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TERRESTRIAL BIRD DIVERSITY OF PALABORA MINING COMPANY AND NEIGHBOURING LAND TYPES

Results of the 2015 survey

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SUMMARY

- Bird diversity was sampled on three land types belonging to PMC (Dump 4, Tailings Dam, Cleveland) and two neighbouring land types (Kruger National Park and rural rangelands adjacent to Namakgale).
- 40 plots of 25m radius were sampled in each land type, during the summer of 2014-15.
- Bird diversity was assessed according to a number of response variables, including species richness (i.e. the total number of species recorded per land type), abundance (i.e. total number of birds recorded per land type), the Shannon-Weiner diversity index, and functional diversity.
- The Tailings Dam showed the lowest diversity, followed by the Dump 4, although diversity of the latter was not far below the two undisturbed land types (Cleveland and Kruger).
- The rural rangeland site (at Namakgale) showed higher diversity than the two rehabilitation sites, and surprisingly had more species than either of the two undisturbed sites.
- The lower diversity of the Tailings Dam, and to a lesser degree the Dump 4, is partly due to the absence of certain functional groups, particularly hawking foragers, nectar feeders and cavity-nesters.
- In order to restore bird diversity of the rehabilitation areas, plant diversity of these areas would need to be improved, particularly on the Tailings Dam. A higher diversity of woody species and taller structures would be the most beneficial restoration action in this regard.
- The sites and methods used for this survey are considered suitable for long-term monitoring of bird diversity at PMC, and these data can form the baseline for repeat surveys in future years.

INTRODUCTION

The mining activities of Palabora Mining Company (PMC) have altered all components of biodiversity in the Phalaborwa area. Birds are a useful component of biodiversity to assess this impact, as they are good indicators of overall biodiversity, are surrogates for the diversity of taxa and are easy to survey. They are therefore one of the taxa selected by SAEON for determining the impacts of PMC's activities on biodiversity, and assessing improvements in biodiversity in response to rehabilitation measures.

Changes in terrestrial ecosystems can affect bird diversity through the loss, or gain, of food resources, habitat and nesting sites. These changes alter the abundance of each species present, resulting in changes in community composition. Due to the large number of species present in the ecosystem in and around PMC, it is more practical and efficient to monitor changes in community composition, rather than changes in the occurrence or abundance of each and every species. However, in the case of species of special concern, i.e. Red Data species (Taylor, *in press*), monitoring populations of particularly species may be required.

The aims of this survey were to:

1. Accurately describe differences in bird community composition on three of the major land types of PMC, as well as two neighbouring areas representing the dominant alternative land uses of the area;
2. Evaluate the effectiveness of a new method for monitoring bird diversity;
3. Identify any species of special concern that would require more intensive monitoring, i.e. monitoring at the population level.

METHODS

Terrestrial bird surveys were conducted during the wet (summer) season spanning from November 2014 to March 2015. Five different land types were selected to compare bird communities (Figure 1): rural rangelands adjacent to Namakgale, Dump 4 (the "rock dump"), the Tailings Dam, Cleveland Game Park and Kruger National Park.

