The striped mouse preferred a soil substrate fairly well covered in grass while the greater red musk shrew preferred a soil substrate interspersed with rocks and with good grass cover (Table 9.2).

9.4.2 Birds

Twenty-four species of birds were recorded (Table 9.3). Notably four African black duck were recorded in two zones (back dynamic zone flying and aquatic zone). Three other water-dependent or water-associated species were recorded, viz: grey heron, hamerkop and white-breasted cormorant. Note that numbers were lowest in the aquatic zone and highest in the lower dynamic zone. Densities were patchy as are reflected by the large standard errors recorded for various species. Fifteen unoccupied weaver nests were recorded in the lower dynamic zone.

Table 9.1 Mammals and signs of mammals recorded at IFR Site 2. Data are presented as number of individuals captured per 100 trapnights followed by one standard error of the mean ($n=5$) except where indicated otherwise.

	Lower Zone	Back Zone	Aquatic Zone
Multimammate mouse	-	0.50±0.50	-
Striped mouse	3.18±2.01	0.50±0.50	-
Greater red musk shrew	1.02±1.02	-	-

<i>Cryptomys</i> spp. (Mole-rats)	-	8 mole-heaps	-
<i>Viverid</i> spp. (Slender mongoose)	1 set of spoor	-	-

Table 9.2 Habitat features characterising capture localities of small mammal species at IFR Site 2.

	Multimammate mouse (n=1)	Striped mouse (n=7)	Greater red musk shrew (n=2)
Vegetation			
Agriculture	-	-	-
Agriculture height	-	-	-
Shrubs	25.00	7.86±7.06	-
Shrub height	150.00	42.86±27.66	-
Sedge	-	-	-
Sedge height	-	-	-
Grass	25.00	85.71±9.22	87.50±12.50
Grass Height	50.00	38.57±4.04	87.50±12.50
Geomorphology			
Bare ground	50.00	7.14±7.14	0
Aspect	10.00	11.57±3.32	5.50±4.50
Soil	50.00	78.57±14.87	50.00±50.00
Rock	50.00	7.14±7.14	25.00±25.00
Clay	25.00	7.85±7.06	-
Sand	50.00	42.85±27.66	-
Pebbles	-	-	-
Boulder	-	-	-

9.4.3 Vegetation

The vegetation structure at IFR Site 2 is provided in Table 9.4. Both the lower and back dynamic zones were dominated by grass. Most of the trees were within the lower dynamic zone, while most shrubs were in the back dynamic zone.

9.4.4 Geomorphology

Both the lower and back dynamic zones comprised primarily of soil with boulders scattered throughout (Table 9.5). Some rocks, cobbles and logs were recorded within the aquatic zone.

9.5 Identification of key species/features, with reasons

The water-dependent bird species (African black duck, hamerkop, grey heron and white-breasted cormorant) are likely to be key species, not only because of their

dependence on water but also because of their low densities. However, other species of birds may be effected indirectly through changes that may occur in the lower dynamic zone, where most bird species were recorded. Species richness in the lower dynamic zone is therefore considered a key feature at IFR Site 2.

The mammal community is depauperate and dominated by a generalist rodent, the striped mouse, which can reach high densities in disturbed habitats (De Graaff 1981). The potential therefore exists that habitat alterations may have consequences for the dynamics of striped mice and in some instances may result in unpredictable fluctuations. The occurrence of greater red musk shrews in relatively high densities at this site is considered as important due to the IUCN classification of this species conservation status as vulnerable (IUCN 1996) (see Chapter 16 for more detail).

Table 9.3 Indices of bird densities (number of individuals per hour) followed by one standard error of the mean, ($n=5$) in the lower, back and aquatic zone of IFR Site 2. IFR Count refers to the total number of individuals observed at this IFR Site including observations outside the localities.

	Lower Zone	Back Zone	Aquatic Zone	IFR Count
Number of individuals	81	69	17	213
African black duck	-	0.53±0.53	0.53±0.53	4
Black-eyed bulbul	-	0.8±0.8	-	5
Banded martin	-	-	1.87±0.90	8
Black stork	-	0.27±0.27	-	1
Cape bunting	1.33±0.84	1.87±0.80	-	14
Cape rock thrush	0.27±0.27	-	-	1
Cape sparrow	3.46±3.46	0.80±0.80	0.27±0.27	25
Cape turtle dove	3.20±1.72	0.80±0.80	-	29
Cape weaver	1.87±1.87	-	-	14
Common waxbill	3.20±3.20	1.07±1.07	-	16
Cape white-eye	1.33±1.33	-	-	5
Cape wagtail	0.27±0.27	0.53±0.33	0.27±0.27	5
Grey heron	-	-	0.27±0.27	1
Hamerkop	0.27±0.27	0.27±0.27	0.27±0.27	3
Neddicky	0.27±0.27	0.53±0.33	-	4
Pied starling	0.53±0.53	1.60±1.60	-	8
Pale-winged starling	3.20±3.20	6.40±6.40	-	42
Rock bunting	-	0.27±0.27	-	1
Red-eyed bulbul	0.53±0.53	-	-	4
Rock martin	-	0.80±0.53	0.27±0.27	4
Rock pigeon	-	0.80±0.53	0.53±0.53	6
Spotted prinia	1.33±0.73	1.06±0.78	-	10
White-breasted cormorant	-	-	0.27±0.27	1
Wailing cisticola	0.53±0.53	-	-	2

Table 9.4 Gross vegetation structure at IFR Site 2. Data are presented as percentage cover followed by one standard error of the mean ($n=5$).

	Lower Zone	Back Zone
Trees	14.50±7.08	0.60±0.48
Shrubs	1.70±0.60	23.00±5.67
Reeds	2.50±2.50	-
Sedge	13.10±12.36	-
Grass	65.00±15.00	55.00±8.48
Bare ground	13.40±5.77	18.60±4.70
Agriculture	-	20.00±7.50

Table 9.5 Gross geomorphological features at IFR Site 2. Width of zones is given in metres, aspect as degrees and the various components as percentage cover of a particular zone. All means are followed by one standard error of the mean ($n=5$).

	Lower Zone	Back Zone		Aquatic Zone
Zone width	6.00±1.00	14.50±1.46	River width	54.00±2.45
Aspect	11.00±1.00	18.00±3.00		
Rock	15.00±7.29	15.50±4.28	River rock	1.40±0.93
Soil	65.00±16.49	77.50±6.12		
Sand	4.00±2.31	-	River sand	-
Cobble	0.50±0.50	5.00±5.00	River cobble	4.20±2.85
Pebble	-	-	River pebble	-
Boulder	22.50±11.45	8.00±7.39	River boulder	-
Clay	-	-		
Island length	-	-	Logs	0.10±0.10
Island width	-	-		
Island sand	-	-		
Island cobbles	-	-		
Island soil	-	-		

10 IFR SITE 3 - Malibamatso River at Paray

10.1 General overview of the characteristics of IFR Site 3

10.1.1 Locality A (29 28'S 28 38'E)

Slow flowing river in southerly direction. The eastern bank was comprised of a cornfield in the back dynamic zone, with shrubs and trees at the water's edge in the lower dynamic zone. The western bank was lined with scattered trees and sedges in the lower dynamic zone. There were low rock cliffs in the back dynamic zone. The small mammal trapping grid was located on eastern bank from the water's edge across both the lower and back dynamic zone.

10.1.2 Locality B (29 29'S 28 39'E)

Slow flowing river with minor rapids southerly direction. The western bank was comprised of grass and sedges, with sandflats in the lower dynamic zone and low rock banks in the back dynamic zone. There was a large tree in back dynamic zone on eastern bank, and lots of grass

and sedges in both dynamic zones. The small mammal trapping grid was located on western bank from the water's edge across both the lower and back dynamic zone.

10.1.3 Locality C (29 30'S 28 40'E)

Fast flowing river in south-east direction crossing a rapid. North-eastern bank was comprised of low rock cliffs delineating back dynamic zone. Lower dynamic some covered with scattered grass. Both dynamic zones on the south-western bank were comprised of grass and sedges. The small mammal trapping grid was located on south-western bank from the water's edge across both the lower and back dynamic zone.

10.1.4 Locality D (29 31'S 28 39'E)

Fast flowing river in south-west direction crossing a rapid. The north-western bank was comprised of low rock cliffs delineating the back dynamic zone. The lower dynamic

zone was covered with scattered shrubs. The south-eastern bank was comprised of grass and sedges in the lower dynamic zone and the low rock cliffs in back dynamic zone. The small mammal trapping grid was located on north-western bank from the water's edge across both the lower and back dynamic zone.

10.1.5 Locality E (29 32'S 28 38'E)

Fast flowing river in south-west direction crossing a rapid. The north-western bank was comprised of low rock cliffs delineating the back dynamic zone. The lower dynamic zone was covered with scattered shrubs. The south-eastern bank comprised grass and sedges in the lower dynamic zone, and low rock cliffs in the back dynamic zone. There was a small log in the aquatic zone. The small mammal trapping grid was located on north-western bank from the water's edge across both the lower and back dynamic zone.

The localities represent an IFR site characterised by a slow flowing river, few rapids, with parts of the upper dynamic zone being cultivated, a lower dynamic zone lined with predominantly scattered shrubs, sedges and grass at the water's edge.

10.2 Description of wildlife ecology at IFR Site 3

See Chapter 10.4.

10.3 Reach represented by IFR Site 3

As for the previous IFR sites, the wildlife component is characterised by primarily generalist species. It is therefore likely that IFR Site 3 will be representative of the Malibatso River from its confluence with the Matsoku River, to its confluence with the Senqu River.

10.4 Results

10.4.1 Mammals

Five species of small mammals were recorded as part of the trapping programme with signs of five additional species, notably the Cape clawless otter, also present (Table 10.1). Multimammate mice and white-tailed mice were only recorded in the lower dynamic zone. The Namaqua rock mouse, striped mouse and greater red musk shrew all appeared to have higher densities in the lower dynamic zone but non-significantly so due to large

between locality variation (Namaqua rock mouse: Mann-Whitney U-test, $Z = -1.88$, $p = 0.06$; striped mouse: Mann-Whitney U-test, $Z = -1.06$, $p = 0.28$ and greater red musk shrew: Mann-Whitney U-test, $Z = -0.77$, $p = 0.44$).

No habitat features were recorded at IFR Site 2.

10.4.2 Birds

Thirty-three species of bird were recorded with seven of these water dependent or associated species (Table 10.2). Approximately half of the birds were recorded in the lower dynamic zone. Birds utilising the aquatic zone directly included African black duck, Cape teal, darter, Egyptian goose, white-breasted cormorant, pied starling, house martin, jackal buzzard and rock pigeon of which the last three were flying. Note the relatively high densities of Cape bunting, common waxbill and Cape weaver in the lower dynamic zone compared to other species occurring in the same zone.

10.4.3 Vegetation

The lower dynamic zone was a mixture of shrubs, sedges, reeds, grasses and bare patches with very little trees (Table 10.3). The back dynamic zone was predominantly covered in grass.

10.4.4 Geomorphology

Relatively steep slopes characterised the lower dynamic zone comprising primarily rock and some sand close to the river (Table 10.4). The back dynamic zone was comprised of rock and sand at a more gentle slope, while the aquatic zone was characterised by little rocks and logs dispersed in the water.

10.5 Identification of key species/features, with reasons

Both the striped mouse and the multimammate mouse are known to reach plague densities in highly disturbed environments. However, the dynamics of these plagues are not well understood (Skinner & Smithers 1990). These two species are therefore considered as key species from a socio-economic point of view. Both the white-tailed mouse and the greater red musk shrew have threatened classifications (IUCN 1996) (see Section 16 for more detail) and are therefore also considered as key species. Furthermore, these species are more frequently found in the lower dynamic zone, which is likely to be

more severely impacted by changes in flow regimes in the short term than the back dynamic zone.

Of the larger mammals, Cape clawless otters are considered significant as they are almost exclusively dependent on water and associated habitats (Skinner and Smithers 1990).

The water-dependent birds (African black duck, Cape teal, darter, Egyptian goose and white-breasted cormorant) are all considered as key species. Bird species richness in the lower dynamic zone is also considered as a key feature for this site. However, a number of birds also utilised the back dynamic zone. Species richness in this zone should also be considered as a key feature for this site.

Table 10.1 Mammals and signs of mammals recorded at IFR Site 3. Data are presented as number of individuals captured per 100 trapnights (followed by one standard error of the mean, $n=5$) except where indicated otherwise.

	Lower Zone	Back Zone	Aquatic Zone
Namaqua rock mouse	10.33±2.35	4.43±1.92	-
Multimammate mouse	3.95±1.08	-	-
White-tailed mouse	2.41±1.93	-	-
Striped mouse	4.19±0.90	2.89±1.16	-
Greater red musk shrew	5.69±4.56	0.61±0.46	-
<i>Cryptomys</i> spp. (Molerats)	-	2 mole-heaps	-
Lagomorph spp. (Shrub hare)	-	12 diggings	-
Mustelid spp. (Cape clawless otter)	-	-	1 set of spoor
Felid spp. (Cats)	5 sets of spoor	1 set of spoor	-
Viverid spp. (Slender mongoose)	3 sets of spoor	1 set of spoor	-

Table 10.2 Indices of bird densities (number of individuals per hour) followed by one standard error of the mean ($n=5$) in the lower, back and aquatic zone of IFR Site 3. IFR Count refers to the total number of individuals observed at this IFR Site including observations outside the localities.

	Lower Zone	Back Zone	Aquatic Zone	IFR Count
Total number of individuals	66	39	17	136
African black duck	-	-	0.53±0.53	4
Black stork	-	0.27±0.27	-	1
Cape bunting	3.73±1.54	2.40±1.07	-	27
Cape batis	0.27±0.27	0.27±0.27	-	2
Cape robin	0.53±0.53	-	-	2
Cape reed warbler	0.27±0.27	-	-	1
Cape teal	-	-	0.53±0.53	4
Cape turtle dove	0.27±0.27	1.33±1.33	-	6
Cape weaver	2.13±2.13	0.53±0.53	-	10
Common waxbill	4.53±4.53	-	-	17
Cape wagtail	0.80±0.53	-	-	3
Darter	-	-	0.53±0.53	3
Drakensberg siskin	-	0.53±0.53	-	2
Egyptian goose	-	-	0.27±0.27	1
Familiar chat	-	-	-	1
Fiscal shrike	-	0.53±0.33	-	2
Grey Heron	0.27±0.27	-	-	1
House martin	0.27±0.27	0.27±0.27	0.80±0.80	5
Jackal buzzard	-	0.27±0.27	0.27±0.27	2
Mountain chat	1.60±1.29	0.27±0.27	-	7
Neddicky	-	-	-	1
Olive thrush	0.53±0.33	0.53±0.53	-	4
Pied starling	-	-	0.27±0.27	1
Pin-tailed whydah	0.53±0.53	-	-	4
Rock bunting	-	0.80±0.53	-	4
Red-eyed bulbul	0.27±0.27	0.80±0.80	-	4
Rock pigeon	-	0.80±0.80	0.27±0.27	4
Stone chat	-	0.53±0.53	-	2
Spotted prinia	-	0.27±0.27	-	1

	Lower Zone	Back Zone	Aquatic Zone	IFR Count
Three-banded plover	0.80±0.53	-	-	3
White-breasted cormorant	-	-	1.07±0.27	4
Wailing cisticola	0.53±0.33	-	-	2
Wattled starling	0.27±0.27	-	-	1

Table 10.3 Gross vegetation structure at IFR Site 3. Data are presented as percentage cover followed by one standard error of the mean ($n=5$).

	Lower Zone	Back Zone
Trees	0.10±0.10	0.10±0.10
Shrubs	33.00±11.79	18.50±6.92
Reeds	12.10±9.66	-
Sedge	25.50±6.86	-
Grass	13.50±5.89	85.00±7.28
Bare ground	23.70±5.29	16.00±6.82

Table 10.4 Gross geomorphological features at IFR Site 3. Width of zones is given in metres, aspect as degrees and the various components as percentage cover of a particular zone. $n=5$.

	Lower Zone	Back Zone	Aquatic Zone
Zone width	6.80±1.67	19.00±4.65	River width 50.00±0.00
Aspect	20.30±10.29	15.20±7.51	
Rock	62.50±7.90	52.60±6.12	River rock 2.60±1.12
Soil	15.00±10.00	52.50±7.28	
Sand	33.00±14.30	7.50±7.50	River sand -
Cobble	-	-	River cobble -
Pebble	-	-	River pebble -
Boulder	-	-	River boulder -
Clay	2.50±2.50	-	
Island length	-	-	Logs 0.10±0.10
Island width	-	-	
Island sand	-	-	
Island cobbles	-	-	
Island soil	-	-	

11 IFR SITE 4 - Senqu River at Sehonghong

11.1 General overview of the characteristics of IFR Site 4

11.1.1 Locality A (29 43'S 28 44'E)

Slow flowing river in south-eastern direction. The south-western bank was comprised of grass interspersed with cobbles in the lower dynamic zone with the back dynamic zone under cultivation. The north-eastern bank was characterised by a narrow lower dynamic zone and steep rocky cliffs in the back dynamic zone. The small mammal trapping grid was located on south-western bank from the water's edge across both the lower and back dynamic zones.

11.1.2 Locality B (29 44'S 28 45'E)

Slow flowing river in south-eastern direction with large sand bank in the aquatic zone. The south-western bank

was comprised of grazed grass the lower dynamic zone with a steep soil ridge flowing into the back dynamic zone under cultivation. The north-eastern bank was characterised by a narrow rocky lower dynamic zone and steep rocky cliffs in the back dynamic zone. The small mammal trapping grid was located on south-western bank from the water's edge across both the lower and back dynamic zones.

11.1.3 Locality C (29 44'S 28 46'E)

Slow flowing river in south-eastern direction with a low gradient rapid and large rocks against the south-western bank. The south-western bank was comprised of grass interspersed with shrubs in the lower dynamic zone and steep rocky cliffs in the back dynamic zone. A small stream entered from the north-east and created a large sand bank in the aquatic zone and an island primarily

covered in grass and shrubs. The north-eastern bank was characterised by a narrow lower dynamic zone with grass and shrubs and steep rocky cliffs in the back dynamic zone. The small mammal trapping grid was located on north-eastern bank from the water's edge across both the lower and back dynamic zones.

11.1.4 Locality D (29 45'S 28 46'E)

Slow flowing river in south-eastern direction with a low gradient rapid. The south-western bank was comprised of grass interspersed with shrubs in the lower dynamic zone and agriculture in the back dynamic zone. A tributary enters from the north-east and creates a large sand bank in the aquatic zone. The north-eastern bank was characterised by a narrow lower dynamic zone with grass and shrubs and agriculture in the back dynamic zone. The small mammal trapping grid was located on north-eastern bank from the water's edge across both the lower and back dynamic zones.

11.1.5 Locality E (29 45'S 28 47'E)

Slow flowing river in south-eastern direction. The south-western bank was comprised of grass interspersed with shrubs in the lower dynamic zone and agriculture in the back dynamic zone. The north-eastern bank was characterised by a narrow lower dynamic zone with grass and shrubs and a grass, interspersed with large rocks, covered the back dynamic zone. The small mammal trapping grid was located on north-eastern bank from the water's edge across both the lower and back dynamic zones.

These localities represent an IFR site with a relatively wide lower dynamic zone partly covered in grass and shrubs, and a back dynamic zone with some areas under cultivation and others steep rocky cliffs. The aquatic zone was characterised by some rapids and large rocks. There was also an island and some sand banks, where small tributaries entered the river.

11.2 Description of wildlife ecology at IFR Site 4

See Chapter 11.4.

11.3 Reach represented by IFR Site 4

As for the previous IFR sites, the wildlife component is characterised by primarily generalist species. It is therefore likely that the wildlife features measured at IFR Site 4 will be representative of the Senqu River from the confluence with the Malibatso River to the confluence with the Tsoelike River.

11.4 Results

11.4.1 Mammals

Only two small mammal species were recorded, both in the back dynamic zone (Table 11.1). This limits the conclusions that can be drawn about habitat features characterising small mammal capture sites (Table 11.2). Signs of six additional mammals were also recorded, the most notable of which were tracks of Cape clawless otters (Table 11.1).

11.4.2 Birds

Thirty species of bird were recorded, with most occurring in the lower dynamic zone (Table 11.3). Of these, two were water-dependent species (hamerkop and little stint).

11.4.3 Vegetation

A mixture of growth forms occurred in both the lower and back dynamic zones (Table 11.4). Trees and shrubs were relatively few.

Table 11.1 Mammals and signs of mammals recorded at IFR Site 4. Data are presented as number of individuals captured per 100 trapnights followed by one standard error of the mean ($n=5$) except where indicated otherwise.

	Lower Zone	Back Zone	Aquatic Zone
White-tailed mouse	-	0.91±0.91	-
Striped mouse	-	0.91±0.91	-
<i>Cryptomys</i> spp. (Molerats)	-	30 mole-heaps	-
Viverid spp. (Slender mongoose)	-	1 set of spoor	-
Felid spp. (Cat)	1 set of spoor	-	-
Greater red musk shrew	-	1 dead specimen	-
Mustelid spp. (Cape clawless otter)	1 set of spoor	-	-
Rodent burrows	-	25	-

Table 11.2 Habitat features characterising capture localities of small mammal species at IFR Site 4. Heights are given in centimetres and all other variables as percentage cover.

	White-tailed mouse (n=1)	Striped mouse (n=1)
Vegetation		
Agriculture	-	-
Agriculture height	-	-
Shrubs	5.00	50.00
Shrub height	30.00	50.00
Sedge	-	-
Sedge height	-	-
Grass	50.00	50.00
Grass Height	30.00	5.00
Geomorphology		
Bare ground	50.00	-
Aspect	1.00	20.00
Soil	100.00	100.00
Rock	-	-
Clay	5.00	50.00
Sand	30.00	50.00
Pebbles	-	-
Boulder	-	-

Table 11.3 Indices of bird densities (number of individuals per hour) followed by one standard error of the mean (n=5) in the lower, back and aquatic zone of IFR Site 4. IFR Count refers to the total number of individuals observed at this IFR Site including observations outside the localities.

	Lower Zone	Back Zone	Aquatic Zone	IFR Count
Total number of individuals	133	44	2	237
Black-backed cisticola	1.87±1.87	-	-	9
Banded martin	1.87±1.55	-	-	7
Black-throated canary	1.07±0.49	1.33±0.59	-	9
Cape bunting	4.27±1.36	0.53±0.53	0.27±0.27	33
Cape canary	1.60±1.60	-	-	7
Cape sparrow	3.20±1.49	0.80±0.80	-	38
Cape turtle dove	1.33±0.59	-	-	8
Cape weaver	0.53±0.32	-	-	7
Common waxbill	0.53±0.53	-	-	2
Cape wagtail	0.80±0.53	-	-	3
Fiscal shrike	0.53±0.53	-	-	2
Hamerkop	-	-	-	1
House martin	-	0.27±0.27	-	1
Le Vaillant's cisticola	-	-	-	3
Little stint	0.27±0.27	-	-	1
Mountain chat	2.40±1.48	-	-	9
Neddicky	0.27±0.27	-	-	1
Olive thrush	-	-	-	1
Pied starling	1.33±0.84	-	-	5
Pin-tailed whydah	-	1.87±1.87	-	7
Pale-winged starling	6.13±4.20	4.00±2.06	-	38
Rock bunting	3.20±2.55	0.27±0.27	-	13
Red-eyed bulbul	0.53±0.33	0.27±0.27	-	3
Rock kestrel	-	0.53±0.53	-	2
Rock martin	0.27±0.27	0.53±0.53	-	4
Rock pigeon	-	0.53±0.53	-	3
Stone chat	-	0.27±0.27	-	1
Spotted prinia	2.13±0.90	-	0.27±0.27	9
Wailing cisticola	0.53±0.53	0.53±0.53	-	4
White-throated canary	0.80±0.80	-	-	3

Table 11.4 Gross vegetation structure at IFR Site 4. Data are presented as percentage cover followed by one standard error of the mean ($n=5$).

