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OLIFANTS, GA-SELATI RIVERS: 2015 WATER-DEPENDENT BIRD SURVEYS IN THE PHALABORWA AREA

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SUMMARY

- Long-term monitoring can aid in understanding the processes that shape animal communities, and in detecting environmental changes. Rivers especially, are fast-changing environments due to the surface water component e.g. increases in water levels might decrease habitat availability for certain species;
- The sampling method (point counts compared to the pre-2014 walks) employed during 2014 and 2015 surveys provided safe, fast and relatively comparable results on the status and structure of water-dependent bird communities of the Olifants and Ga-selati rivers;
- A total of 36 (2015) species were recorded compared to 38 in 2014. Regionally, the number of species increased since 2014 at KRUGOLIF and ARMYOLIF but, not so for CLEVOLIF and CLEVSELA;
- Average number of species increased since 2012 but, with a decrease during 2015 for most river regions. The dry conditions resulting in persistent low water levels since 2014 might have deterred certain birds;
- Total bird abundances imitate the above trends however, an increase since 2014 at KRUGOLIF is due to Egyptian Goose increases that accounted for 54% of all birds recorded at this region. Across all regions a 38% increase in this species was noted since 2014. More exposed sand bars and increased filamentous algae due to nutrient increases could be some of the causes. Unpublished data from the Endangered Wildlife Trust also show ~30% increase in geese numbers since 2014 for the whole of the Olifants River inside Kruger' Park;
- Decreases in the two most abundant water-dependent bird species could be due to Egyptian Goose increases since 2014 as they share similar habitats;
- Only KRUGOLIF produced indicator/faithful species. The strongest, White-fronted Plover, was also the strongest indicator species during the 2014 surveys. The increases in abundance of this species suggests more habitat availability, in this case increased sand bars due to lower water levels in the Olifants River. Since October 2014, below average rain precipitated within the river's catchment but, might have resulted in a lack of diagnostic/faithful species at other regions due to changing habitats or less food;
- We suggest to exclude the White-crowned Lapwing from PMC's Species of Conservation Priority list due to local and global increases;
- Instead, the Black Stork should be added to the above list as it was recorded *ad hoc* and is also a regionally Vulnerable species (IUCN) that rely strongly on rivers for its main diet of fish;
- Two separate but, confirmed Pel's Fishing Owl sightings were made on the Eastern island in the Olifants River adjacent to Cleveland Game Reserve during 2015. These birds (two seen on one occasion) are possibly breeding on the island however, this was not confirmed;
- Densities could not be estimated using 2015 data as exploratory analyses produced unreliable results due to statistical constraints;
- Since it is more difficult to detect water-dependent birds at certain river regions than others, it hampers our ability to compare abundance results between these different regions. However, comparisons between annual survey results at the same region provide valuable insights to the processes that might be governing community structures over time;

INTRODUCTION AND METHODS

Long-term monitoring of animal communities can assist in understanding the processes that govern community patterns over time. Birds especially, are good indicators of environmental health as they are surrogates for other taxa and are easy to survey. Changes in river water quality and -quantity however, may affect habitat- and food availability of water-dependent birds. These changes may alter community composition, species richness and abundances. The latter is of special concern when Red Data (Taylor, 2015) species are present.

The aim of this monitoring project is to detect any changes in the status of water-dependent birds of the two perennial rivers that flow alongside Palabora Mining Company (PMC) properties (the Olifants and Ga-Selati rivers), as well as to assess the suitability of the method used, in terms of the ability to detect annual changes in biodiversity.

Surveys of water-dependent birds of the Olifants and Ga-Selati rivers are conducted during the month of October on an annual basis, since 2012. Certain regions of these rivers were selected for their differing upstream impacts. These regions (1-4) show in Figure 1.