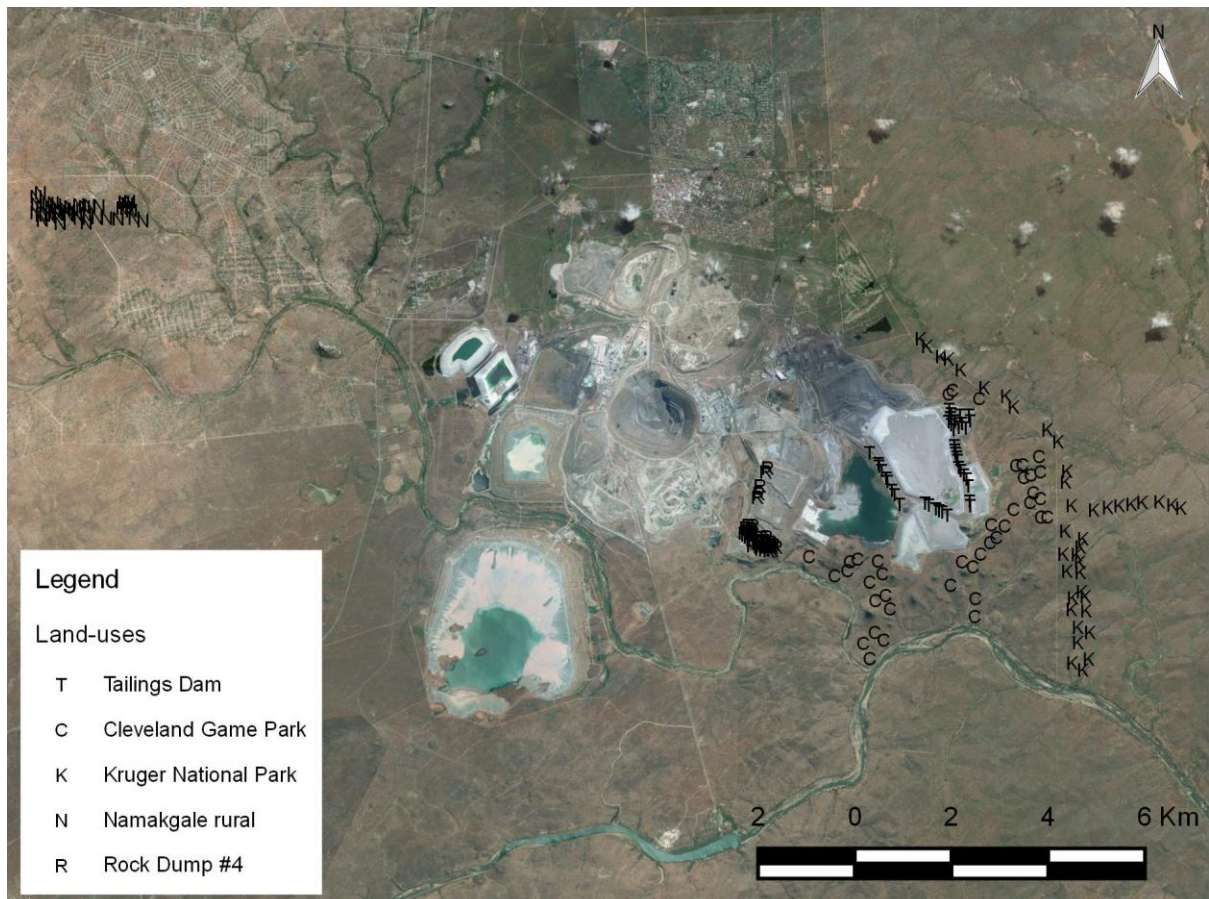


Figure 1: Satellite image of the study area showing land types and corresponding sample sites where terrestrial birds were surveyed. “T”, “R” and “C” are located on the properties of PMC.

In each land type, 40 sample sites were randomly selected using GIS and placed within 100 m from a road, except at Namakgale. This was done to exclude any effect of roads on vegetation structure (and resultant bird community), but also to work within a safe distance to a vehicle. Sites were selected to include riparian zones of ephemeral drainage lines (streams). Riparian zones of the large, perennial rivers in the area (the Selati and Olifants rivers) were deliberately excluded, as these do not occur in each land type (the bird diversity of these riparian zones is sampled and reported on separately).

Site radius was 25 m from the observer(s) for all sites. All birds seen or heard inside the radius were recorded. Birds flying overhead were not recorded, but those that flushed upon arrival at the site and individuals perching within the sites during the counts were recorded. Upon arrival at each sample site, the observer(s) recorded birds for 6 minutes. Surveys did not take place during adverse weather conditions such as strong wind or rain. Ad hoc sightings were recorded when moving between sampling sites.

Observing weather forecasts is pivotal in planning for such surveys. Another important consideration when conducting terrestrial bird surveys in the Phalaborwa-area is that all observers must be adequately trained in identifying - by sight and sound - the approximately 340 bird species that can be found in the area. A challenge is the mimicking of other birds' calls by the common Sabota Lark

Calendulaunda sabota (Figure 2). Observers need to be aware of this bird and its behaviour as incorrect additions to the data will be the result if one is not cautious at all times during surveys. This lark's repertoire for mimicking other species is extensive. Understanding the Sabota Lark's habits would minimise potential sampling error in this regard: it mostly perches on top of trees or shrubs when calling, and the mimicking of other birds' calls is limited to mostly the first syllable of that species' call. A single Sabota Lark can mimic more than one species' call, including Bee-eaters, Canaries, Waxbills and Cuckoos.



Figure 2: Sabota Lark *Calendulaunda sabota*: a common but inconspicuous species that mimics the calls of other birds. Photo - <http://www.grobimages.co.za/>.

Data analysis

Species richness was calculated as the total number of species surveyed in each land type. Total biomass was also calculated for each land type using species biomass values from Hockey *et al.* (2005). Apart from biodiversity indices and density estimation, bird species fidelity and specificity to land types were quantified using IndVal (indicator value analysis). A change in indicator values for specific species in following years would suggest changes in habitat, food- and/or nesting availability, or other disturbances. A land type may have more than one bird indicator species but there will always be a species with a larger more significant indicator value. In this report, I will report on the latter for each land type.

In order to assess functional diversity, all species recorded were divided into different functional groups according to dominant food source, foraging strategy and nesting category, which were all adapted from Hockey *et al.* (2005). Red Data status (Near-threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild etc.) was determined for each species following Taylor (*in press*). Appendix 2 provides the Red Data status and functional groupings for all species recorded in this survey (including ad hoc records).

RESULTS AND DISCUSSION

Suitability of method used

The number of plots sampled at each site captured approximately 54-86% of the total number of bird species present in each land type (Appendix 1). While it would be ideal to sample enough plots per land type to record every species present (i.e. to achieve saturation of the species-accumulation curve), this was not feasible given the number of plots that would be required to achieve this, and the logistical factors that constrain sampling effort. These include the limited sampling season (sampling must be conducted from the months of October and March when migrant species are present), the limited sampling time per day (sampling must be conducted early in the morning), and the travel times to sites in each land type. Considering these factors, the method used provides an acceptable compromise between sampling time / effort and accuracy. However, infrequent and rare (or Red Data species listed in Appendix 2) species' densities are too low to detect with this method. Species-specific monitoring projects would need to be developed, should the abundance of these species need to be monitored.

Community composition

Species richness, total abundance and total biomass for the five land types are shown in Figure 3. Similar trends were observed for all these variables, with Namakgale having the highest values.

Palabora Copper land types

Dump 4 and the nearby Tailings Dam had the smallest number of individuals, species and biomass. This was to be expected due to the limited food and nest site availability provided by the relatively homogenous vegetation of these areas. The higher values for Dump 4, relative to the Tailings Dam, are most likely the result of the high cover of *Acacia nilotica* trees there. Ross (1981) explains that *Acacia* species host a particularly rich invertebrate fauna, which would provide a greater diversity and quantity of food for birds. The low values for species richness and abundance for the Tailings Dams are concerning, considering this land type's position next to Cleveland Game Park. The most likely cause of this is the vegetation, specifically the lack of diversity in plant structure and species. This is mainly a result of the dominance of the shrub layer by the Sand Olive (*Dodonaea viscosa* var. *angustifolia*).