	Lower Zone	Back Zone
Trees	0.60±0.48	1.50±0.61
Shrubs	8.10±4.79	1.70±0.48
Reeds	10.00±10.00	-
Sedge	32.50±5.00	5.00±5.00
Grass	42.50±6.37	67.50±5.00
Bare ground	24.10±9.11	26.00±8.31
Agriculture	-	7.50±5.00
Island bare ground	2.50±2.50	-
Island shrubs	7.50±7.50	-
Island grass	7.50±7.50	-

Table 11.5 Gross geomorphological features at IFR Site 4. Width of zones are given in metres, aspect as degrees and the various components as percentage cover of a particular zone. $n=5$.

	Lower Zone	Back Zone		Aquatic Zone
Zone width	8.20±1.11	26.50±6.30	River width	64.00±2.44
Aspect	11.40±4.95	16.40±6.40		
Rock	25.00±7.90	25.50±10.16	River rock	0.50±0.50
Soil	10.00±6.12	80.00±8.47		
Sand	70.00±6.37	-	River sand	17.50±7.50
Cobble	0.50±0.50	0.50±0.50	River cobble	12.50±5.59
Pebble	-	-	River pebble	-
Boulder	-	-	River boulder	-
Clay	-	-		
Island length	10.00±10.00	-	Logs	-
Island width	2.50±2.50	-		
Island sand	10.00±10.00	-		
Island cobbles	-	-		
Island soil	-	-		

11.4.4 Geomorphology

The lower dynamic zone was dominated by sand, with rock in some areas (Table 11.5). This zone was relatively narrow. The back dynamic zone was comprised primarily of a soil substrate and rocky areas. The aquatic zone had some sand and cobbles.

11.5 Identification of key species/features, with reasons

The key mammal species for this site included the Cape clawless otter. The little stint was also an addition to the list of water dependent or associated birds already identified at IFR Sites 1, 2 and 3. Species richness in the lower dynamic zone was also a key feature for reasons similar to those given for the other sites.

12 IFR SITE 5 - Senqu River at Whitehills

12.1 General overview of the characteristics of IFR Site 5

12.1.1 Locality A (30 03'S 28 24'E)

Slow flowing river in western direction. The southern bank was comprised of grass interspersed with shrubs in the lower dynamic zone with the back dynamic zone under cultivation. Some large boulders were present against this bank in the aquatic zone. The northern bank

was characterised by a narrow lower dynamic zone primarily comprising sand and agriculture in the back dynamic zone. The small mammal trapping grid was located on southern bank from the water's edge across both the lower and back dynamic zones.

12.1.2 Locality B (30 03'S 28 25'E)

Slow flowing river in western direction. The southern bank was comprised of grass interspersed with shrubs in the lower dynamic zone with the back dynamic zone under cultivation. The northern bank was characterised by a narrow lower dynamic zone primarily comprising sand and low rocky cliffs in the back dynamic zone with large rock blocks interspersed. The small mammal trapping grid was located on southern bank from the water's edge across both the lower and back dynamic zones.

12.1.3 Locality C (30 04'S 28 26'E)

Fast flowing river in north-western direction with high gradient rapid. A tributary entered the river from the north, and providing the cobbles for a large alluvial bar. Both zones on the south-western bank were comprised of grass, interspersed with shrubs and large rocks. The north-eastern bank was characterised by a lower dynamic zone primarily comprising sand and cobbles and a back dynamic zone that was under cultivation. The small mammal trapping grid was located on south-western bank from the water's edge across both the lower and back dynamic zones.

12.1.4 Locality D (30 03'S 28 27'E)

Slow flowing river in western direction. The lower dynamic zone on the southern bank was comprised of grass interspersed with shrubs, and the back dynamic zone was under cultivation. The back dynamic zone was bounded by cliffs some distance from the water. The northern bank was characterised by a narrow lower dynamic zone comprising of primarily sand. The back dynamic zone was under cultivation. The small mammal trapping grid was located on southern bank from the water's edge across both the lower and back dynamic zones.

12.1.5 Locality E (30 04'S 28 28'E)

Fast flowing river in western direction with rapid and cobbles. Part of southern side of the aquatic zone covered by boulders. The southern bank was comprised of grass interspersed with shrubs and trees in the lower dynamic zone with the back dynamic zone gentle slope with similar vegetation. The northern bank was characterised by a narrow lower dynamic zone primarily comprising sand and agriculture in the back dynamic zone. The small mammal trapping grid was located on

southern bank from the water's edge across both the lower and back dynamic zones.

These localities illustrate an IFR site characterised by a relatively slow-flowing sand bed river interspersed with some riffles. The natural vegetation in both zones was grass with shrubs and trees. Much of the back dynamic zone was under cultivation. The site was also characterised by a relatively narrow lower dynamic zone.

12.2 Description of wildlife ecology at IFR Site 5

See Chapter 12.4.

12.3 Reach represented by IFR Site 5

The wildlife features measured at IFR Site 5 should will be representative of the Senqu River between the Tsoelike and Senqunyane Rivers (see comments for IFR Sites 1, 2, and 3).

12.4 Results

12.4.1 Mammals

Only one species, the Namaqua rock mouse, was recorded as part of the trapping programme. However, signs of molerats were also observed (Table 12.1). The three Namaqua rock mouse individuals were recorded. These were found in an area dominated by grass and shrubs, with some bare patches of sand and soil (Table 12.2).

12.4.2 Birds

Twenty-two species of bird were recorded including one water-dependent species, the darter (Table 12.3). At this site most species were recorded in the back dynamic zone.

12.4.3 Vegetation

More than 50% of the lower dynamic zone was bare, while grass and shrubs dominated where vegetation was present (Table 12.4). Grass covered more than 50% of the back dynamic zone, which also had some shrub and agriculture present.

12.4.4 Geomorphology

This site was characterised by relatively steep inclines for both the back and lower dynamic zones, with sand, soil, boulders and cobbles characterising substrate structure in

the lower dynamic zone (Table 12.5). The back dynamic zone consisted primarily of soil. Note that boulders were relatively prominent in the aquatic zone.

Table 12.1 Mammals and signs of mammals recorded at IFR Site 5. Data are presented as number of individuals captured per 100 trapnights followed by one standard error of the mean ($n=5$) except where indicated otherwise.

	Lower Zone	Back Zone	Aquatic Zone
Namaqua rock mouse	-	3.09±3.09	-
<i>Cryptomys</i> spp. (Molerats)	5 mole-heaps	11 mole-heaps	-

Table 12.2. Habitat features characterising capture localities of small mammal species at IFR Site 5. Height is given in centimetres and the other variables as percentage cover.

	Namaqua rock mouse ($n=3$)
Vegetation	
Agriculture	-
Agriculture height	-
Shrubs	26.67±13.01
Shrub height	160.00±30.55
Sedge	-
Sedge height	-
Grass	33.33±8.33
Grass Height	53.33±24.03
Geomorphology	
Bare ground	50.00±14.43
Aspect	10.00±0.01
Soil	33.33±8.33
Rock	8.33±8.33
Clay	26.67±13.01
Sand	60.00±30.55
Pebbles	-
Boulder	-

Table 12.3 Indices of bird densities (number of individuals per hour) followed by one standard error of the mean ($n=5$) in the lower, back and aquatic zone of IFR Site 5. IFR Count refers to the total number of individuals observed at this IFR Site including observations outside the localities.

	Lower Zone	Back Zone	Aquatic Zone	IFR Count
Total number of individuals	20	51	3	74
Black-eyed bulbul	-	0.80±0.53	-	3
Banded martin	0.27±0.27	0.80±0.53	-	4
Cape bunting	0.80±0.53	-	-	3
Cape robin	0.53±0.53	-	-	2
Cape sparrow	0.27±0.27	2.40±1.48	-	10
Cape turtle dove	0.27±0.27	1.33±0.84	-	6
Cape wagtail	0.27±0.27	-	-	1
Darter	-	-	0.27±0.27	1
House martin	-	0.53±0.53	-	2
Lesser-striped swallow	-	0.27±0.27	-	1
Mountain chat	-	0.53±0.53	-	2
Neddicky	-	0.27±0.27	-	1
Pale-winged starling	-	0.53±0.53	-	2
Pied wagtail	-	-	0.53±0.33	2
Rock bunting	0.53±0.53	1.60±1.29	-	8
Red-eyed bulbul	1.07±1.07	1.60±0.77	-	10
Rock martin	-	0.53±0.53	-	2
Rock pigeon	-	1.87±0.80	-	7
Speckled mousebird	0.80±0.80	-	-	3
Spotted prinia	-	0.27±0.27	-	1
Wailing cisticola	0.27±0.27	0.27±0.27	-	2
White-rumped swift	0.27±0.27	-	-	1

Table 12.4 Gross vegetation structure at IFR Site 5. Data are presented as percentage cover followed by one standard error of the mean ($n=5$).

	Lower Zone	Back Zone
Trees	1.10±0.57	0.60±0.48
Shrubs	12.10±4.36	12.60±3.96
Reeds	-	-
Sedge	7.50±5.00	-
Grass	28.50±4.91	53.00±4.63
Bare ground	57.50±8.47	34.00±2.69
Agriculture	-	7.50±5.00
Island bare ground	-	-
Island shrubs	-	-
Island grass	-	-

Table 12.5 Gross geomorphological features at IFR Site 5. Width of zones is given in metres, aspect in degrees and the various components as percentage cover of a particular zone. $n=5$.

	Lower Zone	Back Zone		Aquatic Zone
Zone width	10.50±5.01	23.00±5.50	River width	72.00±3.39
Aspect	18.00±4.35	21.00±1.00		
Rock	3.50±2.31	5.00±3.06	River rock	-
Soil	25.00±11.18	80.00±6.37		
Sand	38.00±7.72	-	River sand	10.00±6.12
Cobble	13.10±9.53	0.10±0.10	River cobble	6.00±4.84
Pebble	-	0.50±0.50	River pebble	5.00±5.00
Boulder	18.00±14.43	15.00±6.12	River boulder	15.00±10.00
Clay	-	-		
Island length	-	-	Logs	-
Island width	-	-		
Island sand	-	-		
Island cobbles	-	-		
Island soil	-	-		

12.5 Identification of key species/features, with reasons

The results obtained for this site show no additional key species or features need to be considered in addition to those that have already been highlighted for other sites.

Only the darter is of concern here and like before, species richness in the back dynamic zone will be an important feature.

13 IFR SITE 6 - Senqu River at Seaka Bridge

13.1 General overview of the characteristics of IFR Site 6

13.1.1 Locality A (30 22'S 27 34'E)

Slow flowing river in a south-westerly direction. The south-eastern bank was comprised of grazed grass with few trees at the water's edge. The back dynamic zone is covered in grazed grass. Some large boulders in the aquatic zone against the north-western bank. This bank was characterised by a narrow lower dynamic zone primarily comprising large rocks and boulders. The back dynamic zone had similar features. The small mammal

trapping grid was located on north-western bank from the water's edge across both the lower and back dynamic zones.

13.1.2 Locality B (30 22'S 27 33'E)

Slow flowing river in south-western direction. The south-eastern bank was comprised of grazed grass. The back dynamic zone is covered in grassed grass. There were some large sandbanks in the aquatic zone. The north-western bank was characterised by a narrow lower dynamic zone primarily comprising large rocks and boulders. The back dynamic zone had similar features.

The small mammal trapping grid was located on north-western bank from the water's edge across both the lower and back dynamic zones.

13.1.3 Locality C (30 23'S 27 33'E)

Slow flowing river in south-western direction. The south-eastern bank was comprised of grazed grass. The back dynamic zone is covered in grassed grass. There were some large sandbanks in the aquatic zone. The north-western bank was characterised by a narrow lower dynamic zone primarily comprising large rocks and boulders. The back dynamic zone had similar features. A deep gully characterised this bank. The small mammal trapping grid was located on north-western bank from the water's edge across both the lower and back dynamic zones.

13.1.4 Locality D (30 24'S 27 33'E)

Slow flowing river in south-western direction. The south-eastern bank was comprised of grazed grass and some shrubs. The back dynamic zone is covered in grazed grass. There were some large sandbanks in the aquatic zone. The north-western bank was characterised by a narrow lower dynamic zone primarily comprising large rocks and boulders. The back dynamic zone had similar features. A few large trees lined the water's edge. The small mammal trapping grid was located on north-western bank from the water's edge across both the lower and back dynamic zones.

13.1.5 Locality E (30 25'S 27 33'E)

Slow flowing river in south-western direction with a small stream entering the river from the north. The south-eastern bank was comprised of grazed grass and some shrubs. The back dynamic zone is covered in grazed grass. There were some large sandbanks in the aquatic zone. The north-western bank was characterised by a narrow lower dynamic zone primarily comprising large rocks and boulders. The back dynamic zone had similar features. The small mammal trapping grid was located on north-western bank from the water's edge across both the lower and back dynamic zones.

These localities characterise an IFR site with slow flowing river, large sandbanks in the aquatic zone, a lower dynamic zone that consisted of grass and shrubs, interspersed with trees, rocks and boulders. The back

dynamic zone on the north-western bank was similar to the lower dynamic zone. On the south-eastern bank it was dominated by heavily-grazed grass.

13.2 Description of wildlife ecology at IFR Site 6

See Chapter 13.4.

13.3 Reach represented by IFR Site 6

The wildlife features measured at IFR Site 6 are probably representative of the Senqu River from the confluence with the Senqunyane River to the Lesotho/South African border.

13.4 Results

13.4.1 Mammals

Two species of small mammals were recorded as part of the trapping programme (Table 13.1). Multimammate mice were only recorded in the back dynamic zone, while striped mice were recorded in both zones in near equal densities (Mann-Whitney U-test, $Z = -1.62$, $p = 0.11$). The one multimammate mouse was caught at a site with good grass cover and shrubs on a sandy soil for substrate (Table 13.2). The striped mouse appeared to prefer soil areas that were well covered by grass.

13.4.2 Birds

Twenty-six species of birds were recorded, including three water dependent or associated species viz.: grey heron, black-headed heron and three-banded plover (Table 13.3). Most birds were recorded in the back dynamic zone.

13.4.3 Vegetation

Vegetation was distinct and variable between the two banks resulting in the large standard errors recorded for this site (Table 13.4). The vegetation in both zones was comprised of grass with trees and shrubs, interspersed by bare patches.

13.4.4 Geomorphology

The lower dynamic zone was comprised predominantly of sand and soil substrates and the back dynamic zone of soil (Table 13.5). Approximately 30% of the aquatic zone was covered in sand.

Table 13.1 Mammals and signs of mammals recorded at IFR Site 6. Data are presented as number of individuals captured per 100 trapnights followed by one standard error of the mean (n=5) except where indicated otherwise.

	Lower Zone	Back Zone	Aquatic Zone
Multimammate mouse	-	0.56±0.56	-
Striped mouse	1.02±1.02	1.11±0.49	-
Felid spp. (Cat)	1 set of spoor	-	-

Table 13.2 Habitat features characterising capture localities of small mammal species at IFR Site 6. Heights are given as centimetres while all other variables are given as percentage cover.

	Multimammate mouse (n=1)	Striped mouse (n=5)
Vegetation		
Agriculture	-	-
Agriculture height	-	-
Shrubs	25.00	5.00±5.00
Shrub height	200.00	36.00±36.00
Sedge	-	-
Sedge height	-	-
Grass	75.00	100.00±0.01
Grass Height	20.00	53.00±11.57
Geomorphology		
Bare ground	25.00	1.20±0.96
Aspect	20.00	20.00±0.01
Soil	100.00	95.00±5.00
Rock	-	-
Clay	25.00	5.00±5.00
Sand	100.00	36.00±36.00
Pebbles	-	-
Boulder	-	-

Table 13.3 Indices of bird densities (number of individuals per hour) followed by one standard error of the mean (n=5) in the lower, back and aquatic zone of IFR Site 6. IFR Count refers to the total number of individuals observed at this IFR Site including observations outside the localities.

	Lower Zone	Back Zone	Aquatic Zone	IFR Count
Total number of individuals	51	85	11	176
Black-eyed bulbul	0.53±0.53	0.53±0.33	-	4
Black-headed heron	-	0.27±0.27	0.27±0.27	2
Cape bunting	-	0.53±0.53	-	2
Cape canary	-	0.53±0.53	-	2
Cape robin	0.80±0.53	-	-	3
Cape sparrow	1.33±0.84	4.53±3.02	0.53±0.53	38
Cape turtle dove	1.33±1.33	0.53±0.33	-	8
Common waxbill	0.53±0.53	4.80±3.20	-	20
Cape white-eye	0.80±0.80	3.73±2.61	-	17
Cape wagtail	0.80±0.53	-	-	5
Grey Heron	-	-	1.07±0.49	4
Malachite sunbird	0.53±0.33	-	-	2
Neddicky	0.53±0.33	0.80±0.33	-	5
Olive thrush	0.53±0.53	-	-	2
Pied crow	1.07±1.07	-	-	4
Pin-tailed whydah	0.53±0.53	0.53±0.53	-	6
Pale-winged starling	1.07±1.07	0.53±0.53	-	8
Pied wagtail	0.53±0.53	-	-	3
Rock bunting	0.27±0.27	1.87±0.67	-	11
Red-eyed bulbul	0.80±0.53	0.80±0.53	-	6
Rock pigeon	0.53±0.53	0.53±0.53	0.53±0.33	8
Stone chat	0.53±0.33	0.53±0.53	-	4
Spotted flycatcher	-	0.53±0.53	-	2
Speckled mousebird	0.27±0.27	0.53±0.53	-	3

Three-banded plover	-	-	0.53±0.33	2
Wailing cisticola	0.27±0.27	0.53±0.33	-	4
White-throated canary	-	-	-	1

Table 13.4 Gross vegetation structure at IFR Site 6. Data are presented as percentage cover followed by one standard error of the mean ($n=5$).

	Lower Zone	Back Zone
Trees	33.20±17.17	14.70±9.15
Shrubs	8.50±4.65	15.60±4.34
Reeds	-	-
Sedge	-	-
Grass	40.50±6.09	60.50±4.43
Bare ground	42.50±6.37	31.20±8.05
Agriculture	-	-
Island bare ground	-	-
Island shrubs	-	-
Island grass	-	-

Table 13.5 Gross geomorphological features at IFR Site 6. Width of zones is given in metres, aspect in degrees and the various components as percentage cover of a particular zone. $n=5$.

	Lower Zone	Back Zone		Aquatic Zone
Zone width	6.20±1.18	15.20±1.63	River width	95.50±5.00
Aspect	19.00±2.91	24.00±1.87		
Rock	2.50±2.50	0.50±0.50	River rock	0.20±0.20
Soil	37.50±10.45	95.00±3.06		
Sand	53.00±8.26	-	River sand	30.20±9.19
Cobble	7.50±7.50	-	River cobble	0.20±0.20
Pebble	0.10±0.10	2.60±2.60	River pebble	-
Boulder	-	3.50±2.31	River boulder	0.20±0.20
Clay	-	-		
Island length	-	-	Logs	0.20±0.20
Island width	-	-		
Island sand	-	-		
Island cobbles	-	-		
Island soil	-	-		

13.5 Identification of key species/features, with reasons

The key mammal species were the Namaqua rock rat, white tailed mouse, striped mouse and red musk shrew, all of which were identified previously. The grey heron,

black-headed heron and three-banded plover were of concern here. Once again, species richness in the back dynamic zone was an important feature.

14 IFR SITE 7 - Senqunyane River at Marakabei

14.1 General overview of the characteristics of IFR Site 7

14.1.1 Locality A (29 32'S 28 03'E)

Fast flowing river in south-western direction. The south-eastern bank was comprised of a cornfield in back dynamic zone with grass and scattered shrubs in the lower dynamic zone at the water's edge. The north-western bank was characterised by scattered cobbles and some boulders lined with shrubs in the lower dynamic zone. Agriculture was present in the back dynamic zone.

The small mammal trapping grid was located on north-western bank from the water's edge across both the lower and back dynamic zones.

14.1.2 Locality B (29 33'S 28 02'E)

Fast flowing river in southern direction. The eastern bank was comprised of a cornfield in back dynamic zone with grass and scattered trees in the lower dynamic zone at the water's edge. A stream flowed in providing a relative large aluvial plain in the lower dynamic zone and a rapid at the point of entry. The lower dynamic zone on the western bank was lined with trees. Agriculture was present in the back dynamic zone. The small mammal trapping grid was located on western bank from the water's edge across both the lower and back dynamic zones.

14.1.3 Locality C (29 34'S 28 03'E)

Slow flowing river forming a large pool in a south-eastern direction. Both banks lined in trees in the lower dynamic zone with trees on the south-western bank more dense. The back dynamic zones were characterised by agriculture and a alluvial plain on the north-eastern side. The small mammal trapping grid was located on south-western bank from the water's edge across both the lower and back dynamic zones.

14.1.4 Locality D (29 34'S 28 04'E)

Fast flowing river in a south-eastern direction characterised by two rapids. The northern-eastern bank was characterised by a rocky lower dynamic zone and low rock cliffs in the back dynamic zone. Lower dynamic zone of the south-western bank lined with trees, while limited agriculture featured in the back dynamic zone characterised by low cliffs further away from the river. The small mammal trapping grid was located on south-western bank from the water's edge across both the lower and back dynamic zones.

14.1.5 Locality E (29 35'S 28 04'E)

Slow flowing river forming a large pool in a southern direction. Western bank lined in trees in the lower dynamic zone and a stream entering the river. The back dynamic zone was characterised by agriculture. The eastern bank characterised by a rocky lower and back dynamic zone. Low rock cliffs in the back dynamic zone. The small mammal trapping grid was located on western bank from the water's edge across both the lower and back dynamic zones.

These localities represent an IFR site characterised by a slow flowing river, interspersed with some riffles/rapids. Parts of the upper dynamic zone were cultivated, then lower dynamic zone lined with trees and the back dynamic

zone characterised by relative steep rocky cliffs.

14.2 Description of wildlife ecology at IFR Site 7

See Chapter 14.4.

14.3 Reach represented by IFR Site 7

The wildlife features measured at IFR Site 7 will be representative of the Senqunyane River from the site of the proposed Mohale Dam to the confluence with the Lesobeng River.

14.4 Results

14.4.1 Mammals

Five species of small mammals were recorded as part of the trapping programme (Table 14.1). The multimammate mouse and the white-tailed mouse were not recorded in the back dynamic zone, while significantly higher densities of the Namaqua rock mouse (Mann-Whitney U-

test, $Z = -2.62$, $p = 0.01$) and the striped mouse (Mann-Whitney U-test, $Z = -2.42$, $p = 0.02$) were recorded in the lower dynamic zone than in the back dynamic zone. Note that for this site higher densities of the greater red musk shrew were recorded in the back dynamic zone but that large variations resulted in no significant differences (Mann-Whitney U-test, $Z = -1.67$, $p = 0.09$). Signs of four other mammalian species were also recorded (Table 14.1).

No habitat features were recorded at this site.

14.4.2 Birds

Twenty-three species of bird were recorded, six of which utilised the aquatic zone (Table 14.2). Notable water dependent birds included the grey heron, hamerkop, white-breasted cormorant and giant kingfisher. This site was characterised by more birds being recorded in the back dynamic zone than in the lower dynamic zone.

Table 14.1 Mammals and signs of mammals recorded at IFR Site 7. Data are presented as number of individuals captured per 100 trapnights followed by one standard error of the mean ($n=5$) except where indicated otherwise.

	Lower Zone	Back Zone	Aquatic Zone
Namaqua rock mouse	17.34±2.21	3.61±2.17	-
Multimammate mouse	1.92±1.07	-	-
White-tailed mouse	4.17±1.94	-	-
Striped mouse	9.53±1.43	2.38±1.31	-
Greater red musk shrew	2.62±2.62	11.52±6.04	-
<i>Cryptomys</i> spp. (Molerats)	-	10 mole-heaps	-
Rodent burrows	-	35	-
Felid spp. (Cats)	4 sets of spoor	1 set of spoor	-
Viverid spp. (Slender mongoose)	1 set of spoor	-	-

14.4.3 Vegetation

The lower dynamic zone was relatively bare, with grass and trees comprising most of the present vegetation structure (Table 14.3). The back dynamic zone was dominated by grass interspersed with shrubs and limited agriculture.