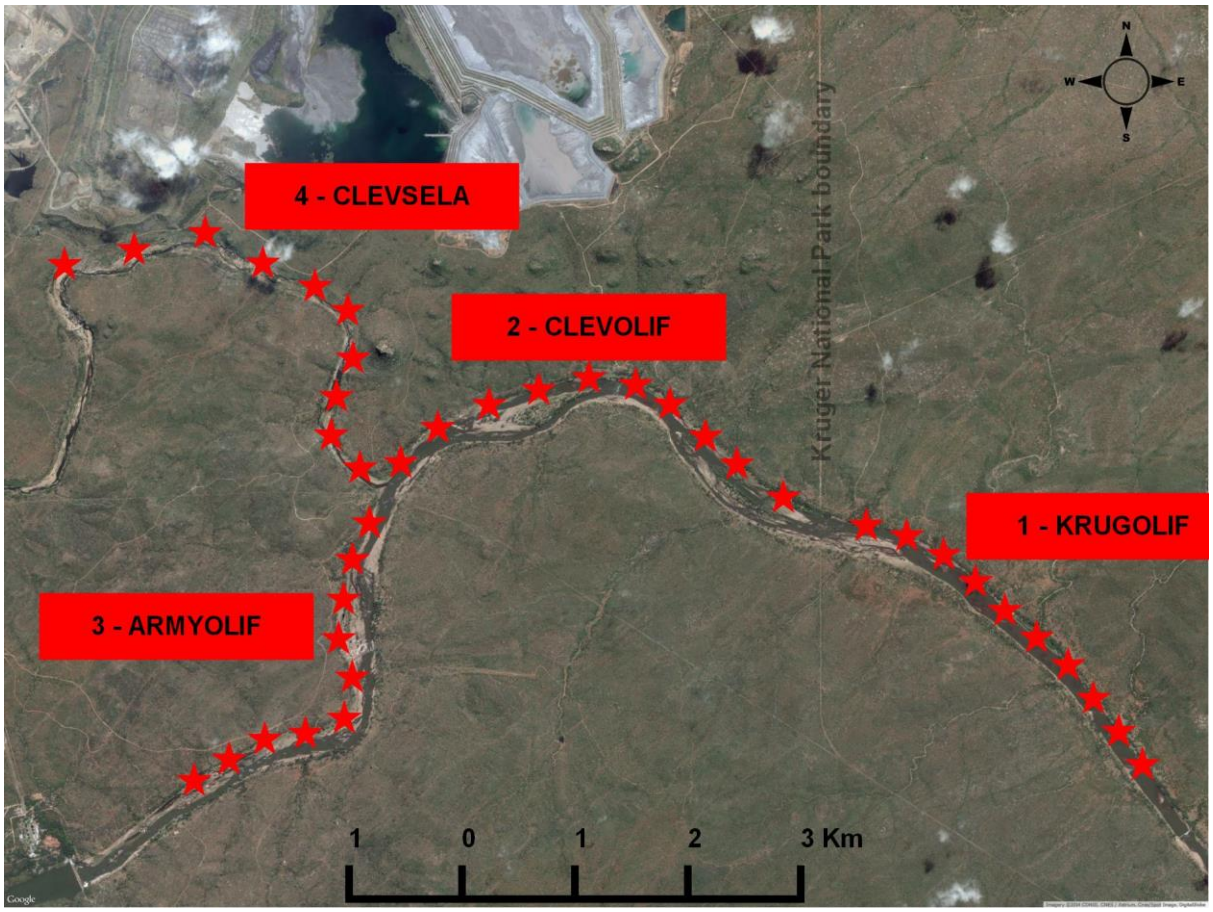

Figure 1: Different river regions (1-4) where water-dependent birds were surveyed. OLIF and SELA are abbreviations for Olifants and Ga-Selati rivers, respectively. KRUG refers to Kruger National Park, CLEV refers to Cleveland Nature Reserve and ARMY is the section of the Olifants River bordering the Mozambique National Resistance's Sawong headquarters. Red stars indicate each region's sample sites wherefrom counts took place. Palabora Copper Limited mine is evident to the North of the rivers.

Prior to 2014, birds were surveyed with teams walking the complete distances on both sides of river regions 1-4. Starting 2014, survey and sampling designs changed to determine the best method for monitoring. This most recent method enabled statistical analyses of results and additional post-processing. The designs are listed below:

- Ten sample sites per region were created and spaced approx. equal distances from one another on the northern banks of both rivers.
- Sample sites were spaced ≥400 m equating to the observer only counting birds within a 200 m radius, preventing overlap of site radii.
- The variable circular plot method or point transect with exact distances was employed.
- At each sample site, only water-dependent bird species (Appendix) were recorded, their abundances and radial distances.
- Observations spanned 15 minutes upon arrival at each sample site.
- Birds flying overhead were not recorded, but those leaving or entering the radius and perched, were.
- Only bird species from the families (mostly non-passerine) in Table 1 were considered to be water-dependent.

This method was continued in 2015 and deemed safe and successful in documenting the majority of birds.

Table 1: Only species of these families were recorded during the water-dependent river bird surveys. Highlighted rows indicate where only certain family members are water-dependent.

Family in order of *Roberts – Birds of Southern Africa*, VIIth ed.	**Water-dependent species**
Dendrocygnidae	Whistling Ducks
Anatidae	Ducks and Geese
Alcedinidae	Excludes African Pygmy-Kingfisher
Cerylidae	Giant Kingfisher and Pied Kingfisher
Strigidae	Includes only Pel's Fishing-Owl
Heliornithidae	Finfoots
Rallidae	Rails, Crakes *et al.**
Scolopacidae	Snipes, 'Shanks', Stints, Sandpipers, Ruff *et al.*
Rostratulidae	Painted-snipes
Jacanidae	Jacanas
Burhinidae	Includes only Water Thick-knee
Recurvirostridae	Stilts and Avocets
Charadriidae	Includes only water-dependent Plovers and Lapwings
Glareolidae	Includes only Pratincoles
Laridae	Skimmers, Terns *et al.*
Accipitridae	Includes only African Fish-Eagle, Osprey and Harriers
Podicipedidae	Grebes
Anhingidae	Darter
Phalacrocoracidae	Cormorants
Ardeidae	Egrets, Herons *et al.*
Scopidae	Hamerkop
Phoenicopteridae	Flamingos