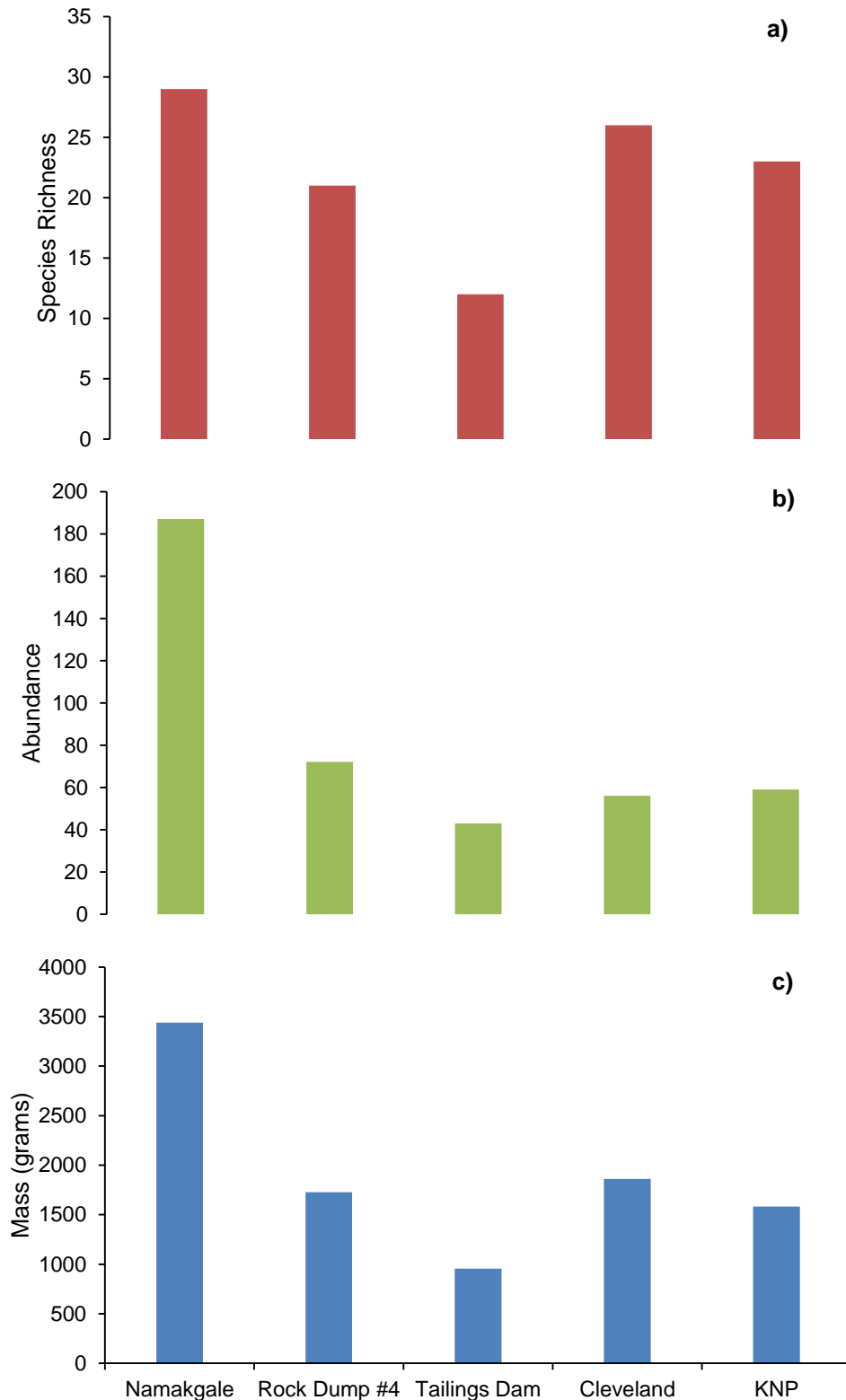


Figure 3: Species richness (a), total abundance (b) and total biomass (c) of all birds recorded in each of the five land types. KNP = Kruger National Park.

The Shannon-Wiener diversity index provides a combined measure of species richness and evenness, and ranges from 0 to infinity. Communities in which most individuals belong to few dominant species will have a lower value than communities with similar species richness but with individuals spread evenly across all the

species. Shannon-Weiner values showed a different pattern across the 5 land types, with the two protected areas having the highest values (Table 1). This indicates that although Namakgale had higher species richness, the majority of the birds recorded belonged to just a few dominant species. In contrast, the two undisturbed sites showed greater species evenness, with higher abundances of sub-dominant species, e.g. Sabota Lark and Ring-necked Dove. Thus, habitat conditions at Namakgale favoured only a handful of species (particularly the Blue Waxbill) compared to Cleveland Game Park and KNP. The low Shannon-Weiner value for the Tailings Dam indicates that not only did this land use have the least individuals and species, but that the individuals recorded there mostly belong to just a few species (particularly the Red Bishop). The relatively higher value for Dump 4 indicates that individuals were spread more evenly across the species, which reflected the community composition of the undisturbed areas more closely. However, a number of fairly common species in the undisturbed land types were not found on Dump 4, e.g. the Emerald-spotted Wood-Dove, and gamebirds such as the spurfowls and francolins (Phasianidae family).

Table 1: Shannon-Wiener diversity values for the five different land types. KNP = Kruger National Park.

Land type	Shannon-Wiener diversity index
Namakgale	2.8
Rock Dump 4	2.7
Tailings Dam	2.0
Cleveland	3.0
KNP	2.9

Indicator species

Indicator species analysis produced indicator species for only three of the land types. The remaining two land types had no particular bird species that were more faithful to that land type than the other species. The indicator species identified were:

- Namakgale: many indicator species, but the strongest was the Blue Waxbill (*Uraeginthus angolensis*) at a density of 75 individuals.km⁻²;
- Rock Dump 4: a single indicator species, the Olive-tree Warbler (*Hippolais olivetorum*) at a density of 13 individuals.km⁻²;
- Tailings Dam: a single indicator species, the Southern Red Bishop (*Euplectes orix*) at a density of 27 individuals.km⁻².