14.4.4 Geomorphology

The lower dynamic zone was comprised of rock, soil, sand and some cobbles and boulders, while the back dynamic zone comprised primarily sand with some rocky features (Table 14.4). The aquatic zone was covered in cobbles, with relatively little boulders and sand.

14.5 Identification of key species/features, with reasons

Key mammal species are the Namaqua rock rat, white tailed mouse, striped mouse and red musk shrew all of which were identified previously. The giant kingfisher was added to the list of key water dependent bird species. A much higher number of birds were recorded in the back dynamic zone at this site than at the other IFR sites, this was probably partly because the lower dynamic zone was only c. 10 m wide, making surveying easier. Species richness changes that may take place in association with changes in flow regimes in the back dynamic zone are therefore considered as a key feature for this site.

Table 14.2 Indices of bird densities (number of individuals per hour) followed by on standard error of the mean ($n=5$) in the lower, back and aquatic zone of IFR Site 7. IFR Count refers to the total number of individuals observed at this IFR Site including observations outside the localities.

	Lower Zone	Back Zone	Aquatic Zone	IFR Count
Total number of individuals	36	56	26	186
Cape bunting	0.27±0.27	1.60±0.78	-	13
Cape batis	-	-	-	1
Cape sparrow	0.53±0.33	1.60±0.78	-	20
Cape turtle dove	1.60±1.07	1.60±0.78	0.27±0.27	35
Cape weaver	-	1.60±1.60	-	7
Common waxbill	1.33±1.03	-	-	5
Cape white-eye	2.67±2.67	0.80±0.80	-	13
Cape wagtail	0.27±0.27	0.27±0.27	-	2
European swallow	-	1.33±1.33	-	5
Grey Heron	-	-	0.27±0.27	1
Giant kingfisher	-	-	0.27±0.27	1
Hamerkop	-	-	0.27±0.27	1
Helmeted guinea-fowl	-	-	5.60±5.60	21
Jackal buzzard	-	-	-	2
Neddicky	1.33±1.3	1.07±0.27	-	16
Pale-winged starling	-	1.07±1.07	-	9
Rock bunting	-	0.27±0.27	-	2
Red-eyed bulbul	1.07±1.07	-	-	7
Rock martin	-	1.07±1.07	-	4
Stone chat	0.27±0.27	0.27±0.27	-	2
Spotted prinia	0.27±0.27	1.33±1.03	-	6
White-breasted cormorant	-	-	0.27±0.27	1
Wailing cisticola	-	1.07±0.65	-	7

Table 14.3 Gross vegetation structure at IFR Site 7. Data are presented as percentage cover followed by one standard error of the mean ($n=5$).

	Lower Zone	Back Zone
Trees	15.00±9.18	2.50±2.50
Shrubs	5.60±5.47	19.10±11.15
Reeds	-	-
Sedge	12.50±6.84	-
Grass	26.60±7.68	57.50±9.35
Bare ground	55.10±8.46	13.00±7.72
Agriculture	-	17.50±12.24
Island bare ground	-	7.50±7.50
Island shrubs	-	0.10±0.10
Island grass	-	2.50±2.50

Table 14.4 Gross geomorphological features at IFR Site 7. Width of zones is given in metres, aspect in degrees and the various components as percentage cover in a particular zone. $n=5$.

	Lower Zone	Back Zone		Aquatic Zone
Zone width	10.50±0.93	14.50±1.65	River width	27.00±3.74
Aspect	10.40±3.39	20.40±8.35		
Rock	30.60±9.96	26.00±12.76	River rock	1.40±0.92
Soil	25.00±19.36	75.50±12.87		
Sand	28.10±9.29	-	River sand	0.50±0.50
Cobble	15.00±12.11	-	River cobble	21.20±11.78
Pebble	-	2.50±2.50	River pebble	-
Boulder	7.50±7.50	-	River boulder	-
Clay	-	-		
Island length	-	2.00±2.00	Logs	-
Island width	-	0.50±0.50		
Island sand	-	-		
Island cobbles	-	7.50±7.50		
Island soil	-	2.50±2.50		

15 IFR SITE 8 - Senqunyane River upstream of the confluence with the Senqu River

15.1 General overview of the characteristics of IFR Site 8

15.1.1 Locality A (30 01'S 28 13'E)

Slow flowing river in south-western direction. The south-eastern bank was comprised of large boulders interspersed between shrubs and trees in the lower dynamic zone. The back dynamic zone characteristically with steep cliffs. The north-western bank was of more gentle slope characterised by sands and grazed grass. The small mammal trapping grid was located on south-eastern bank from the water's edge across both the lower and back dynamic zones.

15.1.2 Locality B (30 01'S 28 12'E)

Slow flowing river in south-western direction. The lower dynamic zone on the south-eastern bank was comprised of large boulders between shrubs and dense trees. The back dynamic zone consisted of steep cliffs. The north-

western bank was of more gentle slope and both zones were characterised by sands and grazed grass interspersed with cobbles. The small mammal trapping grid was located on south-eastern bank from the water's edge across both the lower and back dynamic zones.

15.1.3 Locality C (30 02'S 28 12'E)

Slow flowing river in south-western direction with a rapid. The lower dynamic zone on the south-eastern bank was comprised of large boulders between shrubs and dense trees. The back dynamic zone consisted of steep cliffs. The north-western bank was of more gentle slope and both zones were characterised by grass. Large parts of the aquatic zone covered in cobbles. The small mammal trapping grid was located on south-eastern bank from the water's edge across both the lower and back dynamic zones.

15.1.4 Locality D (30 02'S 28 12'E)

Slow flowing river in western direction with a low gradient rapid. The lower dynamic zone on the southern bank was narrow and dominated by shrubs. The back dynamic zone was under cultivation, and was bounded by steep cliffs. The northern bank was characterised by steep rocky cliffs in both the lower and back dynamic zone. A large sand flat characterised the southern half of the aquatic zone with some pebbles along the northern-eastern bank. The small mammal trapping grid was located on southern bank from the water's edge across both the lower and back dynamic zones.

15.1.5 Locality E (30 03'S 28 11'E)

Slow flowing river in south-western direction entering a larger river (Senqu) south-west of this locality. The south-eastern bank was comprised of soil with little shrub in the lower dynamic zone while agriculture predominated in the back dynamic zone. The north-western bank was characterised by steep rocky cliffs in both the lower and back dynamic zones. Approximately half of the aquatic zone comprised sand. The small mammal trapping grid was located on south-eastern bank from the water's edge across both the lower and back dynamic zones.

These localities represent an IFR site characterised by a slow flowing river and few rapids. Parts the back dynamic zone were cultivated but most comprised low rocky cliffs. The lower dynamic zone was dominated by shrubs and trees, interspersed with cobbles and boulders, and with the odd grazed grassy slope.

15.2 Description of wildlife ecology at IFR Site 8

See Chapter 15.4.

15.3 Reach represented by IFR Site 8

As for the previous IFR sites, the wildlife component is characterised by primarily generalist species. It is therefore likely that the wildlife features measured at IFR Site 8 will be representative of Senqunyane River from the Lesobeng confluence to the confluence with the Senqu River.

15.4 Results

15.4.1 Mammals

Four small mammal species were recorded as part of the trapping programme while signs of one additional mammal were recorded (Table 15.1). The white-tailed mouse was only recorded in the lower dynamic zone with both the Namaqua rock mouse (Mann-Whitney U-test, $Z = -2.67$, $p = 0.01$) and the striped mouse (Mann-Whitney U-test, $Z = -2.67$, $p = 0.01$) occurring in higher densities in the lower dynamic zone. Greater red musk shrews were recorded at higher densities in the back dynamic zone, but as before variation between localities at this site resulted in these differences between zones being not-significant (Mann-Whitney U-test, $Z = -1.78$, $p = 0.07$)

No recordings of habitat features were made at this site.

15.4.2 Birds

Only 11 species of birds were recorded at this site, with most species being recorded in the back dynamic zone (Table 15.2). No species were recorded in the aquatic zone.

15.4.3 Vegetation

The vegetation in the lower dynamic zone was comprised of grass, with more than 50% bare ground (Table 15.3). Some trees and shrubs were present. The back dynamic zone had more trees and fewer bare areas.

15.4.4 Geomorphology

Soil and sand, with some boulders, dominated the lower dynamic zone (Table 15.4). This zone was characteristically narrow. The back dynamic zone was steep and was comprised of soil, rock and boulders. Thirty percent of the aquatic zone was covered in pebbles.

15.5 Identification of key species/features, with reasons

Four small mammal species (Namaqua rock rat, white tailed mouse, striped mouse and red musk shrew) are considered to be key species for IFR site 8, for the same reasons as provided previously. The total lack of water-dependent bird species suggest that these are not key species at this site. However this survey was only conducted once. Some water dependent species are

expected to occur here (see Section 16). The use of the back dynamic zone by most bird species suggests that this may be a key feature of this site.

Table 15.1 Mammals and signs of mammals recorded at IFR Site 8. Data are presented as number of individuals captured per 100 trapnights followed by one standard error of the mean ($n=5$), except where indicated otherwise.

	Lower Zone	Back Zone	Aquatic Zone
Namaqua rock rat	14.20±1.01	7.10±1.01	-
White-tailed mouse	0.72±0.72	-	-
Striped mouse	8.76±0.61	4.50±0.61	-
Greater red musk shrew	1.54±0.55	7.90±3.39	-
<i>Cryptomys</i> spp. (Molerats)	-	6 mole-heaps	-

Table 15.2 Indices of bird densities (number of individuals per hour) followed by one standard error of the mean ($n=5$) in the lower, back and aquatic zone of IFR Site 8. IFR Count refers to the total number of individuals observed at this IFR Site including observations outside the localities.

	Lower Zone	Back Zone	Aquatic Zone	IFR Count
Total number of individuals	27	79	-	121
Cape bunting	0.53±0.53	-	-	2
Cape sparrow	0.53±0.33	0.53±0.53	-	4
Cape turtle dove	0.80±0.53	1.87±1.23	-	14
Familiar chat	0.53±0.53	0.80±0.53	-	5
Neddicky	-	0.53±0.33	-	3
Pale-winged starling	2.40±1.80	8.00±3.67	-	44
Rock bunting	1.07±0.49	2.13±0.68	-	14
Red-eyed bulbul	0.80±0.80	1.33±0.84	-	8
Rock kestrel	-	0.53±0.33	-	2
Rock pigeon	-	5.33±1.83	-	20
Wailing cisticola	0.53±0.53	-	-	3

Table 15.3 Gross vegetation structure at IFR Site 8. Data are presented as percentage cover followed by one standard error of the mean ($n=5$).

	Lower Zone	Back Zone
Trees	1.10±0.57	8.50±2.44
Shrubs	5.60±2.84	22.60±2.40
Reeds	-	-
Sedge	-	-
Grass	46.00±5.84	45.50±6.24
Bare ground	50.50±3.57	25.50±3.57
Agriculture	-	-
Island bare ground	-	-
Island shrubs	-	-
Island grass	-	-

Table 15.4 Gross geomorphological features at IFR Site 8. Width of zones is given in metres, aspect in degrees and the various components as percentage cover of a particular zone. $n=5$.

	Lower Zone	Back Zone		Aquatic Zone
Zone width	6.20±1.18	15.20±1.63	River width	50.00±0.01
Aspect	10.00±0.01	26.00±3.67		
Rock	15.00±9.18	15.00±4.67	River rock	-
Soil	38.00±9.86	67.50±3.06		
Sand	27.50±9.18	-	River sand	-
Cobble	-	-	River cobble	-
Pebble	2.50±2.50	-	River pebble	31.00±14.08
Boulder	17.50±8.47	17.50±5.00	River boulder	-
Clay	-	-		
Island length	-	-	Logs	-
Island width	-	-		
Island sand	-	-		
Island cobbles	-	-		
Island soil	-	-		

16 SUMMARY OF THE PRESENT-DAY CONDITION OF THE LESOTHO RIVERS RELATIVE TO THE NATURAL CONDITION WITH RESPECT TO WILDLIFE ECOLOGY

16.1 Introduction

The data presented illustrate that the wildlife associated with Lesotho's large rivers is relative depauperate. This may be a reflection of the domination of relatively common species at the sites sampled. However, some species that occur in the study area may not have been recorded in the field study. These species may be of conservation concern or economic importance. Furthermore, no flow relevant analyses have been conducted as yet.

The data presented thus far were used to identify key species and characteristics of communities at the IFR sites that need to be considered in the IFR determinations (Table 16.1). The objective of this chapter is to develop models to predict likely changes in these key species and characteristics with changes in flow regimes. This is done in Chapter 16.4.

Section 16.2 provides a full list of species that may occur at IFR sites (but were not necessarily recorded during this study), based on known distribution of species. A summary of their conservation status as currently assessed by the IUCN (IUCN 1996) is also provided. This section also provides an assessment of inter-site differences and is followed by the development of multiple regression models for each species to be incorporated in the IFR Workshop.

16.2 Species list

16.2.1 Mammals

Sixty-eight species of mammals are likely to occur in the catchments of the Lesotho rivers (Table 16.2). Of these 21 are expected to be affected directly or indirectly by any changes in flow regimes of the rivers. Only one mammal species, the Cape clawless otter, are likely to be affected directly and the influence of changes in flow regime has been indicated as high. Two of the indirectly affected species, the striped mouse and the greater red musk shrew, have IUCN recognition (IUCN 1996). Information for the striped mouse is not suitable to make a judgement while the greater musk shrew has been classified as vulnerable (IUCN 1996). Both these species have already been identified as key species and will be dealt with in Part 6.

References consulted in the construction of Table 16.2 include Borquin (1989), Bigalke (1972), Bigalke (1978), Coe & Skinner (1993), de Graaf (1981), Duthie, Skinner & Robertson (1989), Gelderblom (1993), Gelderblom & Bronner (1995), Lynch (1981), Lynch (1983), Lynch (1985), Lynch (1986), Lynch (1989), Lynch (1990), Lynch (1991), Lynch (1993), Lynch & Watson (1990), Lynch & Watson (1992), Meakins *et al.* (1988), Meester (1965), Meester, Rautenbach, Dippenaar & Baker (1986), Nel (1993), Nel, Avenant & Purves (1996), Pringle (1974), Rautenbach (1982), Rowe-Rowe (1982), Rowe-Rowe (1991), Rowe-Rowe (1992), Rowe-Rowe & Meester

(1982a), Rowe-Rowe & Meester (1982b), Rowe-Rowe & Meester (1985), Rowe-Rowe (1983a), Rowe-Rowe Table 16.1 Key species and features identified for IFR sites comprising the present study.

Species/Feature	Reason
Mammals	
Multimammate mouse	Economic impacts
Greater red musk shrew	Conservation status
Striped mouse	Economic impacts
White-tailed mouse	Conservation status
Cape clawless otter	Water dependent
Birds	
Black duck	Water dependent
Hamerkop	Water dependent
Grey heron	Water dependent
White-breasted cormorant	Water dependent
Cape teal	Water dependent
Darter	Water dependent
Egyptian goose	Water associated
Giant kingfisher	Water associated
Yellow-billed duck	Water dependent
Little stint	Water associated
Black-headed heron	Water dependent
Three-banded plover	Water associated
Features	
Species richness in lower dynamic zone	High usage by terrestrial birds
Species richness in back dynamic zone	High usage by terrestrial birds

(1983b), Rowe-Rowe (1984), Rowe-Rowe & Lowry (1982), Rowe-Rowe & Scotcher (1986), Siegfried & Brown (1992), Skinner & Smithers (1990), Stuart & Stuart (1993), van Aarde & Ferreira (1994), Watson (1990a), Watson (1990b), Whitten, Byrne & Henzi (1987) and Willan (1990).

Note that some of the mammal species have been assigned different conservation status based on local assessments in 1986. Of interest is the southern African hedgehog which was rare (Smithers 1986) and which are likely to occur at IFR Sites 5 & 6. Impacts of changing flow regimes on this species are likely to be low. The white-tailed mouse was assigned vulnerable and is endemic to southern Africa (Smithers 1986) with a medium level of impact expected at all sites except IFR Site 5 & 6 where this species is not expected to occur at all. Two felids (African wild cat - vulnerable & serval - rare) are also species with a southern African conservation status assignment and for both impacts are expected to be low at all IFR sites. A number of other species have also been assigned southern African conservation status, but these are not expected to occur at IFR sites and/or be influenced by changes in instream flows.

Some authors (Willan 1990; Nel 1993) suggest that Sloggett's ice rat is endemic to the Lesotho highlands. Sloggett's ice rats along with forest shrews are limited in their distribution. Sloggett's ice rat is not expected to be affected by instream flow changes due to habitat requirements.

The aardwolf is one of the three species considered to be rare and are catholic in their habitat requirements. The occurrence of aardwolf is dependent on the availability of termites, which constitute their principal food. This species, however, was not recorded in the area by Nel (1993) and is thus not expected to occur at the IFR sites.

The serval's distribution follows the limits of the savanna's of Africa with proximity to water an essential component of their habitat requirements. It is unlikely that the serval will occur in the study areas represented by the IFR sites and Nel (1993) has also not recorded it.

The third species considered to be rare is the African weasel, which selects for savanna and particularly associates with grassland. The species is unlikely to occur in the study area and has also not been recorded by Nel (1993).

Five mammal species that may occur in the study area according to general references on the mammals of the southern African subregion are considered vulnerable. The white-tailed mouse has been recorded at various IFR sites with habitat requirements fulfilled by savanna grassland. The African wildcat interbreeds freely with domesticated cats and has a wide potential distribution. Cats occurring in the study area may be house cats or hybrids. Honey badgers are catholic in their habitat requirements and according to Skinner & Smithers (1990) may occur in the study area. However, this species is not likely to occur in the river zones likely to be affected by instream flow changes.

Aardvarks are found in open woodland, scrub and grassland where these are associated with sandy ground. Although recorded by Skinner & Smithers (1990) to be distributed across the Lesotho river catchment, aardvark has not been recorded by Nel (1993) and is thus unlikely to occur in the general study area.

The oribi prefer open grassland, with or without a sparse scattering of trees and bushes. Nel (1993) has not recorded this species and it is thus unlikely to occur in the general study area.

The species listed by Nel (1993) are likely to occur in the study area. He provided the status of 25 mammal species within the Katse area, six of which (black-backed jackal, caracal, African wild cat, grey rhebuck, Cape porcupine, red hare) he considered to be locally endangered and eight of which (chacma baboon, clawless otter, striped polecat, small grey mongoose, water mongoose, highveld gerbil, white-tailed rat and grey climbing rat) he considered to be locally vulnerable. However, of these only the African wild cat and white-tailed rat are considered vulnerable in the South African Red Data Book: Terrestrial Mammals (Smithers 1986). Both of these have a wide distribution, thus developments in the study area should not have a major influence on their conservation status.

The apparent local rarity and vulnerability of mammal species in the area most probably result from man-induced disturbances, habitat destruction and habitat modification. However, vegetation in the area is fairly uniform, even though the topography can vary greatly and this may lead to a limited range of habitats. Thus the

paucity of species in Lesotho could also be related as much to the environmental harshness of the area as to human influences. These suggestions are confirmed by recent observations of mammals in Lesotho (Lynch 1993), which did not seem to differ much from historical records. Impacts of flow changes on mammals are therefore expected to be low, with the exception of a few species highlighted in Section 16.1.

16.2.2 Birds

One-hundred-and-eighty-nine species of bird are expected to occur in the catchment and local region of the Lesotho rivers (Table 16.3). Of these 85 are likely to occur at the IFR sites and be affected by changes in flow regimes. Twelve species are expected to experience high impacts when flow regimes change or vary while 5 are expected to experience medium impacts.

A number of bird species have been assigned some category of conservation status by the IUCN (1996). Surprisingly, only eight species get listed with three of those being considered lower risk and near threatened. Five species have been assigned as threatened species with all falling within the vulnerable category (Table 16.3).

References consulted in the construction of Table 16.3 include: Allan *et al.* (1996), Bonde (1993), Brown (1988), Brown (1989), Brown, (1990a), Brown (1990b), Brown (1990c), Brown (1992a), Brown (1992b), Brown & Barnes (1984), Clancey (1964), Clancey (1965), Clancey (1984), Clancey (1985), Clancey (1986), Clancey (1989), Clancey (1990), Collar & Andrew (1988), Collar *et al.* (1994), Collar & Stuart (1985), Cyrus & Robson (1980), Donnay (1989), Dowsett & Dowsett-Lemaire (1993), Earle & Grobler (1987), Jacot-Guillarmod (1963), Jilbert (1979), Jilbert (1982), Jilbert (1983), Little & Bainbridge (1988), Little & Bainbridge (1992), Manry (1982), Manry (1984), Manry (1985a), Manry (1985b), McKinney, *et al.* (1978), Maclean (1993), Mendelsohn (1984), Mundy *et al.* (1992), Meakins *et al.* (1988), Osborne & Tigar (1989), Osborne & Tigar (1990), Osborne & Tigar (1992a), Osborne & Tigar (1992b), Quickelberge (1989), Siegfried (1967), Siegfried (1968), Siegfried (1970), Siegfried (1992), Siegfried, Ball, Frost & McKinney (1975), Siegfried *et al.* (1977), Skead (1967), Tarboton, Kemp & Kemp (1987), Tarboton *et al.* (1993), van Aarde & Ferreira (1994), Winterbottom (1972) and Winterbottom (1978).

Note that a separate assessment of the southern African conservation status of birds was made during 1984 (Brooke 1984). The wattled crane, which according to Bonde (1993) may occur in Lesotho, is the only endangered species that could potentially occur in the study area. The likelihood of wattled crane occurring at IFR sites is very low since only a few locations of their occurrence are known in southern Africa.

Four of the species that may occur in the area according to Maclean (1993) and Bonde (1993) are considered rare. Of these the white pelican prefer coastal bays, estuaries, lakes, larger pans and dams and is thus highly unlikely to occur at IFR sites. The species has not been recorded in the Katse Basin area by Tarboton, Allan & Vernon (1993) or Osborne & Tigar (1989) and is thus not expected to occur in areas represented by IFR sites. The white stork selects highveld grasslands, mountain meadows, cultivated lands and marshes and should occur on the mountainous grassland. These habitat types will not be affected by changes in instream flow.

The other two rare species that may occur in the area are birds of prey. The bearded vulture are synonymous with the Drakensberg mountain range and occurs on the massif and foothills down to 2000 masl. The Peregrine falcon prefers cliffs, mountains and steep gorges and may hunt over open grassland, farmland and forests. Tarboton *et al.* (1993) or Osborne & Tigar (1989) have not recorded peregrine falcons in the Katse Basin area. These two species are therefore not expected to be affected by instream flow changes.

Four species of birds that are considered vulnerable may occur in the area (Maclean 1993, Bonde 1993). These are the Cape vulture, Stanley's bustard, Rudd's lark and the yellowbreasted pipit. Of these, only the Cape vulture has been recorded in the Katse area (Tarboton *et al.* 1993; Osborne & Tigar 1989). This species prefers mountainous country with inselbergs and escarpments. Rudd's lark is restricted to the Drakensberg range in southern Africa and frequents high-altitude and montane grassveld 1700 masl, usually on crowns and ridges without rocks and with short dense grass cover. Indeed, Hockey *et al.* (1988) argued that this species may never have occurred in Lesotho, and Osborne & Tigar (1989) reported that the species was not been recorded in Lesotho during the life of the Atlas Project. The insectivorous yellowbreasted pipit prefers flat to gently rolling lush montane grassland and according to the more recent references does not occur in Lesotho.

Species with an indeterminate conservation status that may occur in the area include the black stork (recorded at some IFR sites), Baillon's crane, the grass owl and the house martin (recorded at some IFR sites). Baillon's crane prefer reedbeds, marshes and vleis, and should not

occur frequent the study rivers. Neither Tarboton *et al.* (1993) nor Osborne & Tigar (1989) recorded this species in the Katse Basin area. Grass owls select long grass near water, vleis and marshes, while the house martin frequents steep hillsides, rocky places and open grasslands.