Family in order of *Roberts – Birds of Southern Africa*, VIIth ed.	Water-dependent species
Threskiornithidae	Includes only water-dependent Ibises and Spoonbills
Pelecanidae	Pelicans
Ciconiidae	Includes only water-dependent Stork species
Motacillidae	Includes only Wagtails

* *et al.* refers to 'and others'

For comparative reasons, only birds encountered during the 2012/2013 surveys (that employed a different survey method) falling within each of the 2014/2015 sample site radii, were included in this report for total species richness and total abundances. Average bird species richness per river region was compared between sites of 2014 and 2015 only. The latter results were also tested for statistical significance to determine whether figures were obtained by chance.

Bird densities were not estimated for 2015, as exploratory analyses produced unreliable results due to less records.

Important note: The probabilities of detecting water-dependent birds at each river region were estimated to show how habitat structure affect bird detection by the observer (Figure 2). It is important to view this chart in line with the results of this (and past) documents as species and individuals were more or less difficult to detect by the observer depending on the river region and its habitat structure.

To illustrate: at KRUGOLIF there is a 100% probability of detecting a bird up to 120 meters compared to 17.5% at the same distance when surveying birds at CLEVSELA (thick, grey line and arrows depicted in Figure 2). However, if the same observer and exact same sample sites/points are used annually for recording birds, results will be comparable between years. Comparisons (species richness and abundance) between the different river regions however, are more subjective due to these habitat variations.

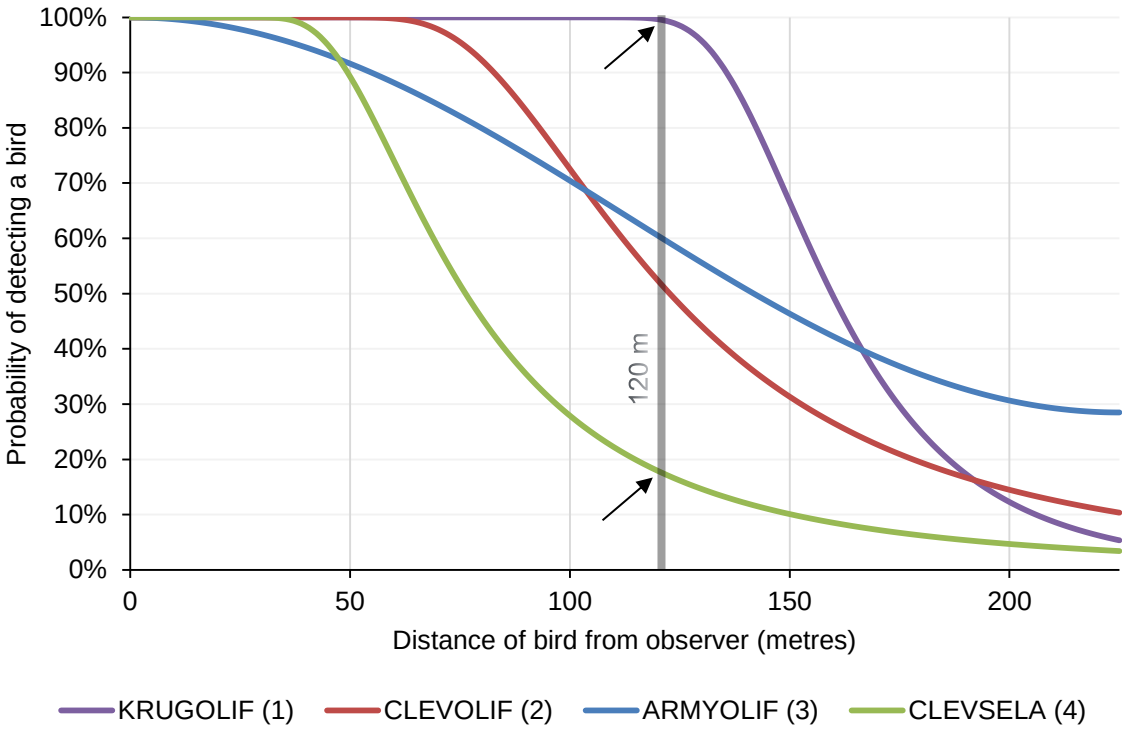

Figure 2: A water-dependent bird detection probability chart for all four river regions. An important consideration when comparing the data of different river regions. See above text for explanation.