Of all the individuals recorded at Namakgale, 21% were Blue Waxbill. This species occupies a diverse range of habitats from cultivated fields to *Acacia*-dominated savanna and gardens around human habitation. Its diet is similarly diverse where it takes a wide range of grass species' seeds, invertebrates and even fruits of Shepard's trees (*Boschia* spp.). It is also dependent on surface water (Hockey *et al.*, 2005). At the Namakgale site, the negative effects of overgrazing on food supply for this species (Hockey *et al.*, 2005) appear to be compensated for by additional food sources from the surrounding urban development.

The high abundance of the uncommon and little-known Olive-tree Warbler's on Dump 4 is undoubtedly a result of the high cover of *Acacia nilotica* shrubs and trees. This species favours spiny plants especially from the Fabaceae family where it gleans (probably) invertebrates from twigs and leaves. Its distribution is largely outside protected areas (Hockey *et al.*, 2005; Figure 4). A possible reason for the latter is overgrazing and a lack of fire that has resulted in encroachment of *Dichrostachys cinerea* and *Acacia* species in many rural areas. It is a non-breeding migrant that arrives November and departs April in southern Africa.

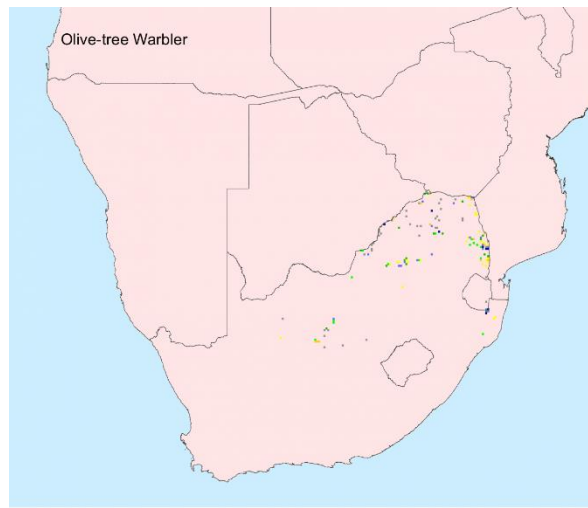


Figure 4: Distribution map of the Olive-tree Warbler *Hippolais olivetorum* in South Africa. South African Bird Atlas Project 2 (<http://sabap2.adu.org.za/index.php>); Accessed: 1 April 2015.

The Southern Red Bishop is a very common, gregarious species across South Africa. Its indicator status at the Tailings Dam can be ascribed to access to open water around and inside this land type, which resulted in the large number of individuals that were recorded. Foraging was mostly observed against the Tailings Dam slopes, where feeding on grass seeds presumably occurs. It also breeds predominantly in reeds (*Phragmites* spp.), which are associated with open water or moist areas, and which are abundant around the edges of the Tailings Dam. Site fidelity is high in breeding males that return to the same site for up to 5 successive breeding seasons (Hockey *et al.*, 2005).

Functional groups

Each bird species was placed into a specific functional group category to investigate functional diversity within the five land types. Explanations of the categories show in the caption of Table 2 below.

Table 2: Bird functional groups and corresponding categories: Gleaning species take prey from twigs and leaves; Hawking species perch and capture prey in the air; Sit-and-wait foragers perch and drop down to the ground to catch prey; Ball-nesters construct nests with a side or bottom entrance hole; Brood parasites lay their eggs in other birds' nests; Burrow-nesters excavate or use existing holes in the ground; Cavity-nesters excavate or make use of existing cavities in trees; Non-breeding migrants do not breed in southern Africa.

Functional group	Category
Dominant foraging strategy	Aerial
	Glean
	Grass
	Ground
	Hawk
	Sit-and-wait
Dominant food source	Fruit
	Invertebrates
	Nectar
	Seeds
	Vertebrates
Nesting category	Ball
	Brood parasite
	Burrow
	Cavity
	Cup
	Ground
	Non-breeding migrant

The abundance of birds in each of the three different functional groups is displayed in Figure 5, as percentage contribution to the total.