Ten of the bird species potentially occurring in the area have a limited distribution. These are the bald ibis, ground woodpecker, thickbilled lark, sentinel rock thrush, orangebreasted rockjumper, rock pipit, yellowbreasted pipit, pied starling, Cape weaver and the Drakensberg siskin. All but one of these species (yellowbreasted pipit) were recorded by Tarboton *et al.* (1993) in the Katse Dam area. They are thus all likely to occur in the study area. However, because of their habitat requirements, they are unlikely to be affected by changes in the flow regimes of the study rivers.

Six the species listed in Table 16.3 are Red Data species Brooke (1984). Twenty-two of the species are endemic to the southern African subregion (Tarboton *et al.* 1993). Many of these species have relatively wide distributions in southern Africa and the Lesotho populations are not considered of great conservation significance for the species (Osborne & Tigar 1992a), but for three species (orangebreasted rockjumper, mountain pipit and Drakensberg siskin) the Lesotho highlands represent a significant portion of their distribution. However, as already highlighted, flow changes in the study rivers are unlikely to impact on these species.

16.3 Variation in communities comprising the wildlife component

16.3.1 Mammals

Small mammal communities differed between the lower and back dynamic zones ($\sigma=0.23$, $p=0.01$, ANOSIM, Clarke & Green 1988). However, small mammal communities recorded on trapping grids also differed between IFR sites ($\sigma=0.46$, $p=0.02$, ANOSIM, Clarke & Green 1988). For this reason, zones at each locality and the associated small mammals recorded there were considered as separate samples for analyses in 16.4.1. Multivariate comparison between the small mammal communities recorded at these various localities and zones with vegetation and geomorphological characteristics, revealed that small mammal communities

Table 16.2 Checklist of mammals that may occur or are likely to occur in the study area. IUCN Categories follow that specified by the IUCN in 1996 (IUCN 1996) while L refer to limited distribution, S to a southern African subregion distribution and A to a distribution beyond the southern African subregion (from Skinner and Smithers 1990). IFRs refer to a specific IFR Site with associated likely influences on species caused by changes of flow regimes indicated by L-low, M-medium and H-high. Blank spaces indicate that the species is not expected to occur at an IFR Site in the area likely to be affected. The comments in brackets in the Latin Name column refer to the southern African conservation status assigned to those species during 1986 (Smithers 1986).

Common Names	Latin Names	IUCN Category	L	S	A	IFR1	IFR2	IFR3	IFR4	IFR5	IFR6	IFR7	IFR8
Shrews and golden moles													
Forest shrew	<i>Myosorex varius</i>	Not listed	X			L	L	L	L	L	L	L	L
Lesser dwarf shrew	<i>Suncus varilla</i>	Not listed			X	L	L	L	L	L	L	L	L
Reddish-grey musk shrew	<i>Crocidura cyanea infumata</i>	Not listed			X	M	M	M	M	M	M	M	M
Greater musk shrew	<i>Crocidura flavescens</i>	Threatened: Vulnerable		X		M	M	M	M	M	M	M	M
Sclater's golden mole	<i>Clorotalpa sclateri</i> (Indeterminate, Endemic)	Not listed	X										
Hottentot golden mole	<i>Amblysomus hottentotus</i>	Not listed		X									
Rock elephant-shrew	<i>Elephantulus myurus</i>	Not listed		X							L		
Southern African Hedgehog	<i>Atelerix frontalis</i> (Rare)	Not listed			X					L	L		
Bats													
Winton's long-eared bat	<i>Laephotis wintoni</i>	Not listed	X										
Egyptian free-tailed bat	<i>Tadarida (Tadarida) aegyptica</i>	Not listed			X								
Schreibers' long-fingered bat	<i>Miniopterus shreibersii</i> (Indeterminate, Endemic)	Lower risk: Near threatened			X								
Temminck's hairy bat	<i>Myotis tricolor</i>	Not listed			X								
Lesueur's hairy bat	<i>Myotis lesueuri</i>	Not listed	X										
Long-tailed serotine bat	<i>Eptesicus hottentotus</i>	Not listed			X								
Cape serotine bat	<i>Eptesicus capensis</i>	Not listed			X								
Common slit-faced bat	<i>Nycteris thebaica</i>	Not listed			X								
Geoffroy's horseshoe bat	<i>Rhinolophus clivosus</i>	Not listed			X								
Primates													
Chacma baboon	<i>Papio ursinus</i>	Not listed			X								
Vervet monkey	<i>Cercopithecus aethiops</i>	Not listed			X								
Hares and rabbits													
Scrub hare	<i>Lepus saxatilis</i>	Not listed			X								
Smith's red rock rabbit	<i>Pronolagus rupestris</i>	Not listed			X								
Natal red rock rabbit	<i>Pronolagus cassicaudatus</i>	Not listed		X									

SPECIALIST REPORT
WILDLIFE AND BIRDS

Table 16.2, continued.

Common Names	Latin Names	IUCN Category	L	S	A	IFR1	IFR2	IFR3	IFR4	IFR5	IFR6	IFR7	IFR8
Rodents													
Common molerat	<i>Cryptomys hottentotus</i>	Not listed			X	M	M	M	M	M	M	M	M
Cape porcupine	<i>Hystrix africaeaustralis</i>	Not listed			X								
Springhaas	<i>Pedetes capensis</i>	Not listed			X								
Woodland dormouse	<i>Graphiurus (Claviglis) murinus</i>	Not listed			X								
Greater canerat	<i>Thryonomys swinderianus</i>	Not listed			X								
Angoni vlei rat	<i>Otomys angoniensis</i>	Not listed			X	M	M	M	M			M	M
Vlei rat	<i>Otomys irroratus</i>	Not listed		X		M	M	M	M	M	M	M	M
Sloggett's rat	<i>Otomys sloggetti</i>	Not listed	X			L	L	L	L			L	
Striped mouse	<i>Rhabdomys pumilio</i>	Data deficient			X	M	M	M	M	M	M	M	M
House mouse	<i>Mus musculus</i>	Not listed		X		L	L	L	L	L	L	L	L
Pygmy mouse	<i>Mus minutoides</i>	Not listed		X									
Multimammate mouse	<i>Mastomys natalensis</i>	Not listed				M	M	M	M	M	M	M	M
	<i>and Mastomys coucha</i>	Not listed		X		M	M	M	M	M	M	M	M
Namaqua rock mouse	<i>Aethomys namaquensis</i>	Not listed			X	L	L	L	L	L	L	L	L
Red veld rat	<i>Aethomys chrysophilus</i>	Not listed			X								
House rat	<i>Rattus rattus</i>	Not listed			X								
Highveld gerbil	<i>Tatera brantsii</i>	Not listed			X								
White-tailed mouse	<i>Mystromys albicaudatus</i> (Vulnerable, Endemic)	Not listed		X		M	M	M	M			M	M
Pouched mouse	<i>Saccostomus campestris</i>	Not listed			X								
Grey climbing mouse	<i>Dendromus melanotis</i>	Not listed			X								
Carnivores													
Aardwolf	<i>Proteles cristatus</i> (Rare)	Data deficient			X								
Leopard	<i>Panthera pardus</i> (Rare)	Not listed			X								
Caracal	<i>Felis caracal</i>	Not listed			X								
African wild cat	<i>Felis lybica</i> (Vulnerable)	Not listed			X	L	L	L	L	L	L	L	L
Serval	<i>Felis serval</i> (Rare)	Not listed			X	L	L	L	L	L	L	L	L
Domestic cat	<i>Felis catus</i>	Not listed			X	L	L	L	L	L	L	L	L
Cape fox	<i>Vulpes chama</i>	Not listed			X								
Black-backed jackal	<i>Canis mesomelas</i>	Not listed			X								
Cape clawless otter	<i>Aonyx capensis</i>	Not listed			X	H	H	H	H	H	H	H	H
Spotted-necked otter	<i>Lutra maculicollis</i>	Not listed			X								
Honey badger	<i>Mellivora capensis</i>	Not listed			X								
African weasel	<i>Poecilogale albinucha</i>	Not listed			X								
Striped polecat	<i>Ictonyx striatus</i>	Not listed			X								

Table 16.2, continued.

Common Names	Latin Names	IUCN Category	L	S	A	IFR1	IFR2	IFR3	IFR4	IFR5	IFR6	IFR7	IFR8
Carnivores (cont.)													
Large-spotted genet	<i>Genetta tigrina</i>	Not listed		X									
Slender mongoose	<i>Herpestes sanguineus</i>	Not listed			X	L	L	L	L	L	L	L	L
Small grey mongoose	<i>Galerella pulverulenta</i>	Not listed			X								
White-tailed mongoose	<i>Ichneumia albicaudata</i>	Not listed			X								
Water mongoose	<i>Atilax paludinosus</i>	Not listed			X					L	L		
Aardvarks													
Aardvark	<i>Orycteropus afer</i> (Vulnerable)	Not listed			X								
Dassies													
Rock dassie	<i>Procapra capensis</i>	Not listed			X								
Tree dassie	<i>Dendrohyrax arboreus</i> (Rare)	Not listed			X								
Antelopes													
Common duiker	<i>Sylvicapra grimmia</i>	Not listed			X								
Klipspringer	<i>Oreotragus oreotragus</i>	Not listed			X								
Oribi	<i>Ourebia ourebi</i> (Vulnerable)	Lower risk: Conservation dependent			X								
Steenbok	<i>Raphicerus campestris</i>	Not listed			X								
Grey rhebok	<i>Pelea capreolus</i>	Lower risk: Conservation dependent		X									
Bushbuck	<i>Tragelaphus scriptus</i>	Not listed			X								
Mountain reedbuck	<i>Redunca fulvorufula</i>	Lower risk: Conservation dependent			X								

SPECIALIST REPORT
WILDLIFE AND BIRDS

Table 16.3 Checklist of bird species are likely to occur in the study area. IUCN Categories follow that specified in IUCN (1996). L = refer to limited distribution, S = southern African subregion distribution and A = distribution beyond the southern Africa (from Maclean 1993). IFR refer to a specific IFR Site, with associated likely influences on species caused by changes of flow regimes indicated by L-low, M-medium and H-high. Blank spaces indicate that the species is not expected to occur at an IFR Site. The comments in brackets in the Latin Name column refer to the southern African conservation status assigned to those species during 1984 (Brooke 1984).

Common Names	Latin Names	IUCN Category	L	S	A	IFR1	IFR2	IFR3	IFR4	IFR5	IFR6	IFR7	IFR8
Dabchicks													
Dabchick	<i>Tachybaptus ruficollis</i>	Not listed			X								
Pelicans													
White pelican	<i>Pelecanus onocrotalus</i> (Rare)	Not listed			X								
Cormorants													
White-breasted cormorant	<i>Phalacrocorax carbo</i>	Not listed			X	H	H	H	H	H	H	H	H
Reed cormorant	<i>Phalacrocorax africanus</i>	Not listed			X	H	H	H	H	H	H	H	H
Darter	<i>Anhinga melanogaster</i>	Lower risk: Near threatened			X	H	H	H	H	H	H	H	H
Hérons, egrets and bitterns													
Grey heron	<i>Ardea cinerea</i>	Not listed			X	H	H	H	H	H	H	H	H
Black-headed heron	<i>Ardea melanocephala</i>	Not listed			X	H	H	H	H	H	H	H	H
Purple heron	<i>Ardea purpurea</i>	Not listed			X								
Great white egret	<i>Egretta alba</i>	Not listed			X								
Little egret	<i>Egretta garzetta</i>	Not listed			X	M	M	M	M	M	M	M	M
Cattle egret	<i>Bubulcus ibis</i>	Not listed			X	L	L	L	L	L	L	L	L
Yellow-billed egret	<i>Egretta intermedia</i>	Not listed			X								
Black-crowned night-heron	<i>Nycticorax nycticorax</i>	Not listed			X								
Hamerkop	<i>Scopus umbretta</i>	Not listed			X	H	H	H	H	H	H	H	H
Stork, ibises and spoonbills													
White stork	<i>Ciconia ciconia</i> (Rare)	Not listed			X								
Black stork	<i>Ciconia nigra</i> (Indeterminate)	Not listed			X	L	L	L	L	L	L	L	L
Abdim's stork	<i>Ciconia abdimii</i>	Not listed											
Sacred ibis	<i>Threskiornis aethiopicus</i>	Not listed			X								
Bald ibis	<i>Geronticus calvus</i> (Vulnerable, Endemic)	Threatened species: Vulnerable	X			L	L	L	L	L	L	L	L
Hadeda ibis	<i>Bostrychia hagedash</i>	Not listed			X	L	L	L	L	L	L	L	L
African spoonbill	<i>Platalea alba</i>	Not listed			X								
Geese and ducks													
Egyptian goose	<i>Alopochen aegyptiacus</i>	Not listed			X	M	M	M	M	M	M	M	M
South African shelduck	<i>Tadorna cana</i>	Not listed		X									
African black duck	<i>Anas sparsa</i>	Not listed			X	H	H	H	H	H	H	H	H
Yellow-billed duck	<i>Anas undulata</i>	Not listed			X	H	H	H	H	H	H	H	H

Red-billed teal

Anas erythrorhyncha

Not listed

X L L L L L L L L

SPECIALIST REPORT
WILDLIFE AND BIRDS

Table 16.3, continued.

Common Names	Latin Names	IUCN Category	L	S	A	IFR1	IFR2	IFR3	IFR4	IFR5	IFR6	IFR7	IFR8
Cape shoveller	<i>Anas smithii</i>	Not listed			X	L	L	L	L	L	L	L	L
Cape teal	<i>Anas capensis</i>	Not listed			X	H	H	H	H	H	H	H	H
Southern pochard	<i>Netta erythrophthalma</i>	Not listed			X								
Spur-winged goose	<i>Plectropterus gambensis</i>	Not listed			X								
Maccoa duck	<i>Oxyura maccoa</i>	Not listed			X								
Bustards													
Secretary bird	<i>Sagittarius serpentarius</i>	Not listed			X								
Stanley's bustard	<i>Neotis denhami</i> (Vulnerable, Endemic)	Not listed			X								
Birds of prey													
Bearded vulture	<i>Gypaetus barbatus</i> (Rare)	Not listed			X								
Cape vulture	<i>Gyps coprotheres</i> (Vulnerable, Endemic)	Threatened species: Vulnerable		X									
Black kite & Yellow-billed kite	<i>Milvus migrans</i>	Not listed			X								
Black-shouldered kite	<i>Elanus caeruleus</i>	Not listed			X								
African fish eagle	<i>Haliaeetus vocifer</i>	Not listed			X								
Black eagle	<i>Aquila verreauxii</i>	Not listed			X								
Booted eagle	<i>Hieraaetus pennatus</i>	Not listed			X								
Steppe buzzard	<i>Buteo buteo</i>	Not listed			X								
Jackal buzzard	<i>Buteo rufofuscus</i>	Not listed		X		L	L	L	L	L	L	L	L
Redbreasted sparrowhawk	<i>Accipiter rufiventris</i>	Not listed											
African marsh harrier	<i>Circus ranivorus</i>	Not listed			X								
Black harrier	<i>Circus maurus</i>	Lower risk: Near threatened		X									
Gymnogene	<i>Polyboroides typus</i>	Not listed											
Peregrine falcon	<i>Falco peregrinus</i> (Rare)	Not listed			X								
Lanner falcon	<i>Falco biarmicus</i>	Not listed			X								
Eastern red-footed kestrel	<i>Falco amurensis</i>	Not listed			X								
Rock kestrel	<i>Falco tinnunculus</i>	Not listed			X	L	L	L	L	L	L	L	L
Lesser kestrel	<i>Falco naumanni</i>	Threatend species: Vulnerable			X								
Francolins, quails and fowls													
Grey-wing francolin	<i>Francolinus africanus</i>	Not listed			X								
Swainson's francolin	<i>Francolinus swainsonii</i>	Not listed											
Red-wing francolin	<i>Francolinus levaillantii</i>	Not listed			X								
Common quail	<i>Coturnix coturnix</i>	Not listed			X								
Helmeted guinea-fowl	<i>Numida meleagris</i>	Not listed			X								
Kurrichane button-quail	<i>Turnix sylvatica</i>	Not listed			X								

Table 16.3, continued.

Common Names	Latin Names	IUCN Category	L	S	A	IFR1	IFR2	IFR3	IFR4	IFR5	IFR6	IFR7	IFR8
Cranes													
Wattled crane	<i>Grus carunculata</i> (Endangered)	Threatened species: Vulnerable			X								
Blue crane	<i>Anthropoides paradisea</i>	Not listed		X									
Crowned crane	<i>Balearica regulorum</i>	Not listed			X								
Waders													
Baillon's crane	<i>Porzana pusilla</i> (Indeterminate)	Not listed			X								
Purple gallinule	<i>Porphyrio porphyrio</i>	Not listed			X								
Moorhen	<i>Gallinula chloropus</i>	Not listed			X								
Red-knobbed coot	<i>Fulica cristata</i>	Not listed			X								
Ringed plover	<i>Charadrius hiaticula</i>	Not listed			X	L	L	L	L	L	L	L	L
Kittlitz's plover	<i>Charadrius pecuarius</i>	Not listed			X								
Three-banded plover	<i>Charadrius tricollaris</i>	Not listed			X	H	H	H	H	H	H	H	H
Crowned plover	<i>Vanellus coronatus</i>	Not listed			X	L	L	L	L	L	L	L	L
Blacksmith plover	<i>Vanellus armatus</i>	Not listed			X								
Common sandpiper	<i>Tringa hypoleucos</i>	Not listed			X	L	L	L	L	L	L	L	L
Wood sandpiper	<i>Tringa glareola</i>	Not listed			X								
Marsh sandpiper	<i>Tringa stagnatilis</i>	Not listed			X								
Greenshank	<i>Tringa nebularia</i>	Not listed			X								
Curlew sandpiper	<i>Calidris ferruginea</i>	Not listed			X								
Little stint	<i>Calidris minuta</i>	Not listed			X	H	H	H	H	H	H	H	H
Ruff and Reeve	<i>Philomachus pugnax</i>	Not listed			X								
Ethiopian snipe	<i>Gallinago nigripennis</i>	Not listed			X								
Black-winged stilt	<i>Himantopus himantopus</i>	Not listed			X	L	L	L	L	L	L	L	L
Spotted dikkop	<i>Burhinus capensis</i>	Not listed			X								
Gulls and terns													
Grey-headed gull	<i>Larus cirrocephalus</i>	Not listed			X								
Whiskered tern	<i>Chlidonias hybridus</i>	Not listed			X								
White-winged tern	<i>Chlidonias leucopterus</i>	Not listed			X								
Pigeons and doves													
Rock pigeon	<i>Columba guinea</i>	Not listed			X	L	L	L	L	L	L	L	L
Red-eyed dove	<i>Streptopelia semitorquata</i>	Not listed			X	L	L	L	L	L	L	L	L
Cape turtle dove	<i>Streptopelia capicola</i>	Not listed			X	L	L	L	L	L	L	L	L
Laughing dove	<i>Streptopelia senegalensis</i>	Not listed			X								
Namaqua dove	<i>Oena capensis</i>	Not listed			X								

SPECIALIST REPORT
WILDLIFE AND BIRDS

Table 16.3, continued.

Common Names	Latin Names	IUCN Category	L	S	A	IFR1	IFR2	IFR3	IFR4	IFR5	IFR6	IFR7	IFR8
Cuckoos													
Red-chested cuckoo	<i>Cuculus solitarius</i>	Not listed			X								
Diederik cuckoo	<i>Chrysococcyx caprius</i>	Not listed			X								
Jacobin cuckoo	<i>Clamator jacobinus</i>	Not listed			X								
Owls and nightjars													
Barn owl	<i>Tyto alba</i>	Not listed			X								
Swifts													
European swift	<i>Apus apus</i>	Not listed			X								
White-rumped swift	<i>Apus caffer</i>	Not listed			X	L	L	L	L	L	L	L	L
Horus swift	<i>Apus horus</i>	Not listed			X								
Little swift	<i>Apus affinis</i>	Not listed			X								
Alpine swift	<i>Apus melba</i>	Not listed			X								
Black swift	<i>Apus barbatus</i>	Not listed			X								
Mousebirds													
Speckled mousebird	<i>Colius striatus</i>	Not listed			X	L	L	L	L	L	L	L	L
Kingfishers													
Pied kingfisher	<i>Ceryle rudis</i>	Not listed			X					L	L		
Giant kingfisher	<i>Ceryle maxima</i>	Not listed			X	H	H	H	H	H	H	H	H
Malachite kingfisher	<i>Alcedo cristata</i>	Not listed			X					L	L		
Rollers													
European roller	<i>Coracias garrulus</i>	Not listed			X								
Hoopoes, honeyguides and woodpeckers													
Hoopoe	<i>Upupa epops</i>	Not listed			X								
Greater honeyguide	<i>Indicator indicator</i>	Not listed			X								
Ground woodpecker	<i>Geocolaptes olivaceus</i>	Not listed	X										
Larks													
Rudd's lark	<i>Mirafra ruddi</i> (Vulnerable, Endemic)	Not listed			X								
Long-billed lark	<i>Mirafra curvirostris</i>	Not listed			X								
Thick-billed lark	<i>Galerida magirostris</i>	Not listed	X										

Red-capped lark

Calandrella cinerea

Not listed

X

SPECIALIST REPORT
WILDLIFE AND BIRDS

Table 16.3, continued.

Common Names	Latin Names	IUCN Category	L	S	A	IFR1	IFR2	IFR3	IFR4	IFR5	IFR6	IFR7	IFR8
Swallows and martins													
European swallow	<i>Hirundo rustica</i>	Not listed			X	L	L	L	L	L	L	L	L
White-throated swallow	<i>Hirundo albicularis</i>	Not listed			X	L	L	L	L	L	L	L	L
Greater striped swallow	<i>Hirundo cucullata</i>	Not listed			X	L	L	L	L	L	L	L	L
Rock martin	<i>Hirundo fuligula</i>	Not listed			X	L	L	L	L	L	L	L	L
House martin	<i>Delichon urbica</i> (Indeterminate)	Not listed			X	L	L	L	L	L	L	L	L
Brown-throated martin	<i>Riparia paludicola</i>	Not listed			X	L	L	L	L	L	L	L	L
Banded martin	<i>Riparia cincta</i>	Not listed			X	L	L	L	L	L	L	L	L
Crows and ravens													
Black crow	<i>Corvus capensis</i>	Not listed			X					L	L		
White-necked raven	<i>Corvus albicollis</i>	Not listed			X								
Tits and bulbuls													
Southern grey tit	<i>Parus afer</i>	Not listed		X									
Red-eyed bulbul	<i>Pycnonotus nigricans</i>	Not listed			X	L	L	L	L	L	L	L	L
Thrushes, chats and robins													
Olive thrush	<i>Turdus olivaceus</i>	Not listed			X					L	L		
Cape rock-thrush	<i>Monticola rupestris</i>	Not listed		X		L	L	L	L	L	L	L	L
Sentinel rock-thrush	<i>Monticola explorator</i>	Not listed	X			L	L	L	L	L	L	L	L
Mountain chat	<i>Oenanthe monticola</i>	Not listed			X	L	L	L	L	L	L	L	L
Familiar chat	<i>Cercomela familiaris</i>	Not listed			X	L	L	L	L	L	L	L	L
Sickle-winged chat	<i>Cercomela sinuata</i>	Not listed		X									
Mocking chat	<i>Thamnolaea cinnamomeiventris</i>	Not listed			X								
Ant-eating chat	<i>Myrmecocichla formicivora</i>	Not listed		X									
Stone chat	<i>Saxicola torquata</i>	Not listed			X	L	L	L	L	L	L	L	L
Orange-breasted rock-jumper	<i>Chaetops aurantius</i>	Not listed	X										
Cape robin	<i>Cossypha caffra</i>	Not listed			X	L	L	L	L	L	L	L	L
Warblers and babblers													
African marsh warbler	<i>Acrocephalus baeticatus</i>	Not listed			X					M	M		
Cape reed warbler	<i>Acrocephalus gracilirostris</i>	Not listed			X	M	M	M	M	M	M	M	M
Layard's tit-babbler	<i>Parisoma layardi</i>	Not listed		X									
African sedge warbler	<i>Bradypterus baboecala</i>	Not listed			X								
Barratt's warbler	<i>Bradypterus barratti</i>	Not listed											
Willow warbler	<i>Phylloscopus trochilus</i>	Not listed			X								

Table 16.3, continued.