The most diagnostic/faithful species of the specific river regions were determined using IndVal (Indicator Value) package in Program R. A value of 1 indicates a species is most faithful to that specific river region, but values near zero reflect no preference for any river region (generalist species). This computation was only performed with the 2015 survey data. Potential changes in indicator species since 2014 will be discussed as, a turnover in indicator species statuses may point to changes in habitat, food availability or other factors e.g. pollution.

RESULTS AND DISCUSSION

2012-2015

The overall water-dependent bird species richness for all river regions surveyed, was 36 during 2015 compared to 2014 (38). This value is smaller than found during 2013 (37) but, larger than found during 2012 (34). Annual trends in total species richness for each of the river regions are presented in Figure 3. ARMYOLIF shows the clearest trend where an exponential increase in species is observed since 2012. This may be due to lower volumes of water released directly below the barrage in later years. 2012 signified a flood year where high water velocities from the barrage could have initially hampered species establishment in this region. These velocities might have also removed other habitats e.g. sand bars.

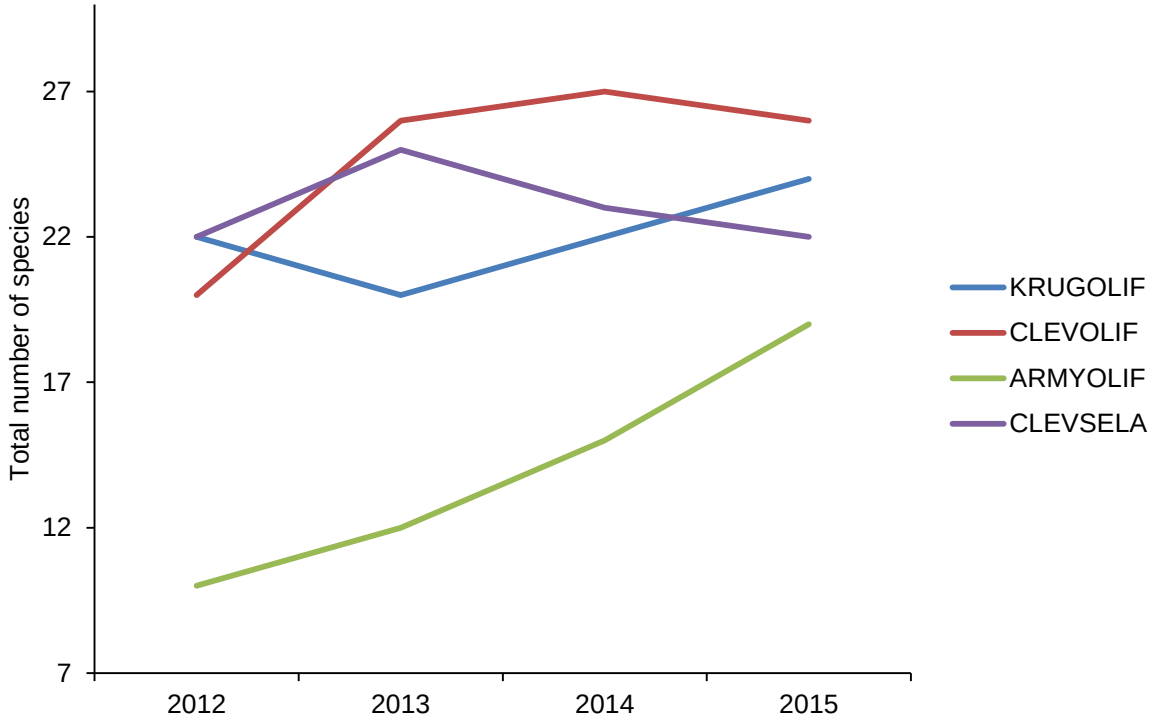

Figure 3: River region-specific total species richness values for all years of water-dependent bird surveys.

Average species richness (Figure 4) showed and total abundance (Figure 5) showed similar trends except for the large increase in abundance at KRUGOLIF.