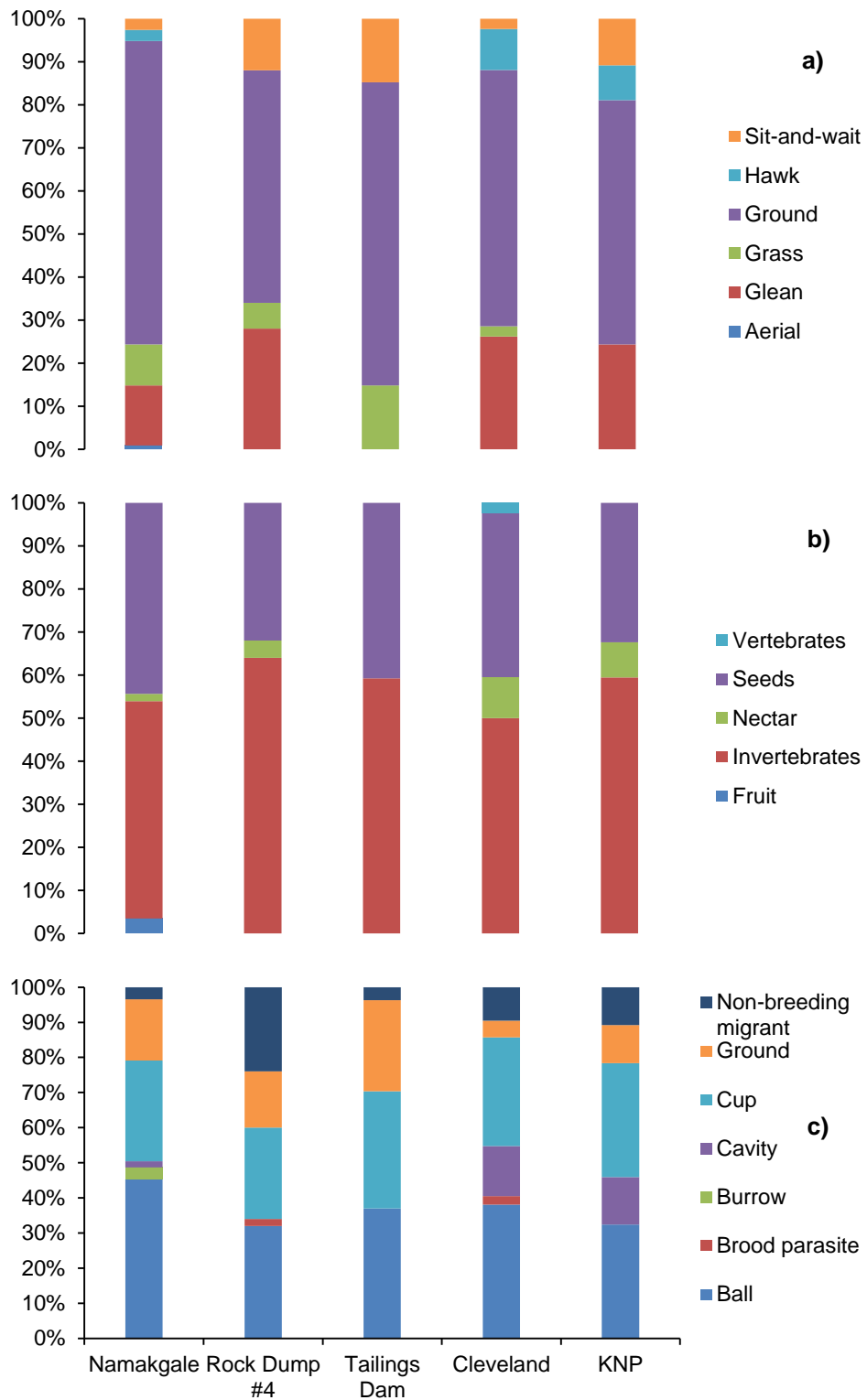


Figure 5: The relative contribution of each functional group for the three functional group categories: a) dominant foraging strategy, b) dominant food source and c) nesting category.

The Tailings Dam produced the least diverse foraging groups, with ground-foragers and ground-nesters dominating. The abundance of species such as the Sabota Lark, which use the ground extensively, were responsible for this pattern. No gleaning birds were recorded in this land type, indicating a lack of invertebrates on the plants there. This may be due to high levels of dust deposition, or the dominance of the Sand Olive shrubs. Conversely, Dump 4 had many gleaning foragers but fewer ground and grass foragers. Dump 4 also had an absence of hawking feeders, in contrast to the undisturbed land types. The high cover of *Acacia nilotica* trees and shrubs on Dump 4 may contribute to this, although the structure and composition of the grass layer may also be important, particularly the high cover of the exotic grass *Pennisetum setaceum*. The large percentage of non-breeding migrants at the Dump 4 can be ascribed to the land types' indicator species (the Olive-tree Warbler). Overall, the functional group composition of Dump 4 was similar to the two undisturbed sites, except for an absence of two functional groups: hawking foragers and cavity nesters.

Species of special concern

Seven species listed as Endangered, Near Threatened or Vulnerable by the Red Data List were recorded (Bateleur, Tawny Eagle, Southern Ground-Hornbill, White-backed Vulture, White-headed Vulture, European roller and Striped Flufftail). The abundances of these species could not be accurately quantified during this survey due to their rarity and the survey design. All these species were actually recorded on an *ad hoc* basis, and mostly only in KNP and Cleveland (Appendix 2). They are mostly large raptors that would require specialized methods to monitor. Furthermore as the home ranges of such species exceed the size of any of the PMC land types, it is difficult to determine the impact of PMC mining or rehabilitation activities on these species. Nevertheless, appropriate management of the rehabilitation areas could make a positive contribution to local populations of these species, by providing additional food sources and nesting sites. For example the Striped Flufftail, a species which prefers rank grass, was recorded on the Tailings Dam slopes.

MANAGEMENT RECOMMENDATIONS

Dump 4 and the Tailings Dam have very different bird communities, with far greater diversity on Dump 4. The bird diversity of the latter is not much less than neighbouring undisturbed sites, with differences largely due to the absence of only a few species. Improvements to the grass layer on Dump 4 should improve this, and further narrow the difference between Dump 4 and the original bird community of that location.

In contrast, the Tailings Dam shows an absence of many species, relative to the undisturbed areas nearby, and excessive dominance by a handful of species that have been able to exploit the unusual vegetation structure of this land type. Major changes in the vegetation of the Tailings Dam would be required to improve the bird diversity and to make it more similar to the historical bird community of the area. Planting of appropriate trees, to provide a more diverse selection of food and habitat is needed, as well as a reduction in the cover of the Sand Olive shrubs which currently dominate but appear to have little value to birds. Furthermore, the absence

of tall trees, which are an important structural component of the neighbouring savanna ecosystems, needs to be rectified.