Common Names	Latin Names	IUCN Category	L	S	A	IFR1	IFR2	IFR3	IFR4	IFR5	IFR6	IFR7	IFR8
Grassbirds and cisticolas													
Grassbird	<i>Sphenoeacus afer</i>	Not listed		X									
Fantailed cisticola	<i>Cisticola juncidis</i>	Not listed			X								
Desert cisticola	<i>Cisticola aridula</i>	Not listed			X								
Cloud cisticola	<i>Cisticola textrix</i>	Not listed		X									
Ayres's cloud cisticola	<i>Cisticola ayresii</i>	Not listed			X								
Wailing cisticola	<i>Cisticola lais</i>	Not listed			X	L	L	L	L	L	L	L	L
Le Vaillant's cisticola	<i>Cisticola tinniens</i>	Not listed			X	L	L	L	L	L	L	L	L
Neddicky	<i>Cisticola fulvicapilla</i>	Not listed			X	L	L	L	L	L	L	L	L
Prinias and flycatchers													
Spotted prinia	<i>Prinia maculosa</i>	Not listed		X		L	L	L	L	L	L	L	L
Spotted flycatcher	<i>Muscicapa striata</i>	Not listed			X	L	L	L	L	L	L	L	L
Fiscal flycatcher	<i>Sigelus silens</i>	Not listed		X		L	L	L	L	L	L	L	L
Fairy flycatcher	<i>Stenostira scita</i>	Not listed		X									
Wagtails, pipits and longclaws													
African pied wagtail	<i>Motacilla aguimp</i>	Not listed				L	L	L	L	L	L	L	L
Cape wagtail	<i>Motacilla capensis</i>	Not listed			X	M	M	M	M	M	M	M	M
Richard's pipit	<i>Anthus novaeseelandiae</i>	Not listed			X								
Grassveld pipit	<i>Anthus sp.</i>	Not listed											
Mountain pipit	<i>Anthus hoeschi</i> (Indeterminate, Endemic)	Lower risk: Near threatened			X								
Long-billed pipit	<i>Anthus similis</i>	Not listed			X								
Plain-backed pipit	<i>Anthus leucophrys</i>	Not listed			X								
Rock pipit	<i>Anthus crenatus</i>	Not listed	X										
Yellow-breasted pipit	<i>Anthus chloris</i> (Vulnerable, Endemic)	Threatend species: Vulnerable	X										
Orange-throated longclaw	<i>Macronyx capensis</i>	Not listed		X									
Shrikes													
Fiscal shrike	<i>Lanius collaris</i>	Not listed			X	L	L	L	L	L	L	L	L
Bokmakierie	<i>Telophorus zeylonus</i>	Not listed		X									
Starlings													
Pied starling	<i>Spreo bicolor</i>	Not listed	X			L	L	L	L	L	L	L	L
Wattled starling	<i>Creatophora cinerea</i>	Not listed			X	L	L	L	L	L	L	L	L
Glossy starling	<i>Lamprotornis nitens</i>	Not listed			X	L	L	L	L	L	L	L	L
Red-winged starling	<i>Onychognathus morio</i>	Not listed			X	L	L	L	L	L	L	L	L

SPECIALIST REPORT
WILDLIFE AND BIRDS

Table 16.3, continued.

Common Names	Latin Names	IUCN Category	L	S	A	IFR1	IFR2	IFR3	IFR4	IFR5	IFR6	IFR7	IFR8
Sunbirds													
Malachite sunbird	<i>Nectarinia famosa</i>	Not listed			X					L	L		
White-eyes, sparrows, weavers, bishops and widows													
Cape white-eye	<i>Zosterops pallidus</i>	Not listed		X		L	L	L	L	L	L	L	L
House sparrow	<i>Passer domesticus</i>	Not listed			X	L	L	L	L	L	L	L	L
Cape sparrow	<i>Passer melanurus</i>	Not listed			X	L	L	L	L	L	L	L	L
Grey-headed sparrow	<i>Passer griseus</i>	Not listed			X	L	L	L	L	L	L	L	L
Cape weaver	<i>Ploceus capensis</i>	Not listed	X			L	L	L	L	L	L	L	L
Masked weaver	<i>Ploceus velatus</i>	Not listed				L	L	L	L	L	L	L	L
Redbilled quelea	<i>Quelea quelea</i>	Not listed				L	L	L	L	L	L	L	L
Red bishop	<i>Euplectes orix</i>	Not listed			X	L	L	L	L	L	L	L	L
Firecrowned bishop	<i>Euplectes hordeaceus</i>	Not listed				L	L	L	L	L	L	L	L
Golden bishop	<i>Euplectes afer</i>	Not listed			X	L	L	L	L	L	L	L	L
Yellow-rumped widow	<i>Euplectes capensis</i>	Not listed			X	L	L	L	L	L	L	L	L
Red-collared widow	<i>Euplectes ardens</i>	Not listed			X	L	L	L	L	L	L	L	L
Long-tailed widow	<i>Euplectes progne</i>	Not listed			X	L	L	L	L	L	L	L	L
Common waxbill	<i>Estrilda astrild</i>	Not listed			X	L	L	L	L	L	L	L	L
Finches and whydahs													
Quail finch	<i>Ortygospiza atricollis</i>	Not listed			X								
Pin-tailed whydah	<i>Vidua macroura</i>	Not listed			X	L	L	L	L	L	L	L	L
Cape canary	<i>Serinus canicollis</i>	Not listed			X	L	L	L	L	L	L	L	L
Black widowfinch	<i>Vidua funerea</i>	Not listed											
Canaries and buntings													
Blackthroated canary	<i>Serinus atrogularis</i>	Not listed				L	L	L	L	L	L	L	L
Streakyheaded canary	<i>Serinus gularis</i>	Not listed											
Goldenbreasted bunting	<i>Emberiza flaviventris</i>	Not listed											
Drakensberg siskin	<i>Serinus symonsi</i>	Not listed	X			L	L	L	L	L	L	L	L
Yellow canary	<i>Serinus flaviventris</i>	Not listed			X								
Whitethroated canary	<i>Serinus albogularis</i>	Not listed											
Cape bunting	<i>Emberiza capensis</i>	Not listed			X	L	L	L	L	L	L	L	L
Rock bunting	<i>Emberiza tahapisi</i>	Not listed			X	L	L	L	L	L	L	L	L
Lark-like bunting	<i>Emberiza impetuani</i>	Not listed			X								

were not related to these characteristics ($\sigma=0.02$, $p=0.17$, RELATE, Clarke & Green 1988). This will most likely also

be the case for the larger mammals and reflect the indirect links between most mammals and river flow dynamics.

16.3.2 Birds

No differences were recorded between the communities at the sites ($\sigma=0.01$, $p=0.42$, ANOSIM, Clarke & Green 1988). However, distinct differences were recorded between zones at a site ($\sigma=0.29$, $p=0.01$, ANOSIM, Clarke & Green 1988). Because of this difference, and the fact that sites and localities were spatially separated, zones at

each locality and associated bird communities were considered as separate samples for analyses in 16.4.2. Multivariate comparisons between communities recorded at various localities and zones with vegetation and geomorphological characteristics revealed that bird communities were related to vegetation and geomorphological characteristics ($\sigma=0.27$, $p=0.01$, RELATE, Clarke & Green 1988). The analysis illustrates that birds or some aspects of bird populations and behaviour are therefore likely to be affected by flow-related changes in habitat features. In general a higher number of bird species are dependent on the river relative to mammals.

16.4 Multiple regression relationships for species and key features

16.4.1 Mammals

Multiple regression models were developed for the five small mammal species recorded at the IFR sites, and for

which density estimates are available (Table 16.4). These relate vegetation and geomorphological features to variations in density indices. The models could be used to predict species-specific densities for related to changes in the flow regimes of the study rivers (see Part 6). However, the low variation explained by these models illustrates the indirect nature of dependence of mammals on riverine habitats.

16.4.2 Birds

In general, multiple regression models for birds resulted in low predictive capabilities with most models explaining less than 30% of the variation in density indices for each species (Table 16.5). Models that explained more than 30% of variation in species-specific densities could only be developed for six species. As was the case for mammals, these models reflect the indirect nature of the influences that are likely to result from changes in flow regimes.

Only 21% of the variation in bird species richness of the lower dynamic zone could be explained by vegetation and geomorphological variables ($y=0.47Se-0.32L+0.24Sh-0.33R-0.21B+0.22A+5.00$, $R^2=0.21$, $F_{6,22}=3.86$, $p<0.03$), while 72% of the variation in species richness in the back dynamic zone could be explained by these variables ($y=0.52T-0.65R+0.59Sh-0.29RB+0.20ISa-0.45Sa+0.52Ba-0.17A-0.48Se+0.33Cl+2.00$, $R^2=0.72$, $F_{17,22}=6.79$, $p<0.01$).

Table 16.4 Multiple regression models developed for mammals captured during the present study. See Section 48 for clarification of variables.

Species	Model	R ²	F-value	p-value
<i>Aethomys namaquensis</i>	$y= 0.39Ba+0.41R+0.21B-0.25A+0.18P+0.17Sh-1.50$	0.32	$F_{6,73}=7.17$	<0.01
<i>Mastomys natalensis</i>	$y= 0.19Se+0.55R+0.16Sh+0.08B-0.08Cl-0.28G+0.62S+0.39Sa-0.12A-1.25$	0.27	$F_{9,70}=4.22$	<0.01
<i>Rhabdomys pumilio</i>	$y= 0.28Ba-0.22W-0.25Sa+0.22R-0.24A+0.13P+3.56$	0.10	$F_{6,73}=2.52$	<0.03
<i>Mystromys albicaudata</i>	$y= -0.13G+0.28Sh+0.38Ba+0.24R-0.24A-0.12Sa-$	0.23	$F_{6,73}=4.85$	<0.01

	0.09			
<i>Crocidura flavescens</i>	$y = 0.34Cl + 0.12Ag + 0.10Sh - 0.12A - 0.38Se - 0.53G - 0.41Ba - 0.11T + 12.90$	0.42	$F_{8,71} = 8.08$	<0.01

Table 16.5 Multiple regression models developed for birds recorded during the present study. See Section 49 for clarification of variables.

Species	Model	R ²	F-value	p-value
Black-backed cisticola	$y = 0.34Sa + 0.14Se - 0.13Re - 0.11Ba - 0.01$	0.11	$F_{4,115} = 4.62$	<0.01
African black duck	$y = 0.18C - 0.18Ba + 0.12$	0.03	$F_{2,117} = 2.59$	0.08
Black-eyed bulbul	$y = 0.14T + 0.21W + 0.11Sh - 0.21R - 0.12C - 0.15Ag + 0.16A - 0.09P - 0.01$	0.08	$F_{8,111} = 2.27$	0.03
Black-headed heron	$y = 0.14RSa + 0.02$	0.01	$F_{1,118} = 2.39$	0.12
Banded martin	$y = 0.35Se - 0.34R + 0.17L - 0.14RSA - 0.11T - 0.13B + 0.15A + 0.25$	0.10	$F_{7,112} = 2.85$	<0.01
Black stork	-	-	-	-
Black-throated canary	$y = 0.53Isa + 0.32W + 0.20Se - 0.25B + 0.36A - 0.19Sh - 0.12B - 0.10Re - 0.14S - 0.11Cl + 0.01$	0.39	$F_{10,109} = 8.6$	<0.01
Cape bunting	$y = 0.29Se + 0.26Sh + 0.26R + 0.22Sa - 0.17Cl - 0.15IL - 0.11$	0.43	$F_{6,113} = 16.2$	<0.01
Cape canary	$y = 0.25Se - 0.32R + 0.15Sh + 0.35Sa - 0.33Ba + 0.17A - 0.15IG + 0.15G - 0.03$	0.17	$F_{8,111} = 4.01$	<0.01
Cape batis	$y = 0.52Sh - 0.16A + 0.20R - 0.10C - 0.13W - 0.13Cl - 0.01$	0.21	$F_{6,113} = 6.36$	<0.01
Cape robin	$y = 0.43Sa + 0.30Sh + 0.26T - 0.38G - 0.22Se + 0.22W - 0.11Re - 0.01$	0.28	$F_{7,112} = 7.70$	<0.01
Cape reed warbler	-	-	-	-
Cape rock thrush	$y = 0.35G - 0.21W - 0.11A - + 0.01$	0.04	$F_{3,113} = 2.80$	<0.04
Cape sparrow	$y = -0.02G - 0.31W + 0.80S - 0.33Ag - 0.29Sh - 0.13P - 0.19T + 0.25Sa + 0.22A - 0.21Ba + 0.13C + 0.09$	0.20	$F_{11,108} = 3.7$	<0.01
Cape teal	$y = 0.46L - 0.27RSa + 0.12RW + 0.01$	0.19	$F_{3,116} = 10.0$	<0.01
Cape turtle dove	$y = -0.11RW + 0.25T + 0.12G - 0.29A + 0.32R + 0.13B - 0.07Re - 0.11Sh + 0.16S + 0.40$	0.17	$F_{9,110} = 3.76$	<0.01
Cape weaver	$y = 0.53Cl + 0.31G - 0.16Sh + 0.15R - 0.11W - 0.09Ag - 0.09B + 0.04$	0.39	$F_{7,112} = 11.9$	<0.01
Common waxbill	$y = 0.44Se + 0.25Sh - 0.25Sa + 0.18Ba - 0.11W - 0.07$	0.21	$F_{5,114} = 7.39$	<0.01
Cape white-eye	$y = 0.32T + 0.45S - 0.25Ag - 0.17Ba - 0.15Sh + 0.09C + 0.01$	0.26	$F_{6,113} = 8.01$	<0.01
Cape wagtail	$y = 0.37Sa + 0.22Se + 0.18RR - 0.15Sh + 0.05$	0.25	$F_{4,115} = 10.7$	<0.01
Darter	$y = 0.21RW + 0.09RR + 0.01$	0.04	$F_{2,117} = 3.63$	<0.03
Drakensberg siskin	$y = 0.32G - 0.35A + 0.34R - 0.15Se - 0.02$	0.14	$F_{4,115} = 6.16$	<0.01
Egyptian goose	-	-	-	-
European swallow	$y = 0.31R - 0.15Se - 0.11Cl - 0.03$	0.05	$F_{3,116} = 3.04$	<0.04
Familiar chat	$y = 0.24B + 0.12Sh - 0.01$	0.06	$F_{2,117} = 5.01$	<0.01
Fiscal shrike	$y = 0.46Sa - 0.41Ba + 0.17W - 0.19IG + 0.16G - 0.01$	0.17	$F_{5,114} = 5.76$	<0.01
Grey Heron	$y = 0.53RR + 0.38L + 0.29Cl + 0.22RSa + 0.11RC + 0.07G - 0.06$	0.57	$F_{6,113} = 27.1$	<0.01

Species	Model	R ²	F-value	p-value
Giant kingfisher	y=0.57RC-0.14RSa-0.01	0.30	F _{2,117} =25.9	<0.01
Hamerkop	y=0.26RC+0.27Ag+0.15B-0.12W-0.10RSa+0.03	0.10	F _{5,114} =3.77	<0.01
Helmeted guinea-fowl	y=0.57RC-0.14RSa-0.06	0.30	F _{2,117} =25.9	<0.01
House martin	y=0.34L-0.17RSa+0.29Re-0.21Sh+0.09	0.12	F _{4,115} =5.12	<0.01
Jackal buzzard	-	-	-	-
Le Vaillant's cisticola	-	-	-	-
Little stint	y=0.25Se-0.27R+0.41Sa-0.38Ba+0.17A- 0.06Re+0.11Sh0.13G-0.13IG-0.01	0.18	F _{9,110} =3.86	<0.01
Lesser-striped swallow	-	-	-	-
Mountain chat	y=0.49Se+0.24Sh-0.17W-0.11Re-0.10B+0.12G- 0.09T-0.03	0.27	F _{7,112} =7.35	<0.01
Malachite sunbird	y=0.66Sa-0.32Se-0.15C-0.17ISh- 0.18Ba+0.12S+0.01	0.16	F _{6,113} =4.87	<0.01
Neddicky	y=0.31S+0.12Sa-0.10P+0.02	0.07	F _{6,116} =3.86	<0.01
Olive thrush	y=0.32Cl+0.32T+0.31R-0.39A- 0.24Se+0.21Sa+0.13W-0.09Re-0.11C+0.12Sh-0.02	0.23	F _{10,109} =4.7	<0.01
Pied crow	y=0.51T+0.30Sa-0.17Se+0.13RW+0.10Ag-0.15	0.28	F _{5,114} =10.3	<0.01
Pied starling	y=0.27C+0.20Se-0.19Ba+0.17G+0.03	0.07	F _{4,115} =3.27	<0.02
Pin-tailed whydah	y=0.32Ba+0.43S-0.29A+0.15Cl-0.21Ag- 0.29G+0.19W-0.12C-0.11B-0.03	0.10	F _{9,110} =2.44	<0.02
Pale-winged starling	y=0.49A-0.14Cl-0.11Sh+0.17Se-0.13R-0.12Ba+0.27	0.08	F _{6,113} =2.79	<0.02
Pied wagtail	-	-	-	-
Red bishop	-	-	-	-
Rock bunting	y=0.28Sh+0.32Sa+0.26W-0.19R-0.15C-0.14IG- 0.11Ba+0.09	0.13	F _{7,112} =3.55	<0.01
Red-eyed bulbul	y=0.25W+0.15T+0.16C+0.44S-0.24Ag-0.28G+0.02	0.18	F _{6,113} =5.38	<0.01
Rock kestrel	y=0.49A-0.35Ba+0.27W-0.22Cl-0.27S+0.10T+0.01	0.13	F _{6,113} =4.04	<0.01
Rock martin	-	-	-	-
Rock pigeon	-	-	-	-
Stone chat	y=0.19Ag+0.18G-0.12B-0.11Sh+0.11IC+0.10Ba-0.01	0.07	F _{6,113} =2.68	<0.02
Spotted flycatcher	y=0.37T-0.22Ba+0.18W+0.01	0.13	F _{3,116} =7.12	<0.01
Speckled mousebird	y=0.18C+0.31W+0.14T+0.04G+0.25Sh- 0.29R+0.29Ba-0.19B-0.35S-0.15Sa-0.01	0.22	F _{10,109} =4.3	<0.01
Spotted prinia	y=1.52IG-0.96ISa+0.24	0.45	F _{2,117} =50.2	<0.01
Three-banded plover	y=0.73Cl+0.33RSa+0.19L+0.17Sh+0.07Se-0.05RC- 0.04	0.75	F _{6,113} =61.9	<0.01
White-breasted cormorant	y= -0.27G-0.18Ba-0.30RSa+0.17L-0.13RP- 0.09Se+0.10RC+0.23	0.13	F _{7,112} =3.52	<0.01
Wailing cisticola	y=0.18Sh+0.26Se+0.13P+0.32S-0.21S- 0.25G+0.13W+0.01	0.17	F _{7,112} =4.56	<0.01

SPECIALIST REPORT
WILDLIFE AND BIRDS

Species	Model	R ²	F-value	p-value
White-rumped swift	$y=0.47C+0.30W-0.24G-0.01$	0.31	$F_{3,116}=18.8$	<0.01
Wattled starling	$y=0.36Sh+0.21Se-0.26Sa-0.42A+0.35R+0.20Ba-0.22W+0.14S-0.01$	0.26	$F_{8,111}=6.23$	<0.01
White-throated canary	$y=0.25Se-0.27R+0.41Sa-0.38Ba+0.17A-0.05Re+0.11Sh+0.13G-0.13IG-0.01$	0.18	$F_{9,110}=3.86$	<0.01
Yellow-billed duck	-	-	-	-

PART 6: FLOW-RELATED INFORMATION

17 STRIPED-MOUSE (*RHABDOMYS PUMILIO*) (see Skinner & Smithers 1990)

17.1 Distributions

Wide distribution beyond the southern African sub-region (Table 16.2).

17.2 Conservation status

Insufficient information available to assess conservation status (Table 16.2).

17.3 Habitat preference

Occurs in wide variety of habitats providing that grass is available. The grass should preferably be short and dense. Feeds primarily on green vegetation, insects and seed and is nocturnal. Prefer seeds to green vegetation. As a result will often reach high densities in agricultural areas.

17.4 Flow-related aspects of lifecycle

Foraging and home range habitat, in particular the

grass cover offered by floodplains, both in the lower and back dynamic zones.

17.5 Breeding/reproduction biology

Breeds during September to April with gestation 25 days and litters of up to 9 pups. Sexual maturity is reached at two months.

17.6 Flow-related physical habitat

Grass and other types of cover in lower and back dynamic zones.

17.7 Water quality and temperature tolerances ranges

Not relevant.

18 GREATER RED MUSK SHREW (*CROCIDURA FLAVESCENS*) (see Skinner & Smithers 1990)

18.1 Distributions

Distribution restricted to the southern African sub-region (Table 16.2).

18.2 Conservation status

Classified as threatened with a vulnerable recognition (Table 16.2).

18.3 Habitat preference

Occurs in wide range of vegetation types. Feeds primarily on invertebrates including earthworms.

18.4 Flow-related aspects of lifecycle

Foraging and home range habitat in the lower and back dynamic zones.

18.5 Breeding/reproduction biology

Breeds from August to April with gestation 28-36 days and litters between 1 and 7 are weaned within 18-22 days. Sexual maturity is reached at 2-3 months with an expected lifespan of 18 months.

18.6 Flow-related physical habitat

Types of cover in lower and back dynamic zones.

18.7 Water quality and temperature tolerances ranges

Not relevant.

19 MULTIMAMMATE MOUSE (*MASTOMYS NATALENSIS/COUCHA*) (see Skinner & Smithers 1990)**19.1 Distributions**

Distribution restricted to the southern African sub-region (Table 16.2).

19.2 Conservation status

Not listed (Table 16.2).

19.3 Habitat preference

Occurs in wide variety of habitats. Omnivorous, but feeds typically on fruits, seeds, grass and insects. Numbers often reach plague proportions in agricultural areas.

19.4 Flow-related aspects of lifecycle

Foraging and home range habitat in the lower and back dynamic zones.

19.5 Breeding/reproduction biology

Prolific breeder under favourable conditions. Breeds throughout the year but less activity during June and July. Gestation of 23 days and litters of up to 22 pups. Sexual maturity is reached at 11 weeks and inter-litter interval 33 days. Prone to population explosions.

19.6 Flow-related physical habitat

Cover in lower and back dynamic zones.

19.7 Water quality and temperature tolerances ranges

Not relevant.

20 WHITE-TAILED MOUSE (*MYSTROMYS ALBICAUDATA*) (see Skinner & Smithers 1990)**20.1 Distributions**

Distribution limited to the southern African sub-region (Table 16.2).

20.2 Conservation status

Not listed (Table 16.2).

20.3 Habitat preference

Savanna grassland and other grassy areas. Feeds on insects, seeds and green vegetation.

20.4 Flow-related aspects of lifecycle

Foraging and home range habitat in the lower and back dynamic zones.

20.5 Breeding/reproduction biology

No particular breeding season with a gestation of 37 days and litters of up to 5 pups. Sexual maturity is reached at four months. Young nipple-cling for 2 weeks and are weaned at 30-38 days.

20.6 Flow-related physical habitat

Grass and other types of cover in lower and back dynamic zones.

20.7 Water quality and temperature tolerances ranges

Not relevant.

21 CAPE CLAWLESS OTTER (*AONYX CAPENSIS*) (see Skinner & Smithers 1990)**21.1 Distributions**

Wide distribution beyond the southern African sub-region (Table 16.2).

Not listed (Table 16.2).