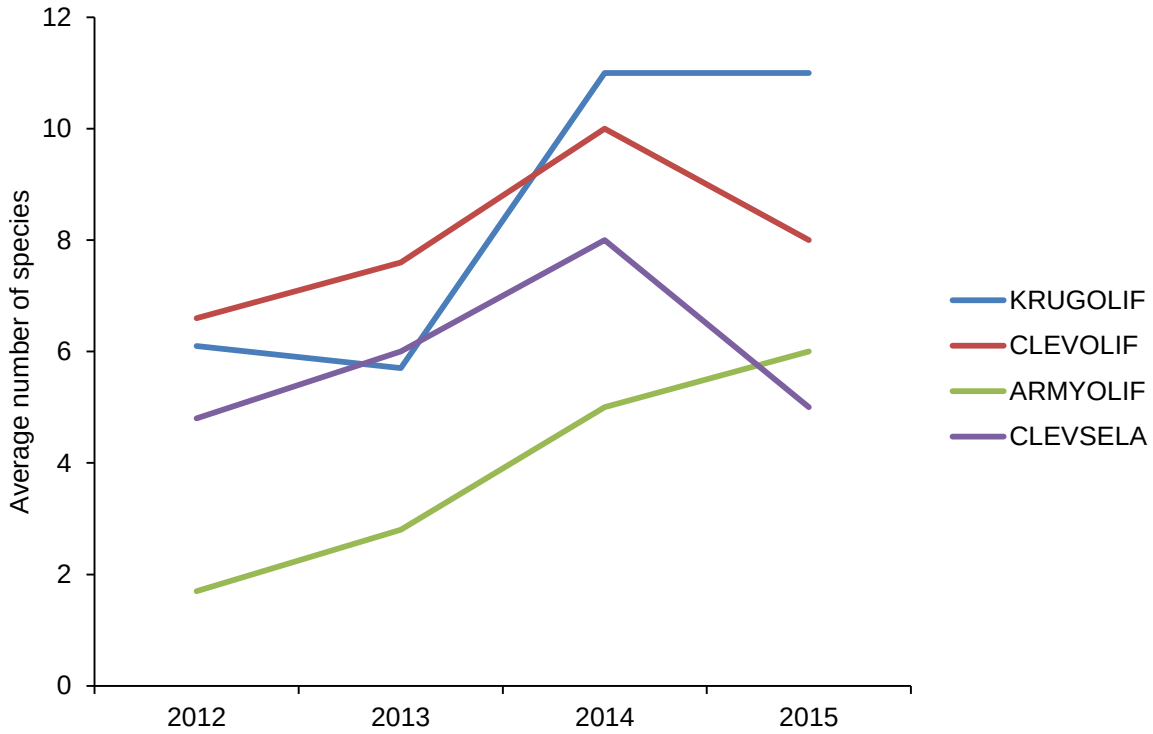

Figure 4: River region-specific average species richness values from 2012-2015.

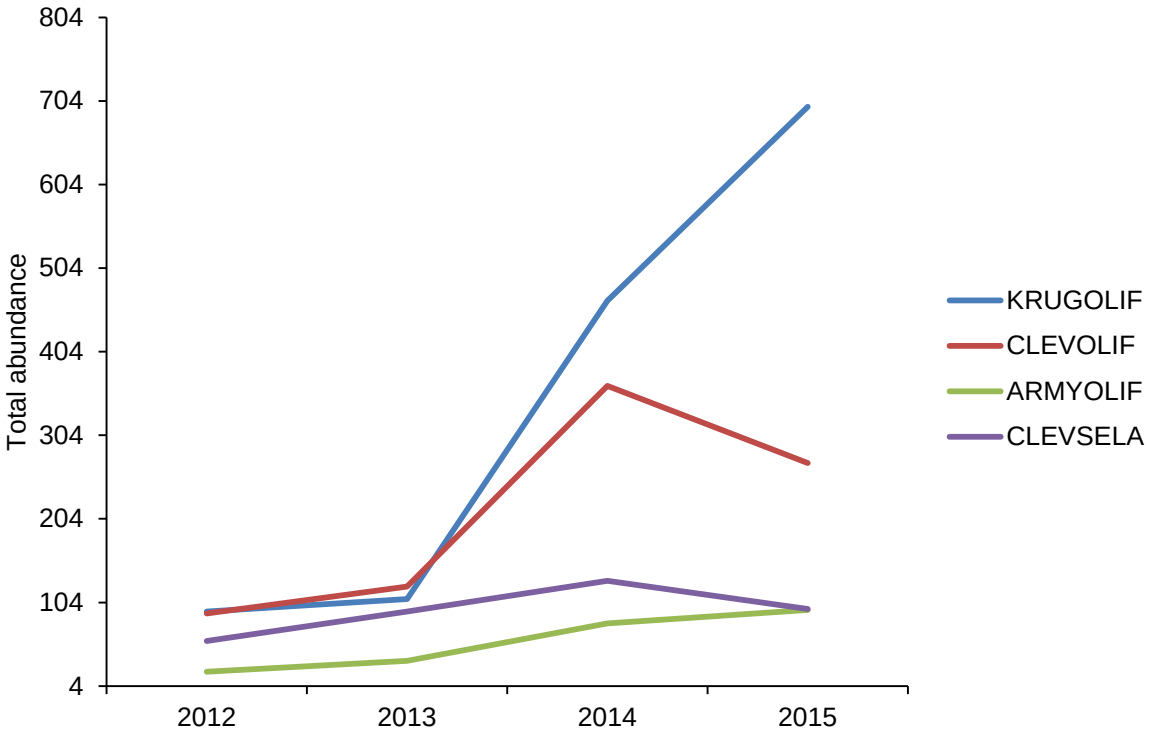

Figure 5: River region-specific total abundance values from 2012-2015.