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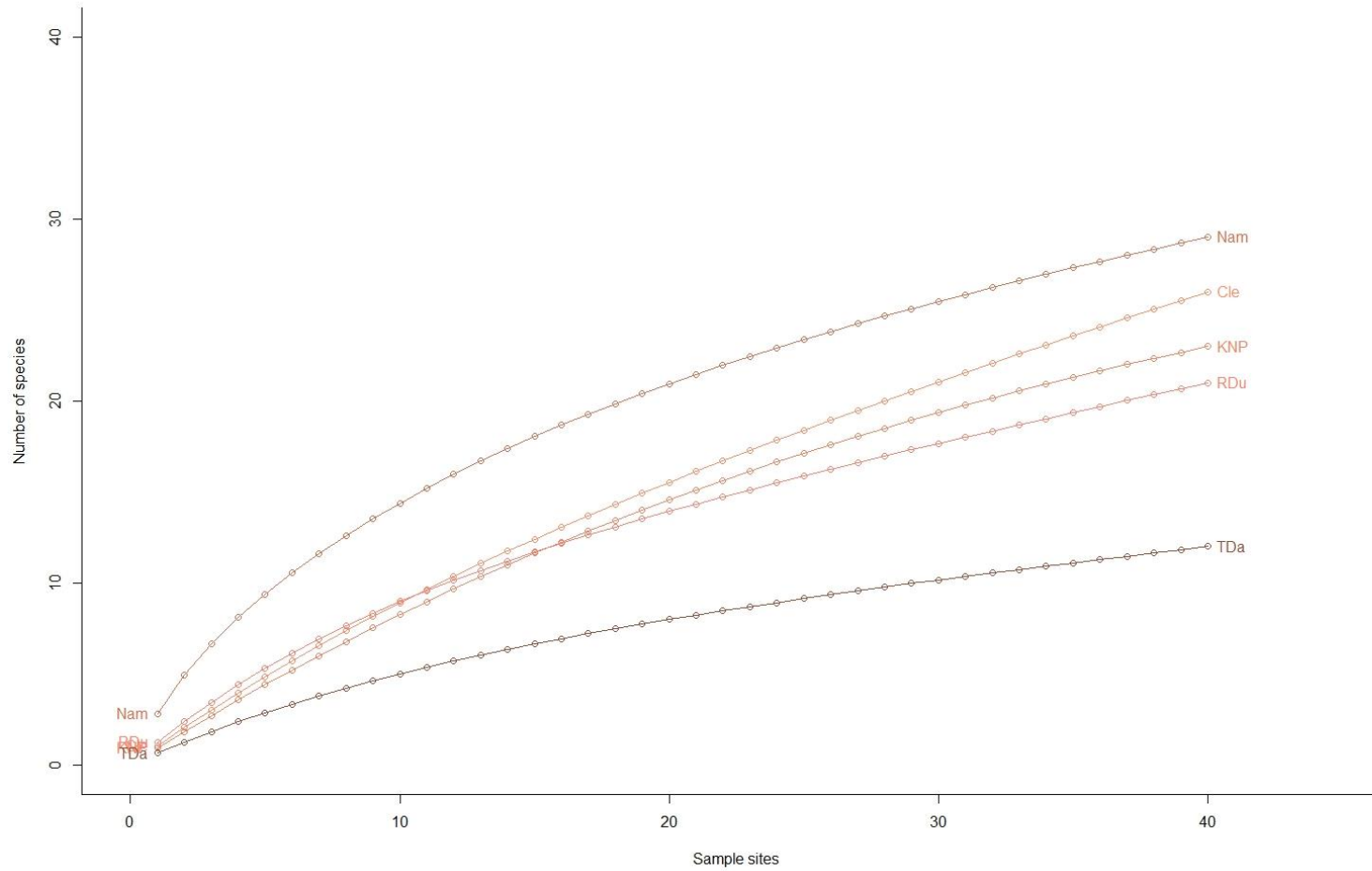
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APPENDICES

Appendix 1: Rarefaction (species accumulation) curves computed for the five land types as cumulative number of terrestrial bird species with increasing sample sites. Nam = Namakgale; Cle = Cleveland Game Park; KNP = Kruger National Park; RDu = Rock Dump #4; TDa = Tailings Dam.



Appendix 2

Bird species recorded on the five land types. This list comprises of records obtained during and between surveys. Asterisks denote presence in the land type. KNP – Kruger National Park. 2014 Red Data statuses follow Taylor (*in press*).

#	Species by family	KNP	Cleveland	Tailings Dam	Dump 4	Namakgale	Red Data	Mass (g)	Foraging strategy	Food source	Nesting category
1	Apalis, Yellow-breasted	*	*					8	glean	invertebrates	ball
2	Babbler, Arrow-marked		*					72	ground	invertebrates	ball
3	Barbet, Acacia Pied		*	*	*	*		31	glean	fruit	cavity
4	Barbet, Black-collared		*					54	glean	fruit	cavity
5	Barbet, Crested	*	*					74	ground	invertebrates	cavity
6	Bateleur	*	*		*		EN	2250	scavenge	vertebrates	cup
7	Batis, Chinspot	*	*		*	*		12	glean	invertebrates	cup
8	Bee-eater, European	*	*	*		*		52	aerial	invertebrates	burrow
9	Bee-eater, Little	*	*			*		15	hawk	invertebrates	burrow
10	Bee-eater, Southern Carmine		*	*				62	aerial	invertebrates	burrow
11	Bishop, Southern Red	*		*				23	ground	seeds	ball
12	Brubru		*			*		24	glean	invertebrates	cup
13	Bulbul, Dark-capped		*					39	glean	invertebrates	cup
14	Bunting, Cinnamon-breasted	*	*	*	*	*		15	ground	seeds	cup
15	Bunting, Golden-breasted	*	*			*		19	ground	seeds	cup