21.2 Conservation status

21.3 Habitat preference

Occurs in wide variety of habitats as long as freshwater, dense vegetation cover, holes and rocks are available. Prefers running water to dams and lakes and not found in polluted water. Feeds mainly on crustaceans. In freshwater this comprises 50-70% crabs, 10-20% frogs, 15% dragonfly larvae and 3-23% fish. Occasionally may eat birds, rodents, reptiles, molluscs and herbivore dung.

21.4 Flow-related aspects of lifecycle

Foraging and home range habitat in particular fast flowing rivers and streams.

21.5 Breeding/reproduction biology

Young appears during December to February with

gestation 60-64 days and litters of up to 3.

21.6 Flow-related physical habitat

Flowing streams and rivers and associated food availability in the aquatic zone.

21.7 Water quality and temperature tolerances ranges

Cannot exist in polluted streams or rivers.

22 AFRICAN BLACK DUCK (*ANAS SPARSA*) (see Maclean 1993)

22.1 Distributions

Wide distribution beyond the southern African subregion (Table 16.3).

22.2 Conservation status

Uncommon localised resident. Not listed by the IUCN (1996) (Table 16.3).

22.3 Habitat preference

Rivers, usually shallow with stony bottoms and wooded banks. Also prefer wooded mountain streams and rarely occur in dams.

22.4 Flow-related aspects of lifecycle

Uses waterside vegetation as roost and hiding sites and may occasionally roost in larger flocks on dams or large pools. Feeds mainly on chironomid larvae and pupae gleaned from under stones in rapids. Changes in flow regimes may therefore alter food availability. However, black duck feed on other aquatic insects, plant material, grain, fruit seed, acorns, small fish and crabs that may

serve as alternatives, particularly when rapid foraging habitats are scarce.

22.5 Breeding/reproduction biology

Breeding season between July and January. Nesting in hollow driftwood or in matted grass on ground above flood level, usually near water. Four to nine eggs in clutch hatching after 28-32 days and chicks fledge after 86 days. The female is the only parent incubating and attending chicks.

22.6 Flow-related physical habitat

Feeding areas, in particular, rapids. Also cover in wooded river banks, and nesting sites on logs or driftwood.

22.7 Water quality and temperature tolerances ranges

Not relevant.

23 HAMERKOP (*SCOPUS UMBRETTA*) (see Maclean 1993)

23.1 Distributions

Beyond the southern African subregion (Table 16.3).

23.2 Conservation status

Common resident in most areas. No IUCN listing (Table 16.3).

23.3 Habitat preference

Most inland waters including small pools.

23.4 Flow-related aspects of lifecycle

Forages by wading in or around shallow water and sometimes on muddy flats. Feeds mainly on adults and tadpoles of platannas, and sometimes on fish and aquatic invertebrates.

23.5 Breeding/reproduction biology

Breeding season from July to January. Builds large nests comprised of a mass of sticks in tree, on cliff edge or on a rock in the river. Clutch consists of 1-5 eggs, which hatch after 28-32 days, with fledging after 44-50 days. Both parents incubate eggs and attend chicks.

23.6 Flow-related physical habitat

Foraging areas, including shallow water, and sandy or muddy flats and banks.

23.7 Water quality and temperature tolerances ranges

Not relevant.

24 GREY HERON (*ARDEA CINEREA*) (see Maclean 1993).

24.1 Distributions

Widespread throughout and beyond the southern African subregion (Table 16.3).

24.2 Conservation status

Relatively uncommon resident not listed by IUCN (1996) (Table 16.3).

24.3 Habitat preference

Mostly shallow inland waters and sometimes open grassland near water.

24.4 Flow-related aspects of lifecycle

Forages in shallow water and may forage in deeper water. Roosts communally on trees or islands. Feeds primarily on fish (weight 10-20g). Also feeds on frogs, crabs, insects, spiders, centipedes, reptiles and some

small mammals, birds, molluscs and worms. Rarely feeds on plant material.

24.5 Breeding/reproduction biology

Breeding occurs during all months, except June. Nests in trees or reedbeds or on cliffs laying 2-7 eggs. Hatching occurs after 23-28 days. Nestlings are independent between 60-70 days after hatching. Both parents incubate eggs and attend chicks.

24.6 Flow-related physical habitat

Shallow water for foraging and physical habitat features for nest sites.

24.7 Water quality and temperature tolerances ranges

Not relevant.

25 WHITE-BREADED CORMORANT (*PHALOCROCORAX CARBO*) (see Maclean 1993)

25.1 Distributions

Distributed beyond the southern African subregion (Table 16.3).

25.2 Conservation status

Common resident not listed by IUCN (1996) (Table 16.3).

25.3 Habitat preference

Marine and inland waters usually associated with larger dams, pools and pans.

25.4 Flow-related aspects of lifecycle

Forages in pools, dams and pans. Feeds mainly on fish. May also eat frogs, crustaceans and molluscs.

25.5 Breeding/reproduction biology

Breeding season between April to October. Nests in trees, on cliffs or on rocky islands, in dense colonies. Lays 2-4 eggs, which are incubated for 27-38 days. Nestlings fledge after 53 days. Both parents incubate eggs and attend chicks.

25.6 Flow-related physical habitat

Slow flowing pools as foraging areas.

**25.7 Water quality and temperature tolerances
ranges**

Not relevant.

26 CAPE TEAL (*ANAS CAPENSIS*) (see Maclean 1993)

26.1 Distributions

Beyond the southern African subregion (Table 16.3).

26.2 Conservation status

Uncommon resident. Not listed by IUCN (1996) (Table 16.3).

26.3 Habitat preference

Mostly shallow brackish inland waters. Prefer larger pools than flowing water.

26.4 Flow-related aspects of lifecycle

Forages in shallow and deep water. Feeds largely on animal material, including insects, crustaceans and

tadpoles. Will also feed on leaves, seeds and stems of water plants.

26.5 Breeding/reproduction biology

Breeding season from April to September. Lays 5-11 eggs. Females incubate for 26-30 days. Chicks fledge after 6-8 weeks and are attended by females. Males often accompany the family.

26.6 Flow-related physical habitat

Foraging areas, in particular, in-channel pools.

26.7 Water quality and temperature tolerances ranges

Not relevant.

27 DARTER (*ANHINGA MELANOGASTER*) (see Maclean 1993)

27.1 Distributions

Distributed beyond the southern African subregion (Table 16.3).

27.2 Conservation status

Common resident. Not listing by IUCN (1996) (Table 16.3).

27.3 Habitat preference

Inland waters of any size, preferably quiet lakes, pans and slow-flowing rivers.

27.4 Flow-related aspects of lifecycle

Forages in water, diving for fish in deeper waters. Roosts gregariously in reedbeds or partly submerged trees. Feed mainly on fish, but will also

eat frogs and arthropods.

27.5 Breeding/reproduction biology

Breeding season from September to January. Lays 2-7 eggs. Incubation lasts 21-28 days (by both parents) with fledging after 6 weeks. Both parents attend.

27.6 Flow-related physical habitat

Foraging habitat, in particular, slow flowing deep pools. Roosting sites including reedbeds and partially submerged trees.

27.7 Water quality and temperature tolerances ranges

Not relevant.

28 EGYPTIAN GOOSE (*ALOPOCHEN AEGYPTIACUS*) (see Maclean 1993)**28.1 Distributions**

Distributed widely beyond the southern African subregion (Table 16.3).

28.2 Conservation status

Very common resident with regular moult migrations. Not listed by the IUCN (1996) (Table 16.3).

28.3 Habitat preference

Most inland waters, including rivers, dams, floodplains, pans, marshes and cultivated fields.

28.4 Flow-related aspects of lifecycle

Shoreline and sandbanks for roosting. Foraging habitat, floodplains with grass and cultivated fields. Roosts on shoreline usually in trees. Flocks aggregate on larger water bodies to moult. Feeds primarily on grass, leaves,

seeds, grain, crop seedlings and some aquatic rhizomes and tubers.

28.5 Breeding/reproduction biology

Breed during all months peaking between August and September. Lays 5-11 eggs, which hatch after 28-30 days of incubation (female only). Chicks fledge after 55 days, and are attended by both parents.

28.6 Flow-related physical habitat

Slow-flowing river pools for resting and moulting. Some sandbanks (level of use depends on slope) for resting and floodplains covered in grass or agriculture for feeding areas.

28.7 Water quality and temperature tolerances ranges

Not relevant.

29 GIANT KINGFISHER (*CERYLE MAXIMA*) (see Maclean 1993)**29.1 Distributions**

Widely distributed beyond the southern African subregion (Table 16.3).

29.2 Conservation status

Uncommon to locally common resident. Not listed by IUCN (1996) (Table 16.3).

29.3 Habitat preference

Primarily rivers, lakes and wooded streams.

29.4 Flow-related aspects of lifecycle

Uses rocks or low branches near water as perching sites from whence foraging takes place. Feeds primarily on

fish, crabs and frogs. Nests in tunnels in river banks about 1 m from the crest.

29.5 Breeding/reproduction biology

Breeding season from August to January. Lays 3-5 eggs. Both parents attend young.

29.6 Flow-related physical habitat

Rocks and branches, as perching sites, and shallow water as foraging areas. River banks consisting of soil for nest tunnels.

29.7 Water quality and temperature tolerances ranges

Not relevant.

30 YELLOW-BILLED DUCK (*ANAS UNDULATA*) (see Maclean 1993)**30.1 Distributions**

Beyond the southern African subregion (Table 16.3).

30.2 Conservation status

Very common, particularly in agricultural areas. Resident with local movements. Not listed by the IUCN (1996) (Table 16.3). Osborne & Tigar (1992b) recorded declines in population sizes prior to 1940. Not known what the trends are at present.

30.3 Habitat preference

Dams, pans, marshes, floodplains, pools and slow flowing rivers.

30.4 Flow-related aspects of lifecycle

Feeds in both shallow and deep waters. Grazes on floodplains gleaning grain from cultivated fields after reaping. Will rest on shoreline in groups. Nests in a variety of vegetation types within 20m of water. Food includes plant material, seeds, stems, tubers and leaves of water plants, grain, sunflower seeds and grass. Will also eat insects and their larvae.

30.5 Breeding/reproduction biology

Breeding season July to January. Lays 4-12 eggs that hatch after 28-30 days (incubation by the female only). Chicks fledge 68 days after hatching and are attended by the female only. Fledglings are dependent on female for up to 6 weeks after flying.

30.6 Flow-related physical habitat

Riverine vegetation cover for nesting. Shallow and deep waters for foraging, and grazing areas on floodplains provided they are covered in grass or agriculture.

30.7 Water quality and temperature tolerances ranges

Not relevant.

31 LITTLE STINT (*CALIDRIS MINUTA*) (see Maclean 1993)

31.1 Distributions

Widely distributed beyond the southern African subregion (Table 16.3).

31.2 Conservation status

Common non-breeding Palaearctic migrant September to April. Not listed by the IUCN (1996) (Table 16.3).

31.3 Habitat preference

Open muddy shores of a variety of waters including pools, lakes and dams.

31.4 Flow-related aspects of lifecycle

Forage on muddy flats probing bill in mud or sand

feeding on mollusks, crustaceans, insects and worms.

31.5 Breeding/reproduction biology

Non-breeding in southern Africa.

31.6 Flow-related physical habitat

Muddy and sandy flats as foraging areas.

31.7 Water quality and temperature tolerances ranges

Not relevant.

32 BLACK-HEADED HERON (*ARDEA MELANOCEPHALA*) (see Maclean 1993)

32.1 Distributions

Beyond the southern African subregion (Table 16.3).

32.2 Conservation status

Common resident not listed by IUCN (1996) (Table 16.3).

32.3 Habitat preference

Open grassland, fallow fields, forest clearings and edges of inland waters. Breeds in colonies in trees, reeds or on cliff edges.

32.4 Flow-related aspects of lifecycle

Forages in shallow water and roosts in colonies in trees and reedbeds on islands up to 30 km from feeding grounds. Feeds mainly on frogs, fish, crabs, insects rodents, birds, small reptiles, worms and spiders.

32.5 Breeding/reproduction biology

Breeding season between July and January. Lays 2-6 eggs. Incubation is by both sexes, and lasts 23-27 days. Fledglings fly at 40-45 days and are independent at 60 days. Chicks are attended by both parents.

32.6 Flow-related physical habitat

Primarily shallow water as foraging habitat.

32.7 Water quality and temperature tolerances ranges

Not relevant.

33 THREE-BANDED PLOVER (*CHARADRIUS TRICOLLARIS*) (see Maclean 1993)

33.1 Distributions

Distributed beyond the southern African subregion (Table 16.3).

33.2 Conservation status

Common resident, but nomadic on inland temporary waters. Not listed by the IUCN (1996) (Table 16.3).

33.3 Habitat preference

Prefers firm or gravelly shorelines of lakes, dams, pans, rivers and marshes.

33.4 Flow-related aspects of lifecycle

Feeds on shoreline insects, crustaceans, molluscs and worms. Nests on exposed gravel or mudflat near water.

33.5 Breeding/reproduction biology

Breeding season from May to January. Lays 1-2 eggs. Incubation lasts for 26-30 days by both sexes. Fledging occurs at 30-32 days. Young are dependent on both parents until 40-42 days.

33.6 Flow-related physical habitat

Muddy and gravel shorelines for feeding and muddy to gravel flats for breeding.

33.7 Water quality and temperature tolerances ranges

Not relevant.

34 BIRD SPECIES RICHNESS IN THE LOWER DYNAMIC ZONE

34.1 Natural range

Variations in bird species richness are likely to follow seasonal patterns as well as changes in habitat features indirectly associated inter-annual variations in the flow regimes of rivers.

34.2 Flow-related variations

Flow-related variations are primarily indirect and are related to flooding of the lower dynamic zone.

35 BIRD SPECIES RICHNESS IN THE BACK DYNAMIC ZONE

35.1 Natural range

Long-term variations are likely to reflect availability of resources, which will be dependent on a variety of factors. Changes in habitat features associated with indirect effects of flow regimes may also have long-term consequences for variation in bird species richness in this zone.

Flow-related variations are also primarily indirect and related to regular flooding on the back dynamic zone. Large floods will be the most important flow-related factor

35.2 Flow-related variations

as these are major contributors to riverine habitat structure, which in turn determines bird species richness.

PART 7: ACKNOWLEDGEMENTS AND REFERENCES**36 ACKNOWLEDGEMENTS**

I would like to acknowledge the logistical and financial support provided by the client, Lesotho Highlands Development Authority and Metsi Consultants in Cape Town (Dr Cate Brown and Dr Jackie King) and Maseru (Dr Hossein Sabet). Discussion with the rest of the LHDA 648 Biophysical Team proved invaluable in refining ideas and concepts. Anne-Marie Smit typed all the tables and appendices, and provided moral support during the long hours of keyboard massaging.

37 REFERENCES

- Allan, D., Jenkins, A., Barnes, K. & Whittington, P. (1996) Birds. In: *Baseline biology survey and reserve development Phase 1B*. Final Report Contract No. 1008, Lesotho Highland Water Project, Lesotho Highlands Development Authority, Maseru.
- Arthington, A.H., Bunn, S.E., Pusey, B.J., Bluhdorn, D.R., King, J.M., Day, J.A., Tharme, R.E. & O'Keefe, J.H. (1992). Development of an holistic approach for assessing environmental flow requirements of riverine ecosystems. In: Pigrum, J.J. and Hooper, B.P. (eds). *Proceedings of an international seminar and workshop on water allocation for the environment, November 1991*. The Centre for Water Policy Research, University of New England, Armidale.
- Bigalke, R.C. (1978). The contemporary mammal fauna of Africa. In: Keast, A., Erk, F.C and Glass, B. (eds). *Evolution, mammals and the southern continents*. State University of New York Press, Albany.
- Bigalke, R.C. (1972). Mammals. In: Werger, M.J.A. (ed). *Biogeography and ecology of southern Africa*. Junk, The Hague.
- Bonde, K. (1981). *An annotated check-list to the birds of Lesotho*. Privately published, Maseru.
- Bonde, K. (1984). *An annotated check-list to the birds of Lesotho*. Privately published, Herning.
- Bonde, K. (1993). *Birds of Lesotho : A guide to the distribution past and present*. University of Natal Press, Pietermaritzburg.
- Borquin, O. (1989). *Vertebrate fauna (excluding fish) from eastern Lesotho*. Drakensberg/Maluti Mountain Catchment Conservatyion Programme, Document 8. Natal Parks Board, Pietermaritzburg.
- Brooke, R.K. (1984). *South African Red Data Book - Birds*. South African National Scientific Programmes Report No. 97.
- Brown, C.J. (1988). *A study of the bearded vulture Gypaetus barbatus in southern Africa*. Ph.D. thesis, University of Natal, Pietermaritzburg.
- Brown, C.J. (1989). Plumages and measurements of the bearded vulture in southern Africa. *Ostrich* 60: 165-171.
- Brown, C.J. (1990a). Breeding biology of the bearded vulture in southern Africa, Part I: The pre-laying and incubation periods. *Ostrich* 61: 24-32.
- Brown, C.J. (1990b). Breeding biology of the bearded vulture in southern Africa, Part II: The nestling period. *Ostrich* 61: 33-42.
- Brown, C.J. (1990c). Breeding biology of the bearded vulture in southern Africa, Part III: The post-nestling dependence period. *Ostrich* 61: 43-49.
- Brown, C.J. (1992a). An investigation into the decline of the bearded vulture *Gypaetus barbatus* in southern Africa. *Biological Conservation* 57: 315-337.
- Brown, C.J. (1992b). Distribution and status of the bearded vulture *Gypaetus barbatus* in southern Africa. *Ostrich* 63: 1-9.
- Brown, C.J. and Barnes, P.R. (1984). Birds of the Natal alpine belt. *Lammergeyer* 33: 1-13.
- Caughley, G. (1977). *The analysis of vertebrate populations*. John Wiley and Sons, New York.
- Clancey, P.A. (1964). *The birds of Natal and Zululand*. Oliver & Boyd, Edinburgh.
- Clancey, P.A. (1965). On the colonisation of Natal by Swainson's francolin *Francolinus (Pternistis) swainsonii*. *Ostrich* 36: 35-36.
- Clancey, P.A. (1984). On the so-called mountain pipit of the afrotropics, in Miscelaneous Taxonomic Notes on African Birds LXV. *Durban Museum Novitates* 13: 189-194.
- Clancey, P.A. (1985). *The rare birds of southern Africa*. Winchester Press, Johannesburg.
- Clancey, P.A. (1986). Endemicity in the southern African avifauna. *Durban Museum Novitates* 13: 245-284.
- Clancey, P.A. (1989). Four additional species of southern African endemic birds. *Durban Museum Novitates* 14: 140-152.
- Clancey, P.A. (1990). A review of the indigenous pipits (Genus: *Anthus* Bechstem: Motacillidae) of the afrotropics. *Durban Museum Novitates* 15: 42-72.
- Clark, B.K. and Green, R.H. (1988). Statistical design and analysis for a 'biological effects' study. *Marine Ecology Programme Series* 46: 213-226.

- Coe, M.J. and Skinner, J.D. (1993). Connections, disjunctions and endemism in the eastern and southern African mammal faunas. *Transactions of the Royal Society of South Africa* 48: 233-254.
- Collar, N.J. and Andrew, P. (1988). Birds to watch: the ICBP World Checklist of Threatened Birds. *International Council for Bird Preservation Technical Publication* 8: 1-303.
- Collar, N.J.U., Crosby, M.J. and Stattersfield, A.J. (1994). Birds to watch 2. The world list of threatened birds. *Birdlife Conservation Series* 4: 1-407.
- Collar, N.J. and Stuart, S.N. (1985). *Threatened birds of Africa and related islands: the ICBP/IUCN Red Data Book, Part I*. ICBP/IUCN, Cambridge.
- Cyrus, D.P. and Robson, N.F. (1980). *Bird atlas of Natal*. University of Natal Press. Pietermaritzburg.
- De Graaff, G. (1981). *The rodents of southern Africa*. Butterworths, Durban.
- Donnay, T.J. (1989). Semongkong Cape vulture colony takes a plunge. *Bokmakierie* 41: 19-22.
- Dowsett, R.J. and Dowsett-Lemaire, F. (1993). *A contribution to the distribution and taxonomy of afro-tropical and Malagasy birds*. Tauraco Research Report No. 5, Tauraco Press, Liege.
- Du Plessis, S.F. (1969). *The past and present geographical distribution of the Perrisodactyla and Artiodactyla in southern Africa*. M.Sc. thesis, University of Pretoria, Pretoria.
- Duthie, A.G., Skinner, J.D. and Robertson, T.J. (1989). The distribution and status of the riverine rabbit *Bunolagus monticularis*, South Africa. *Biological Conservation* 47: 195-202.
- Earle, R.A. and Grobler, H.J. (1987). *First atlas of bird distribution in the Orange Free State*. National Museum, Bloemfontein.
- Gelderblom, C.M. (1993). *Conservation status of small endemic mammals of South Africa, with emphasis on the subterranean families*. M.Sc. thesis, University of Cape Town, Cape Town.
- Gelderblom, C.M. and Bronner, G.N. (1995). Patterns of distribution and protection status of the endemic mammals in South Africa. *South African Journal of Zoology* 30: 127-135.
- Gore, J.A., Layzer, J.B. and Russel, I.H. (1990). A non-traditional application of instream flow techniques for conserving habitat of biota in the Sabie river of southern Africa. *Proceedings of Congress on the Conservation and Management of Rivers*, University of York, 10-13 September 1990.
- Hockey, P.A.R., Allan, D.G., Rebelo, A.G. and Dean, W.R.J. (1988). The distribution, habitat requirements and conservation status of Rudd's Lark *Heteromirafra ruddi* in South Africa. *Biological Conservation* 45:255-266.
- IUCN (1996). *1996 IUCN red list of threatened animals*. IUCN, Gland, Switzerland.
- IUCN (1996). *IUCN red list categories*. IUCN, Gland, Switzerland.
- Jacot-Guillardmod, C. (1963). *Catalogue of the birds of Basutoland*. South African Avifauna Series No. 8, Percy Fitzpatrick Institute of African Ornithology, Cape Town.
- Jilbert, J. (1979). Cape vulture sites in Lesotho - a summary of current knowledge. *Vulture News* 2: 3-14.
- Jilbert, J. (1982). 1982 Lesotho Cape vulture project - preliminary report. *Vulture News* 8: 19-25.
- Jilbert, J. (1983). Cape vulture sites in Lesotho: a continuing investigation. *Bokmakierie* 35: 85-88.
- Jourdonais, J.H., Stanford, J.A., Hauer, F.R. and Hall, C.A.S. (1990). Assessing options for stream regulation using hydrologic simulations and cumulative impact analysis: Flathead river basin, U.S.A. *Regulated Rivers: Research and Management* 5: 279-293.
- Kadlec, J.A. (1976). Methodologies for assessing instream flows for wildlife. In: Stainaker, C.B. and Arnette, S.C. (Eds). *Methodologies for the determination of stream resource flow requirements: an assessment*. U.S. Fish and Wildlife Services, Office of Biological Services Western Water Association.
- King, J.M. and Louw, D. (In press). Instream flow assessments for regulated rivers in South Africa using the Building Block Methodology. *Aquatic Ecosystem Health and Restoration*.
- Little, R.M. and Bainbridge, W.R. (1988). Avifaunal conservation in the state forests of the Natal Drakensberg. *Proceedings of the 6th Pan-African Congress* 263-280.
- Little, R.M. and Bainbridge, W.R. (1992). *Birds of the Natal Drakensberg Park*. Natal Branch of the Wildlife Society of South Africa, Durban.
- Lynch, C.D. (1981). The status of the Cape grey mongoose, *Herpestes pulverulentus* Wagner, 1839 (Mammalia: Viverridae). *Navorsings van die Nasionale Museum Bloemfontein* 4: 121-168.
- Lynch, C.D. (1983). The mammals of the Orange Free State. *Memiors of the National Museum Bloemfontein* 18: 1-218.
- Lynch, C.D. (1985). Mammalian distribution patterns in the Orange Free State. *Navorsings van die Nasionale Museum Bloemfontein* 4: 473-500.
- Lynch, C.D. (1986). The ecology of the lesser dwarf shrew, *Suncus varilla* with reference to the use of termite mounts of *Trinervitermes trinervoides*. *Navorsings van die Nasionale Museum Bloemfontein* 5: 277-297.
- Lynch, C.D. (1989). The mammals of the north-eastern Cape Province. *Memiors of the National Museum Bloemfontein* 25: 1-116.
- Lynch, C.D. (1990). Reproduction in the lesser dwarf shrew, *Suncus varilla* (Mammalia: Soricidae). *Navorsings van die Nasionale Museum Bloemfontein* 7: 45-59.