The largest increase in abundance is visible at KRUGOLIF (Figure 5) and can be ascribed to increases in Egyptian Goose *Alopochen aegyptiacus* numbers (in the form of large flocks making up 54% of all birds recorded here). There was also a 38% increase in individuals across all river regions since 2014. These increases (33%) are also reported across the whole of the Olifants River inside Kruger National Park (Endangered Wildlife Trust, *pers. comm.*). No evidence exists but, filamentous algae might be the result of local increases in Egyptian Goose abundances. These annual increases are seen by some as a concern due to the species' aggressive behaviour and ability to use nests of other tree-users, potentially resulting in the eviction of or competition with Endangered (IUCN) vulture species or Pel's Fishing Owl that use the same habitats for breeding.

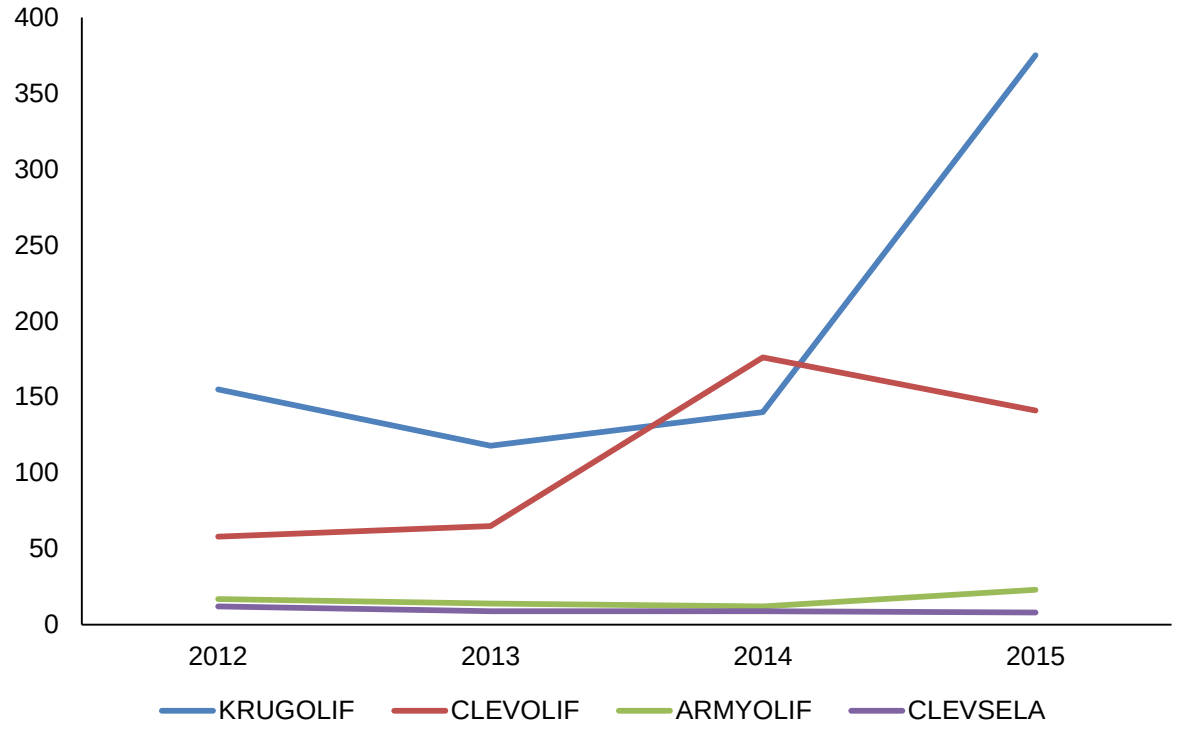

Figure 6: Egyptian Goose abundances from 2012-2015.

Opposing species richness trends between 2014 and 2015 can be due to changes in habitat or food. It is possible that the riverine vegetation (reeds, sedges, bank grasses etc.) changed, and filamentous algae (Figure 7) biomass increased since below average rain was received from October 2014 to October 2015. The algae and persisting low water levels may have a negative impact on fish species (major food source for many water-dependent bird species). Filamentous algae are known to hamper river health and biodiversity (Torn and Martin, 2012) and increase due to anthropogenic activities that add nitrogen and phosphorus to the water. With low water levels, the concentrations of these macro-elements are higher. The algae phenomenon is under investigation but, no evidence exists on its impact on the birds of the region.