#	Species by family	KNP	Cleveland	Tailings Dam	Dump 4	Namakgale	Red Data	Mass (g)	Foraging strategy	Food source	Nesting category
16	Buzzard, Common					*		730	sit-and-wait	invertebrates	non-breeding migrant
17	Canary, Yellow-fronted	*	*	*		*		12.5	ground	seeds	cup
18	Chat, Familiar			*	*			22	sit-and-wait	invertebrates	cup
19	Cisticola, Desert			*	*			9	grass	invertebrates	ball
20	Cisticola, Rattling	*	*	*	*	*		16	grass	invertebrates	ball
21	Cisticola, Zitting			*				9	grass	invertebrates	ball
22	Coucal, Burchell's		*					170	ground	vertebrates	cup
23	Courser, Bronze-winged				*			155	ground	invertebrates	ground
24	Courser, Temminck's				*			70	ground	invertebrates	ground
25	Crombec, Long-billed	*	*	*	*	*		11	glean	invertebrates	ball
26	Crow, Pied					*		550	ground	vegetation	cup
27	Cuckoo, African		*					105	glean	invertebrates	brood parasite
28	Cuckoo, Diderick		*			*		30	glean	invertebrates	brood parasite
29	Cuckoo, Jacobin		*					81	glean	invertebrates	brood parasite
30	Cuckoo, Klaas'		*					26	glean	invertebrates	brood parasite
31	Cuckoo, Levillant's	*						122	glean	invertebrates	brood parasite
32	Cuckoo, Red-chested		*					75	glean	invertebrates	brood parasite
33	Cuckooshrike, Black	*	*					32	glean	invertebrates	cup
34	Dove, Emerald-spotted Wood	*	*					64	ground	seeds	cup

#	Species by family	KNP	Cleveland	Tailings Dam	Dump 4	Namakgale	Red Data	Mass (g)	Foraging strategy	Food source	Nesting category
35	Dove, Laughing	*	*	*	*	*		100	ground	seeds	cup
36	Dove, Namaqua			*		*		40	ground	seeds	cup
37	Dove, Red-eyed	*		*				252	ground	seeds	cup
38	Dove, Ring-necked	*	*		*	*		153	ground	seeds	cup
39	Drongo, Fork-tailed	*	*			*		44	hawk	invertebrates	cup
40	Eagle, African Hawk-		*					1450	sit-and-wait	vertebrates	cup
41	Eagle, Black-chested Snake		*					1500	soar	vertebrates	cup
42	Eagle, Brown Snake	*	*					2000	sit-and-wait	vertebrates	cup
43	Eagle, Lesser Spotted		*					1350	ground	invertebrates	non-breeding migrant
44	Eagle, Steppe	*						2750	ground	invertebrates	non-breeding migrant
45	Eagle, Tawny	*					EN	1940	sit-and-wait	vertebrates	cup
46	Falcon, Amur		*	*				142	sit-and-wait	invertebrates	non-breeding migrant
47	Firefinch, Jameson's	*	*			*		9	ground	seeds	ball
48	Firefinch, Red-billed		*					9	ground	seeds	ball
49	Flufftail, Striped			*			VU	28	ground	invertebrates	cup
50	Flycatcher, African Paradise		*					14	hawk	invertebrates	cup
51	Flycatcher, Spotted	*	*					15	hawk	invertebrates	non-breeding migrant
52	Francolin, Coqui		*					250	ground	invertebrates	ground

#	Species by family	KNP	Cleveland	Tailings Dam	Dump 4	Namakgale	Red Data	Mass (g)	Foraging strategy	Food source	Nesting category
53	Francolin, Crested	*	*					350	ground	invertebrates	ground
54	Go-away-bird, Grey	*	*		*			270	glean	fruit	cup
55	Goshawk, Dark Chanting-	*						682	sit-and-wait	vertebrates	cup
56	Guineafowl, Helmeted		*					1350	ground	invertebrates	ground
57	Honeyguide, Lesser	*						28	glean	invertebrates	brood parasite
58	Hoopoe, African	*	*					53	ground	invertebrates	cavity
59	Hornbill, African Grey	*	*					155	glean	vertebrates	cavity
60	Hornbill, Southern Ground-	*					EN	3770	ground	invertebrates	cavity
61	Hornbill, Southern Red-billed	*	*					140	ground	invertebrates	cavity
62	Hornbill, Southern Yellow-billed	*	*					190	ground	invertebrates	cavity
63	Kingfisher, Brown-hooded		*					60	sit-and-wait	invertebrates	burrow
64	Kingfisher, Striped		*					38	sit-and-wait	invertebrates	cavity
65	Kingfisher, Woodland	*	*					63	sit-and-wait	invertebrates	cavity
66	Kite, Yellow-billed			*				674	soar	invertebrates	non-breeding migrant
67	Korhaan, Red-crested	*	*					675	ground	invertebrates	ground
68	Lapwing, Blacksmith			*				166	ground	invertebrates	ground

#	Species by family	KNP	Cleveland	Tailings Dam	Dump 4	Namakgale	Red Data	Mass (g)	Foraging strategy	Food source	Nesting category
69	Lark, Chestnut-backed Sparrow-					*		22	ground	seeds	ground
70	Lark, Rufous-naped	*		*		*		44	ground	invertebrates	ground
71	Lark, Sabota	*	*	*	*	*		23	ground	invertebrates	ground
72	Mannikin, Bronze					*		10	ground	seeds	ball
73	Martin, Brown-throated			*				12.5	aerial	invertebrates	burrow
74	Mousebird, Red-faced	*	*	*		*		56	glean	fruit	cup
75	Mousebird, Speckled				*	*		55	glean	fruit	cup
76	Neddicky	*	*					9	ground	invertebrates	ball
77	Nightjar, Fiery-necked	*						52	hawk	invertebrates	ground
78	Nightjar, Freckled	*						80	ground	invertebrates	rock
79	Nightjar, Square-tailed			*		*		60	hawk	invertebrates	ground
80	Oriole, Black-headed	*	*					65	glean	invertebrates	cup
81	Owlet, Pearl-spotted	*	*					76	sit-and-wait	invertebrates	cavity
82	Oxpecker, Red-billed	*	*		*			50	Host mammal	invertebrates	cavity
83	Parrot, Brown-headed	*						145	glean	fruit	cavity
84	Pipit, African	*						24.5	ground	invertebrates	ground
85	Prinia, Tawny-flanked	*	*	*		*		9.5	ground	invertebrates	ball
86	Puffback, Black-backed	*	*					26	glean	invertebrates	cup
87	Pytilia, Green-		*					15	ground	seeds	ball