- Lynch, C.D. (1991). Population dynamics in the lesser dwarf shrew, *Suncus varilla* (Mammalia: Soricidae). *Navorsings van die Nasionale Museum Bloemfontein* 7: 465-473.
- Lynch, C.D. (1993). The mammals of Lesotho. *Navorsings van die Nasionale Museum Bloemfontein* 10: 177-241.
- Lynch, C.D. and Watson, J.P. (1990). The mammals of Sehlabathebe National Park, Lesotho. *Navorsings van die Nasionale Museum Bloemfontein* 6: 523-554.
- Lynch, C.D. and Watson, J.P. (1992). The distribution and ecology of *Otomys sloggettii* (Mammalia: Rodentia) with notes on its taxonomy. *Navorsings van die Nasionale Museum Bloemfontein* 8: 141-158.
- MacClean, G.L. (1993). *Robert's Birds of Southern Africa*. The Trustees of the John Voelcker Bird Book Fund, Cape Town.
- Manry, D.E. (1982). Habitat use by foraging bald ibises *Geronticus calvus* in western Natal. *South African Journal of Wildlife Research* 12: 85-93.
- Manry, D.E. (1984). Factors influencing the use of winter-burnt grassland by foraging bald ibises *Geronticus calvus*. *South African Journal of Zoology* 19: 12-15.
- Manry, D.E. (1985a). Reproductive performance of the bald ibis *Geronticus calvus* in relation to rainfall and grass-burning. *Ibis* 127: 159-173.
- Manry, D.E. (1985a). Distribution, abundance and conservation of the bald ibis *Geronticus calvus* in southern Africa. *Biological Conservation* 33: 351-362.
- McKinney, D.F., Siegfried, W.R., Ball, I.J. and Frost, P.G.H. (1978). Behavioural specializations for river life in the African black duck. *Zeitschrift für Tierpsychologie* 48: 349-400.
- Meakins, R.H., Hargreaves, B.J. and Mochaba, F.M. (1988). *Fauna and flora survey of the Katse Dam catchment area of the Lesotho Highlands Development Authority Stage 1A*. National University of Lesotho, Maseru.
- Meester, J.A.J. (1965). The origins of the southern African mammal fauna. *Zoologica Africana* 1: 87-93.
- Meester, J.A.J., Rautenbach, I.L., Dippenaar, N.J. and Baker, C.M. (1986). Classification of southern African mammals. *Transvaal Museum Monographs* 5: 1-359.
- Mendelsohn, J. (1984). The mountain pipit in the Drakensberg. *Bokmakierie* 36: 40-44.
- Metsi Consultants. (1997). Inception report. In *Lesotho Highlands Water Project Contract LHDA 648: Consulting services for the establishment and monitoring of the instream flow requirements for river courses downstream of LHWP dams*. Report No. 648-01, Lesotho Highlands Development Authority, Maseru.
- Metsi Consultants. (1999). Biophysical process for determination of instream flow requirements. In *Lesotho Highlands Water Project Contract LHDA 648: Consulting services for the establishment and monitoring of the instream flow requirements for river courses downstream of LHWP dams*. Draft to be incorporated in Report No. 648 - Instream flow requirements for Lesotho Highlands Water Project Dams, Lesotho Highlands Development Authority, Maseru.
- Mosley, M.P. (1983). Flow requirements for recreation and wildlife in New Zealand rivers - a review. *Journal of Hydrology (N.Z.)* 22: 152-174.
- Mundy, P., Butchard, D., Ledger, J. and Piper, S. (1992). *The vultures of Africa*. Acorn Books and Russel Friedman Books, Johannesburg.
- Nel, J.A.J. (1993). *Baseline Biological Survey, Fauna and Flora. Lesotho Highlands Water Project Phase 1A*. Contract 75, Volume 4, Mammals. Loxton, Venn & Associates.
- Nel, J.A.J., Avenant, N. and Purves, M. (1996). Mammals. In: *Baseline biology survey and reserve development Phase 1B*. Final Report Contract No. 1008, Lesotho Highland Water Project, Lesotho Highlands Development Authority, Maseru.
- Osborne, P.E. and Tigar, B.J. (1989). *Smaller birds of the LHWP Phase 1A area: possible impacts and suggested management*. Lesotho Highlands Development Authority, Maseru.
- Osborne, P.E. and Tigar, B.J. (1990). *The status and distribution of birds in Lesotho*. Alexander Library, University of Oxford, Oxford.
- Osborne, P.E. and Tigar, B.J. (1992a). Priorities for bird conservation in Lesotho. *Biological Conservation* 61: 159-169.
- Osborne, P.E. and Tigar, B.J. (1992b). Interpreting bird atlas data using logistic models: an example from Lesotho, southern Africa. *Journal of Applied Ecology* 29: 5-62.
- Pringle, J.A. (1974). The distribution of mammals in Natal. Part I: Primates, Hyracoidea, Lagomorpha (except *Lepus*), Pholidota and Tubilidentata. *Annals of the Natal Museum* 23: 93-115.
- Quickelberge, C.D. (1989). *Birds of the Transkei*. Durban Natural History Museum, Durban.
- Rautenbach, I.L. (1982). Mammals of the Transvaal. *Ecoplan Management* 1: 1-211.
- Rowe-Rowe, D.T. (1982). Home range and movements of black-backed jackals in an African montane region. *South African Journal of Wildlife Research* 12: 79-84.
- Rowe-Rowe, D.T. (1983a). Habitat preferences of five Drakensberg antelopes. *South African Journal of Wildlife Research* 13: 1-8.
- Rowe-Rowe, D.T. (1983b). Black-backed jackals diet in relation to food availability in the Natal Drakensberg. *South African Journal of Wildlife Research* 13: 17-33.
- Rowe-Rowe, D.T. (1984). Black-backed jackal population structure in the Natal Drakensberg. *Lammergeyer* 32: 1-7.

- Rowe-Rowe, D.T. (1991). *The ungulates of Natal*. Natal Parks Board, Pietermaritzburg.
- Rowe-Rowe, D.T. (1992). *The carnivores of Natal*. Natal Parks Board, Pietermaritzburg.
- Rowe-Rowe, D.T. and Lowry, P.B. (1982). Influence of fire on small-mammal populations in the Natal Drakensberg. *South African Journal of Wildlife Research* 12: 130-139.
- Rowe-Rowe, D.T. and Meester, J.A.J. (1982a). Population dynamics of small mammals in the Drakensberg of Natal, South Africa. *Zeitschrift für Saugertierkunde* 47: 347-356.
- Rowe-Rowe, D.T. and Meester, J.A.J. (1982b). Habitat preferences and abundance relations of small mammals in the Natal Drakensberg. *South African Journal of Zoology* 17: 202-209.
- Rowe-Rowe, D.T. and Meester, J.A.J. (1985). Biology of *Myosorex varius* in an African montane region. *Acta Zoologica Fennica* 173: 271-273.
- Rowe-Rowe, D.T. and Scotcher, J.S.B. (1986). Ecological carrying capacity of the Natal Drakensberg for wild ungulates. *South African Journal of Wildlife Research* 16: 12-16.
- Siegfried, W.R. (1967). The distribution and status of the black stork in southern Africa. *Ostrich* 38: 179-185.
- Siegfried, W.R. (1968). The black duck in the south-west Cape. *Ostrich* 40: 213-214.
- Siegfried, W.R. (1970). Wildfowl distribution, conservation and research in southern Africa. *Waterfowl* 21: 122.
- Siegfried, W.R. (1992). Conservation status of the South African endemic avifauna. *South African Journal of Wildlife Research* 22: 61-64.
- Siegfried, W.R., Ball, I.J., Frost, P.G.H. and McKinney, D.F. (1975). Waterfowl populations in the Eerste River Valley, South Africa. *Journal of the Southern African Wildlife Management Association* 5: 69-73.
- Siegfried, W.R. and Brown, C.A. (1992). The distribution and protection of the mammals endemic to southern Africa. *South African Journal of Wildlife Research* 22: 11-16.
- Siegfried, W.R., Frost, P.G.H., Ball, I.J. and McKinney, D.F. (1977). Evening gatherings and night roosting of African black ducks. *Ostrich* 48: 5-16.
- Skead, C.J. (1967). Ecology of birds in the eastern Cape Province. *Ostrich Supplement* 7: 1-103.
- Skinner, J.D. and Smithers, R.H.N. (1990). *The mammals of the southern African subregion*. University of Pretoria, Pretoria.
- Smithers, R.H.N. (1986). *South African Red Data Book - Terrestrial Mammals*. South African National Scientific Programmes Report No. 125.
- Sokal, R.R. and Rohlf, F.J. (1983). *Biometry. The principles and practice of statistics in biological research*. W.H. Freeman and Company, San Francisco.
- Staples, R. AND Hudson, W.K. (1938). *An ecological survey of the mountain area of Basutoland*. Crown Agents, London.
- Stuart, C. and Stuart, T. (1993). *Mammals of southern Africa: a field guide*. Struik Publishers, Cape Town.
- Tarboton, W.R., Allan, D. and Vernon, C.T. (1993). *Baseline Biological Survey, Fauna and Flora. Lesotho Highlands Water Project Phase 1A*. Contract 75, Volume 7, Birds. Loxton, Venn & Associates.
- Tarboton, W.R., Kemp, M.I. and Kemp, A.C. (1987). *Birds of the Transvaal*. Transvaal Museum, Pretoria.
- Van Aarde, R.J. and Ferreira, S.M. (1994). *Report on a desk top study of the insects, reptiles, birds and mammals in areas demarcated for Phase 2 & 3 of the Lesotho Highlands Water Project*. Steffen, Robertson and Kirsten Consulting Engineers, Johannesburg.
- Watson, J.P. (1990a). Westward range extension of Temminck's hairy bat in South Africa and Lesotho. *South African Journal of Wildlife Research* 20: 119-121.
- Watson, J.P. (1990b). New distribution records of *Laephotis* in South Africa and Lesotho. *Navorsings van die Nasionale Museum Bloemfontein* 7: 61-70.
- Whitten, A., Byrne, R.W. and Henzi, S.P. (1987). The behavioural ecology of mountain baboons. *International Journal of Primatology* 8: 367-388.
- Willan, K. (1990). Reproductive biology of the southern African ice rat. *Acta Theriologica* 35: 61-70.
- Winterbottom, J.M. (1972). The ecological distribution of birds in southern Africa. *Monographs of the Percy Fitzpatrick Institute of African Ornithology* 1: 1-82.
- Winterbottom, J.M. (1972). Birds. In: Werger, M.J.A. (ed). *Biogeography and ecology of southern Africa*. Junk, The Hague.

PART 8: APPENDICES

APPENDIX 1: IFR SITE 1

38 IFR-SITE 1

38.1 Mammal raw data

Mammal raw data represented as number of individuals per 100 trapnights where a trapnight refers to one trap set for one night. *n* represents the number of traps set in each zone at each locality. See Table 16.2 for common names.

	Locality				
	A	B	C	D	E
Lower dynamic zone (<i>n</i>)	12	18	12	18	15
<i>Mastomys natalensis/coucha</i>	3.78	-	-	-	-
<i>Rhabdomys pumilio</i>	-	-	-	10.91	-
<i>Crocidura flavescens</i>	-	-	-	2.48	-
Upper dynamic zone (<i>n</i>)	24	16	22	18	15
<i>Mastomys natalensis/coucha</i>	-	-	2.02	2.48	-
<i>Rhabdomys pumilio</i>	3.78	5.79	4.13	5.11	2.99
<i>Crocidura flavescens</i>	-	5.79	-	-	-

38.2 Bird raw data

Bird raw data represented as number of individuals counted per hour. See Table 16.3 for latin names. *n* represents the total number of individuals observed in a zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone (<i>n</i>)	101	20	13	48	3
Cape bunting	-	5.33	-	-	-
Cape sparrow	9.33	5.33	8.00	46.67	-
Cape turtle dove	-	2.67	2.67	-	1.33
Cape weaver	2.67	8.00	2.67	2.67	1.33
Cape white-eye	-	-	-	13.33	-
Cape wagtail	1.33	1.33	2.67	-	-
Drakensberg siskin	1.33	-	-	-	-
Neddicky	-	1.33	-	1.33	-
Red bishop	120.00	-	-	-	-
Stone chat	-	-	1.33	-	-
Spotted prinia	-	2.67	-	-	1.33
Upper dynamic zone (<i>n</i>)	12	3	3	-	4
Cape bunting	-	2.67	-	-	-
Cape sparrow	-	-	1.33	-	-
Cape turtle dove	-	-	-	-	1.33
Common waxbill	5.33	-	-	-	-
Hamerkop	-	1.33	-	-	-
Rock bunting	-	-	2.67	-	2.67
Rock martin	1.33	-	-	-	-
Stone chat	5.33	-	-	-	1.33
Aquatic zone (<i>n</i>)	5	-	2	-	-
Cape wagtail	1.33	-	1.33	-	-
Grey Heron	2.67	-	-	-	-
House martin	-	-	1.33	-	-
Yellow-billed duck	2.67	-	-	-	-

38.3 Mammal presence/absence data summary

See Table 8.1.

38.4 Bird presence/absence data summary

See Table 8.3.

38.5 Gross vegetation structural raw data

Vegetation raw data presented as % cover.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Trees	-	2.5	50	0.5	25
Shrubs	2.5	-	-	0.5	2.5
Sedge	-	-	25	-	-
Grass	87.5	37.5	-	87.5	62.5
Bare ground	13	62.5	37.5	2.5	27.5
Back dynamic zone					
Shrubs	-	25	-	-	-
Grass	50	15	27.5	62.5	37.5
Bare ground	13	27.5	40	-	25
Agriculture	37.5	37.5	25	37.5	37.5

38.6 Gross geomorphological raw data

Geomorphological raw data presented as follows: width of zones are given in meters, aspect as degrees and the various components as percentage cover of a particular zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Zone width	8	7.5	5	3.5	6
Aspect	15	20	10	20	10.5
Rock	-	50	25	-	12.5
Soil	100	2.5	50	100	62.5
Sand	-	50	25	2.5	12.5
Cobble	-	2.5	-	-	15
Back dynamic zone					
Zone width	10	7.5	12.5	8.5	7.5
Aspect	15	20	35	10	20
Rock	2.5	2.5	50	-	37.5
Soil	100	100	52.5	100	62.5
Cobble	-	-	2.5	-	-
Aquatic Zone					
River width	30	30	30	25	20
River rock	25	5	5	5	1
River sand	-	-	-	25	-
River cobble	-	25	-	-	25
River pebble	-	-	1	-	-

APPENDIX 2: IFR SITE 2

39 IFR-SITE 2

39.1 Mammal raw data

Mammal raw data represented as number of individuals per 100 trapnights where a trapnight refers to one trap set for one night. *n* represents the number of traps set in each zone at each locality. See Table 16.2 for common names.

	Locality				
	A	B	C	D	E
Lower dynamic zone (<i>n</i>)	18	18	15	18	18
<i>Rhabdomys pumilio</i>	-	2.48	-	2.48	10.91
Upper dynamic zone (<i>n</i>)	18	18	15	18	18
<i>Mastomys natalensis/coucha</i>	-	-	-	2.48	-
<i>Rhabdomys pumilio</i>	-	-	-	-	2.48

39.2 Bird raw data

Bird raw data represented as number of individuals counted per hour. See Table 16.3 for latin names. *n* represents the total number of individuals observed in a zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone (<i>n</i>)	22	4	3	14	38
Cape bunting	4.00	2.67	-	-	-
Cape rock thrush	-	1.33	-	-	-
Cape sparrow	-	-	-	-	17.33
Cape turtle dove	4.00	-	-	2.67	9.33
Cape weaver	-	-	-	-	9.33
Common waxbill	16.00	-	-	-	-
Cape white-eye	-	-	-	-	6.67
Cape wagtail	1.33	-	-	-	-
Hamerkop	-	-	1.33	-	-
Neddicky	-	-	-	-	1.33
Pied starling	-	-	2.67	-	-
Pale-winged starling	-	-	-	16.00	-
Red-eyed bulbul	-	-	-	-	2.67
Spotted prinia	1.33	1.33	-	-	4.00
Wailing cisticola	2.67	-	-	-	-
Upper dynamic zone (<i>n</i>)	5	12	17	5	30
African black duck	-	-	2.67	-	-
Black-eyed bulbul	-	4.00	-	-	-
Black stork	-	-	-	-	1.33
Cape bunting	2.67	4.00	-	2.67	-
Cape sparrow	-	-	-	-	4.00
Cape turtle dove	-	-	4.00	-	-
Common waxbill	-	-	5.33	-	-
Cape wagtail	1.33	1.33	-	-	-
Neddicky	-	1.33	-	-	1.33
Pale-winged starling	-	-	-	-	32.00
Rock bunting	-	-	-	-	1.33
Rock martin	-	1.33	-	2.67	-
Rock pigeon	2.67	-	1.33	-	-
Spotted prinia	-	4.00	1.33	-	-
Aquatic zone (<i>n</i>)	2	5	8	1	1
African black duck	-	-	2.67	-	-
Banded martin	-	4.00	4.00	-	1.33
Cape sparrow	-	1.33	-	-	-

	Locality				
	A	B	C	D	E
Cape wagtail	1.33	-	-	-	-
Grey Heron	-	-	-	1.33	-
Hamerkop	-	-	1.33	-	-
Rock martin	1.33	-	-	-	-
Rock pigeon	-	-	2.67	-	-
White-breasted cormorant	-	1.33	-	-	-

39.3 Mammal presence/absence data summary

See Table 9.1.

39.4 Bird presence/absence data summary

See Table 9.3.

39.5 Gross vegetation structural raw data

Vegetation raw data presented as % cover.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Trees	15.00	-	2.50	40.00	15.00
Shrubs	0.50	3.00	2.50	-	2.50
Reeds	-	-	-	12.50	-
Sedge	62.50	0.50	2.50	-	-
Grass	12.50	87.50	62.50	62.50	100.00
Bare ground	25.50	0.50	27.50	12.50	1.00
Back dynamic zone					
Trees	0.50	-	2.50	-	-
Shrubs	37.50	25.00	25.00	25.00	2.50
Grass	75.00	62.50	62.50	25.00	50.00
Bare ground	3.00	27.50	12.50	25.00	25.00
Agriculture	12.50	-	12.50	37.50	37.50

39.6 Gross geomorphological raw data

Geomorphological raw data presented as follows: width of zones are given in meters, aspect as degrees and the various components as percentage cover of a particular zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Zone width	5.00	5.00	10.00	5.00	5.00
Aspect	10.00	10.00	15.00	10.00	10.00
Rock	37.50	-	25.00	12.50	-
Soil	25.00	87.50	25.00	87.50	100.00
Sand	-	12.50	5.00	2.50	-
Cobble	-	-	-	-	2.50
Boulder	50.00	12.50	50.00	-	-
Back dynamic zone					
Zone width	17.50	17.50	15.00	12.50	10.00
Aspect	10.00	25.00	15.00	15.00	25.00
Rock	2.50	25.00	12.50	25.00	12.50
Soil	75.00	75.00	62.50	75.00	100.00
Cobble	-	-	25	-	-
Boulder	37.50	2.50	-	-	-
Aquatic Zone					
River width	50.00	50.00	50.00	60.00	60.00
River rock	-	1.00	-	5.00	1.00

River cobble	-	1.00	5.00	15.00	-
Logs	-	0.50	-	-	-

APPENDIX 3: IFR SITE 3

40 IFR-SITE 3

40.1 Mammal raw data

Mammal raw data represented as number of individuals per 100 trapnights where a trapnight refers to one trap set for one night. *n* represents the number of traps set in each zone at each locality. See Table 16.2 for common names.

	Locality				
	A	B	C	D	E
Lower dynamic zone (n)	18	18	18	18	18
<i>Aethomys namaquensis</i>	1.28	10.63	12.47	14.69	12.61
<i>Mastomys natalensis/coucha</i>	-	3.87	5.88	4.27	5.88
<i>Mystromys albicaudata</i>	-	-	-	9.98	2.35
<i>Rhabdomys pumilio</i>	1.02	4.42	4.42	6.63	4.51
<i>Crocidura flavescens</i>	23.65	4.13	-	0.64	-
Upper dynamic zone (n)	18	18	18	18	18
<i>Aethomys namaquensis</i>	3.41	6.96	10.51	1.28	-
<i>Rhabdomys pumilio</i>	2.29	4.42	6.55	1.2	0.17
<i>Crocidura flavescens</i>	-	0.66	-	-	2.38

40.2 Bird raw data

Bird raw data represented as number of individuals counted per hour. See Table 16.3 for latin names. *n* represents the total number of individuals observed in a zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone (n)	13	5	5	32	11
Cape bunting	-	4.00	2.67	9.33	2.67
Cape batis	-	-	-	1.33	-
Cape robin	-	-	-	2.67	-
Cape reed warbler	1.33	-	-	-	-
Cape turtle dove	-	-	-	-	1.33
Cape weaver	10.67	-	-	-	-
Common waxbill	-	-	-	22.67	-
Cape wagtail	-	1.33	2.67	-	-
Grey Heron	1.33	-	-	-	-
House martin	-	1.33	-	-	-
Mountain chat	-	-	1.33	-	6.67
Olive thrush	1.33	-	-	1.33	-
Pin-tailed whydah	-	-	-	2.67	-
Red-eyed bulbul	-	-	-	-	1.33
Three-banded plover	2.67	-	-	1.33	-
Wailing cisticola	-	-	-	1.33	1.33
Wattled starling	-	-	-	-	1.33
Upper dynamic zone (n)	17	4	5	7	6
Black stork	-	1.33	-	-	-
Cape bunting	-	2.67	5.33	-	4.00
Cape batis	-	-	-	1.33	-
Cape turtle dove	6.67	-	-	-	-
Cape weaver	2.67	-	-	-	-
Drakensberg siskin	2.67	-	-	-	-
Fiscal shrike	1.33	1.33	-	-	-
House martin	-	-	1.33	-	-
Jackal buzzard	-	-	-	1.33	-
Mountain chat	-	-	-	1.33	-

	Locality				
	A	B	C	D	E
Olive thrush	2.67	-	-	-	-
Rock bunting	2.67	-	-	1.33	-
Red-eyed bulbul	-	-	-	-	4.00
Rock pigeon	-	-	-	4.00	-
Stone chat	2.67	-	-	-	-
Spotted prinia	1.33	-	-	-	-
Aquatic zone (n)	7	4	1	3	2
African black duck	-	2.67	-	-	-
Cape teal	2.67	-	-	-	-
Darter	-	-	-	1.33	1.33
Egyptian goose	-	-	-	1.33	-
House martin	4.00	-	-	-	-
Jackal buzzard	-	1.33	-	-	-
Pied starling	1.33	-	-	-	-
Rock pigeon	1.33	-	-	-	-
White-breasted cormorant	-	1.33	1.33	1.33	1.33

40.3 Mammal presence/absence data summary

See Table 10.1.

40.4 Bird presence/absence data summary

See Table 10.2.