Similar average species richness values for KRUGOLIF between 2014 and 2015 could be due to the scarcity of riverine vegetation and riparian vegetation in this region. The large sand bars remained relatively unchanged since 2014 with slight increases in annual forbs and grasses on these. Satellite imagery and site visits show that CLEVOLIF contains a mosaic of fast-flowing water over rocks, standing pools with and without marginal vegetation and a split river channel, to mention a few habitat characteristics. Many of these different habitats might have diminished in size or disappeared creating a more homogenous landscape that hosts less bird diversity. A single factor Analysis of Variance (ANOVA) test supported the 2015 results and showed that there was a strongly significant difference between the average species richness values of the different river regions, i.e. less than 0.001% probability that the survey results were obtained by chance/coincidence ($F_{10,3} = 8.6$, $p < 0.001$).

Figure 7: Aerial image showing floating (lighter shade of green areas near shores) and submerged (darker green sloughing) filamentous algae that is present over much of the study area. The species is presumed to belong to the globally-occurring genus: *Cladophora*.

Total abundances for the four most common species show in Figure 8. Decreases since 2014 in the two most abundant species (Blacksmith Lapwing *Vanellus armatus* and Black-winged Stilt *Himantopus himantopus*) could be due to increases of Egyptian Goose that occurred at KRUGOLIF. It cannot be proved but, these former two species share the geese's habitat: adjacent to river channels and shallow waters. In contrast, the gradual decrease in Striated Heron (Green-backed Heron) *Butorides striata* could be due to persistent low water levels since 2014 as this species is dependent on fish for food.

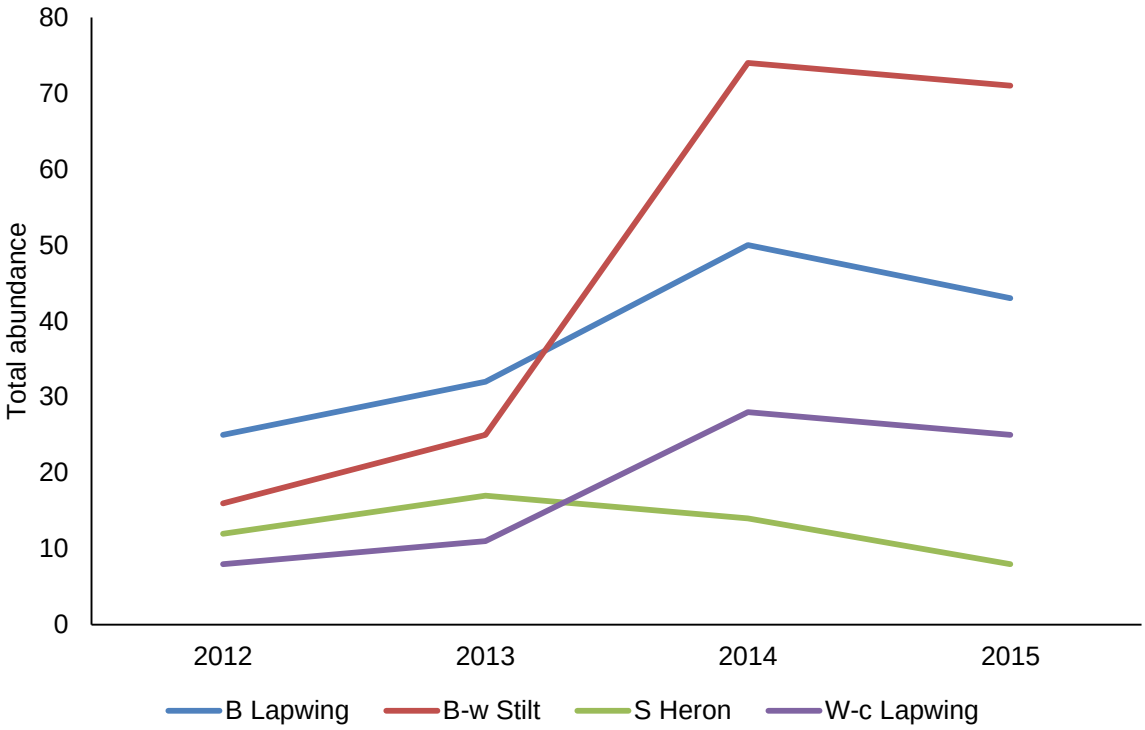

Figure 8: Total abundance values for all years of the four most common water-dependent species. B Lapwing = Blacksmith Lapwing *Vanellus armatus*; B-w Stilt = Black-winged Stilt *Himantopus himantopus*; S Heron = Striated Heron (previously named Green-backed Heron) *Butorides striata*; W-c Lapwing = White-crowned Lapwing *Vanellus albiceps* (former Red Data species; Barnes, 2000).