#	Species by family	KNP	Cleveland	Tailings Dam	Dump 4	Namakgale	Red Data	Mass (g)	Foraging strategy	Food source	Nesting category
	winged										
88	Quelea, Red-billed		*	*				19	ground	seeds	ball
89	Robin, White-browed Scrub	*	*		*	*		20	ground	invertebrates	cup
90	Robin-Chat, White-throated				*			23	ground	invertebrates	cup
91	Roller, European	*	*	*		*	NT	122	sit-and-wait	invertebrates	non-breeding migrant
92	Roller, Lilac-breasted	*	*	*				108	sit-and-wait	invertebrates	cavity
93	Sandgrouse, Double-banded		*					230	ground	seeds	ground
94	Scimitarbill, Common		*					32	glean	invertebrates	cavity
95	Seed-eater, Streaky-headed				*			20	ground	seeds	cup
96	Shrike, Grey-headed Bush		*					77	glean	invertebrates	cup
97	Shrike, Lesser Grey	*		*	*	*		46	sit-and-wait	invertebrates	non-breeding migrant
98	Shrike, Magpie	*	*					82	sit-and-wait	invertebrates	cup
99	Shrike, Red-backed	*	*	*	*	*		29	sit-and-wait	invertebrates	non-breeding migrant
100	Shrike, Southern White-crowned		*					70	sit-and-wait	invertebrates	cup
101	Sparrow, Southern Grey-headed	*	*	*		*		24	ground	seeds	cavity
102	Spurfowl, Natal	*	*					410	ground	vegetation	ground
103	Spurfowl,	*	*					605	ground	vegetation	ground

#	Species by family	KNP	Cleveland	Tailings Dam	Dump 4	Namakgale	Red Data	Mass (g)	Foraging strategy	Food source	Nesting category
	Swainson's										
104	Starling, Cape	*	*					90	ground	fruit	cavity
105	Starling, Greater Blue-eared	*	*					90	ground	fruit	cavity
106	Starling, Violet-backed	*	*		*			45	glean	invertebrates	cavity
107	Sunbird, Marico		*		*			11	glean	nectar	ball
108	Sunbird, Scarlet-chested					*		13.6	glean	nectar	ball
109	Sunbird, White-bellied	*	*	*	*	*		7.5	glean	nectar	ball
110	Swallow, Barn	*	*	*	*			20	aerial	invertebrates	non-breeding migrant
111	Swallow, Grey-rumped			*				10	aerial	invertebrates	burrow
112	Swallow, Lesser Striped		*					18	aerial	invertebrates	mud
113	Swallow, Red-breasted	*						31	aerial	invertebrates	mud
114	Swift, African Palm-		*					14	aerial	invertebrates	cup
115	Swift, Little		*					25	aerial	invertebrates	ball
116	Swift, White-rumped		*					24	aerial	invertebrates	ball
117	Tchagra, Black-crowned	*	*	*	*			53	ground	invertebrates	cup
118	Tchagra, Brown-crowned	*	*		*	*		33	ground	invertebrates	cup
119	Thick-knee, Spotted			*	*			465	ground	invertebrates	ground
120	Thrush, Groundscraper	*	*					76	ground	invertebrates	cup
121	Thrush, Kurrichane	*						63	ground	invertebrates	cup

#	Species by family	KNP	Cleveland	Tailings Dam	Dump 4	Namakgale	Red Data	Mass (g)	Foraging strategy	Food source	Nesting category
122	Tit, Grey Penduline-		*					6.5	glean	invertebrates	ball
123	Tit, Southern Black	*	*			*		21	glean	invertebrates	cavity
124	Vulture, White-backed	*	*				EN	5500	scavenge	vertebrates	cup
125	Vulture, White-headed	*					EN	4200	scavenge	vertebrates	cup
126	Warbler, Olive-tree				*	*		18	glean	invertebrates	non-breeding migrant
127	Warbler, Stierling's Wren-	*	*			*		13	glean	invertebrates	ball
128	Warbler, Willow	*	*	*				9	glean	invertebrates	non-breeding migrant
129	Waxbill, Blue	*	*	*	*	*		10	ground	seeds	ball
130	Waxbill, Common			*				8	ground	seeds	ball
131	Weaver, Lesser Masked		*		*	*		20.5	glean	invertebrates	ball
132	Weaver, Red-billed Buffalo	*	*					78	ground	invertebrates	ball
133	Weaver, Southern Masked		*	*	*	*		24	ground	seeds	ball
134	Whydah, Long-tailed Paradise	*			*			20	ground	seeds	brood parasite
135	Wood-Hoopoe, Green	*	*					80	glean	invertebrates	cavity
136	Woodpecker, Bearded	*						80	glean	invertebrates	cavity
137	Woodpecker, Cardinal	*	*					30	glean	invertebrates	cavity

Red Data statuses follow Taylor (*in press*); Foraging strategy (dominant), Food source (dominant) and Nesting category adapted from Hockey *et al.* (2005).