40.5 Gross vegetation structural raw data

Vegetation raw data presented as % cover.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Trees	-	-	-	0.5	-
Shrubs	37.5	-	12.5	62.5	52.5
Reeds	10	50	0.5	-	-
Sedge	-	25	37.5	27.5	37.5
Grass	27.5	-	25	-	15
Bare ground	5	25	25	38	25.5
Back dynamic zone					
Trees	-	0.5	-	-	-
Shrubs	2.5	2.5	25	37.5	25
Grass	100	75	62.5	100	87.5
Bare ground	12.5	25	37.5	5	-

40.6 Gross geomorphological raw data

Geomorphological raw data presented as follows: width of zones are given in meters, aspect as degrees and the various components as percentage cover of a particular zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Zone width	3	8.5	12.5	5	5
Aspect	60	10	5.5	20.5	5.5
Rock	87.5	50	50	50	75
Soil	-	-	-	25	50
Sand	-	50	75	37.5	2.5
Back dynamic zone					
Zone width	32.5	27.5	10	10	15
Aspect	5.5	5.5	45	10	10
Rock	75	50	50	37.5	50
Soil	50	25	62.5	62.5	62.5
Sand	-	37.5	-	-	-
Aquatic Zone					
River width	50	50	50	50	50
Logs	0.5	-	-	-	-

APPENDIX 4: IFR SITE 4

41 IFR-SITE 4

41.1 Mammal raw data

Mammal raw data represented as number of individuals per 100 trapnights where a trapnight refers to one trap set for one night. *n* represents the number of traps set in each zone at each locality. See Table 16.2 for common names.

	Locality				
	A	B	C	D	E
Lower dynamic zone (<i>n</i>)	10	10	10	10	10
Upper dynamic zone (<i>n</i>)	10	10	10	10	10
<i>Mystromys albicaudata</i>	-	-	-	4.58	-
<i>Rhabdomys pumilio</i>	-	-	-	-	4.58

41.2 Bird raw data

Bird raw data represented as number of individuals counted per hour. See Table 16.3 for latin names. *n* represents the total number of individuals observed in a zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone (<i>n</i>)	3	24	6	40	60
Black-backed cisticola	-	9.33	-	-	-
Banded martin	-	-	-	1.33	8.00
Black-throated canary	-	-	2.67	1.33	1.33
Cape bunting	2.67	8.00	-	5.33	5.33
Cape canary	-	-	-	-	8.00
Cape sparrow	-	4.00	-	8.00	4.00
Cape turtle dove	1.33	2.67	-	2.67	-
Cape weaver	-	1.33	-	-	1.33
Common waxbill	-	-	-	-	2.67
Cape wagtail	-	1.33	-	-	2.67
Fiscal shrike	-	-	-	-	2.67
Little stint	-	-	-	-	1.33
Mountain chat	-	-	-	6.67	5.33
Neddicky	-	1.33	-	-	-
Pied starling	-	-	-	2.67	4.00
Pale-winged starling	-	-	-	21.33	9.33
Rock bunting	-	1.33	-	1.33	13.33
Red-eyed bulbul	-	-	-	1.33	1.33
Rock martin	-	-	-	-	1.33
Spotted prinia	-	2.67	5.33	1.33	1.33
Wailing cisticola	-	-	-	-	2.67
White-throated canary	-	-	-	-	4.00
Upper dynamic zone (<i>n</i>)	15	5	13	7	4
Black-throated canary	-	-	2.67	2.67	1.33
Cape bunting	2.67	-	-	-	-
Cape sparrow	-	4.00	-	-	-
House martin	-	-	-	1.33	-
Pin-tailed whydah	9.33	-	-	-	-
Pale-winged starling	-	2.67	12.00	2.67	2.67
Rock bunting	-	-	-	-	1.33
Red-eyed bulbul	1.33	-	-	-	-
Rock kestrel	-	-	2.67	-	-
Rock martin	-	-	-	2.67	-
Rock pigeon	2.67	-	-	-	-
Stone chat	1.33	-	-	-	-
Wailing cisticola	2.67	-	-	-	-
Aquatic zone (<i>n</i>)	-	-	1	-	1
Cape bunting	-	-	-	-	1.33

Spotted prinia	-	-	1.33	-	-
----------------	---	---	------	---	---

41.3 Mammal presence/absence data summary

See Table 11.1.

41.4 Bird presence/absence data summary

See Table 11.4.

41.5 Gross vegetation structural raw data

Vegetation raw data presented as % cover.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Trees	0.5	-	-	-	2.5
Shrubs	0.5	2.5	12.5	-	25
Reeds	-	-	50	-	-
Sedge	37.5	37.5	12.5	37.5	37.5
Grass	37.5	37.5	62.5	25	50
Bare ground	25	37.5	5	50	3
Island bare ground	-	-	12.5	-	-
Island shrubs	-	-	37.5	-	-
Island grass	-	-	37.5	-	-
Back dynamic zone					
Trees	2.5	2.5	2.5	-	-
Shrubs	0.5	2.5	2.5	0.5	2.5
Sedge	-	-	-	-	25
Grass	50	75	75	75	62.5
Bare ground	50	37.5	2.5	25	15
Agriculture	-	-	12.5	-	25

41.6 Gross geomorphological raw data

Geomorphological raw data presented as follows: width of zones are given in meters, aspect as degrees and the various components as percentage cover of a particular zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Zone width	10	10	10	5	6
Aspect	5.5	1	10.5	30	10
Rock	50	25	25	25	-
Soil	-	-	-	25	25
Sand	62.5	87.5	75	50	75
Cobble	-	-	-	2.5	-
Island length	-	-	50	-	-
Island width	-	-	12.5	-	-
Island sand	-	-	50	-	-
Back dynamic zone					
Zone width	25	12.5	25	20	50
Aspect	5.5	15	40.5	15.5	5.5
Rock	2.5	25	62.5	25	12.5
Soil	100	87.5	50	75	87.5
Cobble	2.5	-	-	-	-
Aquatic Zone					
River width	70	70	60	60	60
River rock	-	-	2.5	-	-
River cobble	-	25	37.5	25	-
River pebble	-	25	12.5	25	-

APPENDIX 5: IFR SITE 5

42 IFR-SITE 5

42.1 Mammal raw data

Mammal raw data represented as number of individuals per 100 trapnights where a trapnight refers to one trap set for one night. *n* represents the number of traps set in each zone at each locality. See Table 16.2 for common names.

	Locality				
	A	B	C	D	E
Lower dynamic zone (n)	10	6	10	10	10
Upper dynamic zone (n)	10	14	10	10	10
<i>Aethomys namaquensis</i>	-	-	15.49	-	-

42.2 Bird raw data

Bird raw data represented as number of individuals counted per hour. See Table 16.3 for latin names. *n* represents the total number of individuals observed in a zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone (n)	1	1	-	4	14
Banded martin	-	1.33	-	-	-
Cape bunting	-	-	-	2.67	1.33
Cape robin	-	-	-	-	2.67
Cape sparrow	-	-	-	1.33	-
Cape turtle dove	1.33	-	-	-	-
Cape wagtail	-	-	-	1.33	-
Rock bunting	-	-	-	-	2.67
Red-eyed bulbul	-	-	-	-	5.33
Speckled mousebird	-	-	-	-	4.00
Wailing cisticola	-	-	-	-	1.33
White-rumped swift	-	-	-	-	1.33
Upper dynamic zone (n)	11	21	1	9	9
Black-eyed bulbul	-	2.67	1.33	-	-
Banded martin	-	-	-	1.33	2.67
Cape sparrow	8.00	2.67	-	1.33	-
Cape turtle dove	-	4.00	-	-	2.67
House martin	-	2.67	-	-	-
Lesser-striped swallow	-	-	-	-	1.33
Mountain chat	-	2.67	-	-	-
Neddicky	-	1.33	-	-	-
Pale-winged starling	-	2.67	-	-	-
Rock bunting	-	6.67	-	-	1.33
Red-eyed bulbul	2.67	-	-	4.00	1.33
Rock martin	-	-	-	-	2.67
Rock pigeon	2.67	2.67	-	4.00	-
Spotted prinia	1.33	-	-	-	-
Wailing cisticola	-	-	-	1.33	-
Aquatic zone (n)	1	-	-	1	1
Darter	-	-	-	1.33	-
Pied wagtail	1.33	-	-	-	1.33

42.3 Mammal presence/absence data summary

See Table 12.1.

42.4 Bird presence/absence data summary

See Table 12.3.

42.5 Gross vegetation structural raw data

Vegetation raw data presented as % cover.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Trees	-	0.5	-	2.5	2.5
Shrubs	13	12.5	5	2.5	27.5
Sedge	25	12.5	-	-	-
Grass	25	37.5	40	27.5	12.5
Bare ground	37.5	37.5	62.5	75	75
Back dynamic zone					
Trees	-	2.5	-	0.5	-
Shrubs	3	25	15	5	15
Grass	37.5	52.5	62.5	50	62.5
Bare ground	40	27.5	27.5	37.5	37.5
Agriculture	25	-	-	12.5	-

42.6 Gross geomorphological raw data

Geomorphological raw data presented as follows: width of zones are given in meters, aspect as degrees and the various components as percentage cover of a particular zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Zone width	5	4.5	10	3	30
Aspect	15	15	35	15	10
Rock	2.5	12.5	-	-	2.5
Soil	25	50	-	50	-
Sand	50	12.5	27.5	50	50
Cobble	13	-	-	2.5	50
Boulder	12.5	-	75	-	2.5
Back dynamic zone					
Zone width	15	17.5	42.5	27.5	12.5
Aspect	20	20	25	20	20
Rock	12.5	12.5	-	-	-
Soil	75	75	62.5	100	87.5
Cobble	0.5	-	-	-	-
Pebble	-	-	-	-	2.5
Boulder	12.5	12.5	37.5	-	12.5
Aquatic Zone					
River width	70	60	80	75	75
River rock	-	-	-	-	-
River sand	-	-	50	-	25
River cobble	-	-	-	25	25
River pebble	-	-	-	5	25
River boulder	-	-	25	-	-

APPENDIX 6: IFR SITE 6

43 IFR-SITE 6

43.1 Mammal raw data

Mammal raw data represented as number of individuals per 100 trapnights where a trapnight refers to one trap set for one night. *n* represents the number of traps set in each zone at each locality. See Table 16.2 for common names.

	Locality				
	A	B	C	D	E
Lower dynamic zone (<i>n</i>)	18	18	18	12	36
<i>Rhabdomys pumilio</i>	-	-	5.12	-	-
<i>Crocidura flavescens</i>	-	-	-	-	-
Upper dynamic zone (<i>n</i>)	18	18	16	24	36
<i>Mastomys natalensis/coucha</i>	-	-	-	2.80	-
<i>Rhabdomys pumilio</i>	-	2.48	-	1.85	1.22

43.2 Bird raw data

Bird raw data represented as number of individuals counted per hour. See Table 16.3 for latin names. *n* represents the total number of individuals observed in a zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone (<i>n</i>)	21	3	20	6	1
Black-eyed bulbul	-	-	2.67	-	-
Cape robin	1.33	-	2.67	-	-
Cape sparrow	-	-	4.00	2.67	-
Cape turtle dove	6.67	-	-	-	-
Common waxbill	2.67	-	-	-	-
Cape white-eye	-	-	4.00	-	-
Cape wagtail	1.33	-	-	2.67	-
Malchite sunbird	1.33	-	-	-	1.33
Neddicky	-	1.33	-	1.33	-
Olive thrush	-	-	2.67	-	-
Pied crow	-	-	5.33	-	-
Pin-tailed whydah	-	-	2.67	-	-
Pale-winged starling	5.33	-	-	-	-
Pied wagtail	2.67	-	-	-	-
Rock bunting	-	-	1.33	-	-
Red-eyed bulbul	2.67	1.33	-	-	-
Rock pigeon	2.67	-	-	-	-
Stone chat	-	-	1.33	1.33	-
Speckled mousebird	-	1.33	-	-	-
Wailing cisticola	1.33	-	-	-	-
Upper dynamic zone (<i>n</i>)	3	25	37	7	13
Black-eyed bulbul	-	-	-	1.33	1.33
Black-headed heron	-	-	1.33	-	-
Cape bunting	-	2.67	-	-	-
Cape canary	-	-	2.67	-	-
Cape sparrow	-	-	16.00	5.33	1.33
Cape turtle dove	1.33	1.33	-	-	-
Common waxbill	-	-	16.00	-	-
Cape white-eye	-	13.33	5.33	-	-
Neddicky	-	1.33	1.33	-	1.33
Pin-tailed whydah	-	-	-	-	2.67
Pale-winged starling	-	2.67	-	-	-
Rock bunting	1.33	2.67	4.00	-	1.33
Red-eyed bulbul	1.33	2.67	-	-	-

	Locality				
	A	B	C	D	E
Rock pigeon	-	2.67	-	-	-
Stone chat	-	-	-	2.67	-
Spotted flycatcher	-	2.67	-	-	-
Speckled mousebird	-	-	2.67	-	-
Wailing cisticola	-	1.33	-	-	1.33
Aquatic zone (n)	1	1	2	5	2
Black-headed heron	-	-	1.33	-	-
Cape sparrow	-	-	-	2.67	-
Grey Heron	-	1.33	1.33	2.67	-
Rock pigeon	1.33	-	-	-	1.33
Three-banded plover	-	-	-	1.33	1.33

43.3 Mammal presence/absence data summary

See Table 13.1.

43.4 Bird presence/absence data summary

See Table 13.3.

43.5 Gross vegetation structural raw data

Vegetation raw data presented as % cover.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Trees	12.5	75	75	2.5	1
Shrubs	2.5	25	2.5	12.5	-
Grass	25	37.5	40	37.5	62.5
Bare ground	25	37.5	50	62.5	37.5
Back dynamic zone					
Trees	5	50	2.5	1	15
Shrubs	12.5	12.5	25.5	25	2.5
Grass	62.5	52.5	62.5	75	50
Bare ground	40	3	37.5	25.5	50

43.6 Gross geomorphological raw data

Geomorphological raw data presented as follows: width of zones are given in meters, aspect as degrees and the various components as percentage cover of a particular zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Zone width	7.5	3	5.5	5	10
Aspect	15	30	15	20	15
Rock	12.5	-	-	-	-
Soil	37.5	75	37.5	12.5	25
Sand	50	25	62.5	52.5	75
Cobble	-	-	-	37.5	-
Pebble	-	-	-	0.5	-
Back dynamic zone					
Zone width	15	20	17.5	11	12.5
Aspect	30	20	25	25	20
Rock	2.5	-	-	-	-
Soil	87.5	100	100	100	87.5
Pebble	13	-	-	-	-
Boulder	-	2.5	2.5	-	12.5
Aquatic Zone					
River width	100	100	75	100	100
River rock	1	-	-	-	-
River sand	1	25	25	50	50
River cobble	-	-	-	-	1

River boulder	-	-	1	-	-
Logs	-	-	-	1	-

APPENDIX 7: IFR SITE 7

44 IFR-SITE 7

44.1 Mammal raw data

Mammal raw data represented as number of individuals per 100 trapnights where a trapnight refers to one trap set for one night. *n* represents the number of traps set in each zone at each locality. See Table 16.2 for common names.

	Locality				
	A	B	C	D	E
Lower dynamic zone (<i>n</i>)	18	18	18	18	18
<i>Aethomys namaquensis</i>	14.06	15.89	19.71	12.34	24.71
<i>Mastomys natalensis/coucha</i>	-	1.86	5.88	1.86	-
<i>Mystromys albicaudata</i>	6.71	-	4.16	-	10.01
<i>Rhabdomys pumilio</i>	8.67	8.67	8.75	6.54	15.04
<i>Crocidura flavescens</i>	13.11	-	-	-	-
Upper dynamic zone (<i>n</i>)	18	18	18	18	18
<i>Aethomys namaquensis</i>	0.57	-	-	10.51	6.96
<i>Rhabdomys pumilio</i>	0.60	0.17	0.17	6.55	4.42
<i>Crocidura flavescens</i>	18.25	32.11	4.90	-	2.35

44.2 Bird raw data

Bird raw data represented as number of individuals counted per hour. See Table 16.3 for latin names. *n* represents the total number of individuals observed in a zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone (<i>n</i>)	-	19	5	7	5
Cape bunting	-	-	1.33	-	-
Cape sparrow	-	1.33	-	-	1.33
Cape turtle dove	-	5.33	-	-	2.67
Common waxbill	-	-	5.33	1.33	-
Cape white-eye	-	13.33	-	-	-
Cape wagtail	-	-	-	1.33	-
Neddicky	-	-	-	5.33	1.33
Red-eyed bulbul	-	5.33	-	-	-
Stone chat	-	-	-	1.33	-
Spotted prinia	-	-	-	-	1.33
Upper dynamic zone (<i>n</i>)	6	4	9	11	26
Cape bunting	1.33	-	-	2.67	4.00
Cape sparrow	1.33	-	2.67	-	4.00
Cape turtle dove	-	2.67	1.33	-	4.00
Cape weaver	-	-	-	-	8.00
Cape white-eye	-	-	-	4.00	-
Cape wagtail	-	-	-	-	1.33
European swallow	-	-	-	-	6.67
Neddicky	1.33	1.33	1.33	-	1.33
Pale-winged starling	-	-	-	5.33	-
Rock bunting	1.33	-	-	-	-
Rock martin	-	-	-	-	5.33
Stone chat	-	-	1.33	-	-
Spotted prinia	-	1.33	5.33	-	-
Wailing cisticola	2.67	-	-	2.67	-
Aquatic zone (<i>n</i>)	-	1	1	-	24
Cape turtle dove	-	1.33	-	-	-
Grey Heron	-	-	-	-	1.33
Gaint kingfisher	-	-	1.33	-	-
Hamerkop	-	-	-	-	1.33
Helmeted guinea-fowl	-	-	-	-	28.00

White-breasted cormorant	-	-	-	-	1.33
--------------------------	---	---	---	---	------

44.3 Mammal presence/absence data summary

See Table 14.1.

44.4 Bird presence/absence data summary

See Table 14.2.

44.5 Gross vegetation structural raw data

Vegetation raw data presented as % cover.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Trees	-	50	12.5	-	12.5
Shrubs	27.5	-	-	0.5	-
Sedge	-	12.5	37.5	12.5	-
Grass	15	40	13	50	15
Bare ground	50	50	50.5	37.5	87.5
Back dynamic zone					
Trees	-	-	-	-	12.5
Shrubs	62.5	2.5	13	15	2.5
Grass	37.5	37.5	87.5	62.5	62.5
Bare ground	2.5	-	-	37.5	25
Agriculture	-	62.5	25	-	-
Island bare ground	-	-	37.5	-	-
Island shrubs	-	-	0.5	-	-
Island grass	-	-	12.5	-	-

44.6 Gross geomorphological raw data

Geomorphological raw data presented as follows: width of zones are given in meters, aspect as degrees and the various components as percentage cover of a particular zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Zone width	12.5	10	10	12.5	7.5
Aspect	1	5.5	15.5	10	20
Rock	-	15	50	38	50
Soil	-	100	-	25	-
Sand	40	-	50	37.5	13
Cobble	62.5	-	-	12.5	-
Boulder	-	-	-	-	37.5
Back dynamic zone					
Zone width	12.5	15	15	10	20
Aspect	15.5	1	10.5	50	25
Rock	15	2.5	-	50	62.5
Soil	87.5	100	100	52.5	37.5
Pebble	-	-	-	12.5	-
Island length	-	-	10	-	-
Island width	-	-	2.5	-	-
Island sand	-	-	-	-	-
Island cobbles	-	-	37.5	-	-
Island soil	-	-	12.5	-	-
Aquatic Zone					
River width	20	25	30	40	20
River rock	1	-	1	5	-
River cobble	-	-	-	2.5	-
River pebble	1	5	50	-	50

APPENDIX 8: IFR SITE 8

45 IFR-SITE 8

45.1 Mammal raw data

Mammal raw data represented as number of individuals per 100 trapnights where a trapnight refers to one trap set for one night. *n* represents the number of traps set in each zone at each locality. See Table 16.2 for common names.

	Locality				
	A	B	C	D	E
Lower dynamic zone (n)	18	18	18	18	18
<i>Aethomys namaquensis</i>	14.06	14.06	17.61	14.06	11.22
<i>Mystromys albicaudata</i>	-	-	3.63	-	-
<i>Rhabdomys pumilio</i>	8.67	8.67	10.79	8.67	6.97
<i>Crocidura flavescens</i>	0.66	2.81	2.81	1.27	0.13
Upper dynamic zone (n)	18	18	18	18	18
<i>Aethomys namaquensis</i>	6.96	9.96	10.51	4.12	6.96
<i>Rhabdomys pumilio</i>	4.42	4.42	6.55	2.72	4.42
<i>Crocidura flavescens</i>	3.88	8.88	0.15	6.43	20.18

45.2 Bird raw data

Bird raw data represented as number of individuals counted per hour. See Table 16.3 for latin names. *n* represents the total number of individuals observed in a zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone (n)	11	4	3	3	6
Cape bunting	-	-	-	-	2.67
Cape sparrow	-	-	1.33	1.33	-
Cape turtle dove	-	1.33	-	2.67	-
Familiar chat	-	2.67	-	-	-
Pale-winged starling	9.33	-	2.67	-	-
Rock bunting	1.33	1.33	-	-	2.67
Red-eyed bulbul	4.00	-	-	-	-
Wailing cisticola	-	-	-	-	2.67
Upper dynamic zone (n)	37	23	11	7	1
Cape sparrow	2.67	-	-	-	-
Cape turtle dove	6.67	1.33	1.33	-	-
Familiar chat	2.67	-	-	-	1.33
Neddicky	-	-	1.33	1.33	-
Pale-winged starling	18.67	13.33	8.00	-	-
Rock bunting	4.00	2.67	1.33	2.67	-
Red-eyed bulbul	4.00	2.67	-	-	-
Rock kestrel	1.33	1.33	-	-	-
Rock pigeon	9.33	9.33	2.67	5.33	-
Aquatic zone (n)	-	-	-	-	-

45.3 Mammal presence/absence data summary

See Table 15.1.

45.4 Bird presence/absence data summary

See Table 15.2.

45.5 Gross vegetation structural raw data

Vegetation raw data presented as % cover.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Trees	0.5	2.5	2.5	-	-
Shrubs	2.5	12.5	12.5	0.5	-
Grass	50	40	27.5	50	62.5
Bare ground	50	50	62.5	50	40
Back dynamic zone					
Trees	12.5	12.5	12.5	2.5	2.5
Shrubs	25	25	13	25	25
Grass	50	40	50	62.5	25
Bare ground	25	25	37.5	15	25
Agriculture	-	-	-	-	25

45.6 Gross geomorphological raw data

Geomorphological raw data presented as follows: width of zones are given in meters, aspect as degrees and the various components as percentage cover of a particular zone.

	Locality				
	A	B	C	D	E
Lower dynamic zone					
Zone width	7.5	3	5.5	5	10
Aspect	10	10	10	10	10
Rock	-	-	-	37.5	37.5
Soil	52.5	50	50	-	37.5
Sand	12.5	12.5	25	62.5	25
Pebble	-	-	12.5	-	-
Boulder	37.5	37.5	12.5	-	-
Back dynamic zone					
Zone width	15	20	17.5	11	12.5
Aspect	20	20	25	25	40
Rock	12.5	12.5	-	25	25
Soil	62.5	62.5	75	62.5	75
Boulder	25	25	25	12.5	-
Aquatic Zone					
River width	50	50	50	50	50
River pebble	-	5	25	75	50

47 CODES USED IN THE MULTIPLE REGRESSION MODELS

W	Zone width
A	Aspect
R	Percentage substrate area comprising rock
S	Percentage substrate area comprising soil
Sa	Percentage substrate area comprising sand
C	Percentage substrate area comprising cobbles
P	Percentage substrate area comprising pebbles
B	Percentage substrate area comprising boulders
Cl	Percentage substrate area comprising clay
IL	Island length
IW	Island width
ISa	Percentage island substrate area comprising sand
IC	Percentage island substrate area comprising cobbles
IS	Percentage island substrate area comprising soil
RW	River width
RR	Percentage river area comprising rock
RB	Percentage river area comprising boulder
RSa	Percentage river area comprising sand
RC	Percentage river area comprising cobbles
RP	Percentage river area comprising pebbles
L	Percentage river area comprising logs
T	Percentage area covered by trees
Sh	Percentage area covered by shrubs
Re	Percentage area covered by reeds
Se	Percentage area covered by sedges
G	Percentage area covered by grass
Ba	Percentage area bare
Ag	Percentage area covered by agriculture
IBa	Percentage island area bare
ISh	Percentage island area covered by shrubs
IG	Percentage island area covered by grass