The 2015 surveys produced only diagnostic species at KRUGOLIF (1). A list of 9 species (Table 2) were significant at this river region. The White-fronted Plover *Charadrius marginatus* was the strongest and most significant during 2014 and 2015. It favours sandy shores or sand bars from coastal areas to rivers and lakes: a habitat that dominated the KRUGOLIF region. This specific population recorded during the surveys are of an inland sub-species: *C. m. mechowi*, but are migratory in response to flooding and usually moves to coastal areas from December-May. It is important to note that on the Zambesi River, abundances were reduced after hydrological disturbance (Hockey *et al.*, 2005). Such disturbances have not occurred from October 2014 to October 2015 possibly due to persistent low water levels and a decrease in flow that kept sand bars exposed over this period (Figure 9). The latter might have also resulted in the White-fronted Plover population doubling over this period from 19 (2014) to 40 records in 2015, and the addition of other indicators that rely on this habitat, e.g. Sandpipers, Black-winged Stilt *Himantopus himantopus*, Common Greenshank *Tringa nebularia* and Little Stint *Calidris minuta*.

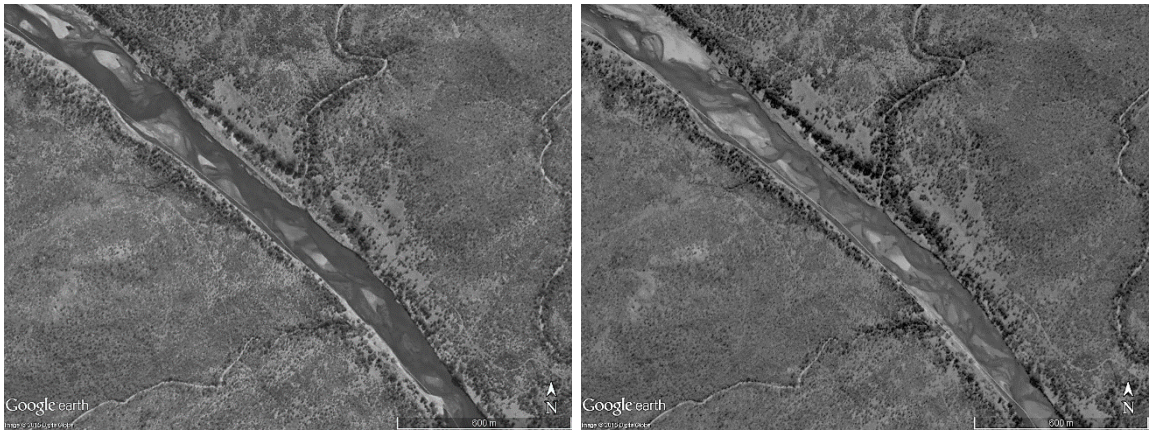

Figure 9: Satellite images showing persistent low water levels and sand bars of the KRUGOLIF region. July 2014 (left) and June 2015 (right).

A lack of diagnostic/indicator species at CLEVOLIF, ARMYOLIF and CLEVSELA suggest a turnover in water-dependent bird species since 2014. Thus, neither faithful nor diagnostic species were recorded at these regions possibly due to a lack of food sources or changes in habitat(s) as a result of lower water levels.

Table 3: Diagnostic/Faithful species of the KRUGOLIF river region. Species are arranged from strongest to weakest indicator (confidence intervals are ≥95%).

Species	**Indicator value**
White-fronted Plover	0.80
Black-winged Stilt	0.64
Egyptian Goose	0.62
Wood Sandpiper *Tringa glareola*	0.60
Marsh Sandpiper *Tringa stagnatilis*	0.58
Common Greenshank	0.53
Little Stint	0.50
Blacksmith Lapwing	0.44
Saddle-billed Stork	0.30

Latin names are included for those species not mentioned in the text *per se*.

Certain species which depend on the Olifants and Ga-Selati rivers for habitat or food have been identified as current Species of Conservation Priority in the PMC Biodiversity Action Plan (BAP). These are:

- Pel's Fishing-Owl (*Scotopelia peli*)
- Saddle-billed Stork (*Ephippiorhynchus senegalensis*)
- White-crowned Lapwing (*Vanellus albiceps*)
- Yellow-billed Stork (*Mycteria ibis*)
- White-backed Night-Heron (*Gorsachius leuconotus*)

The 2014 surveys recorded 28 White-crowned Lapwing compared to 25 records in 2015. We would suggest that this species be removed from the Species of Conservation Priority list, as its status has also been down listed by the IUCN (International Union for the Conservation of Nature) from Near-threatened to Least Concern in South Africa.

Instead, the Black Stork *Ciconia nigra* should be added to the list of Species of Conservation Priority as it is currently Vulnerable (Taylor, 2015 up-listed from Near-threatened in Barnes, 2000) in South Africa and has been recorded *ad hoc* during 2015.

Sightings of these rarely encountered species, (except White-crowned Lapwing) show in Figure 10. Additionally, each of the species' natural history is explained below with the addition of one species: the Black Stork. More information on Red Data species and the listing can be found at http://www.iucnredlist.org/. Note that there is a regional and a global status for species. Discussed below, are regional statuses from Barnes (2000) and Taylor (2015).

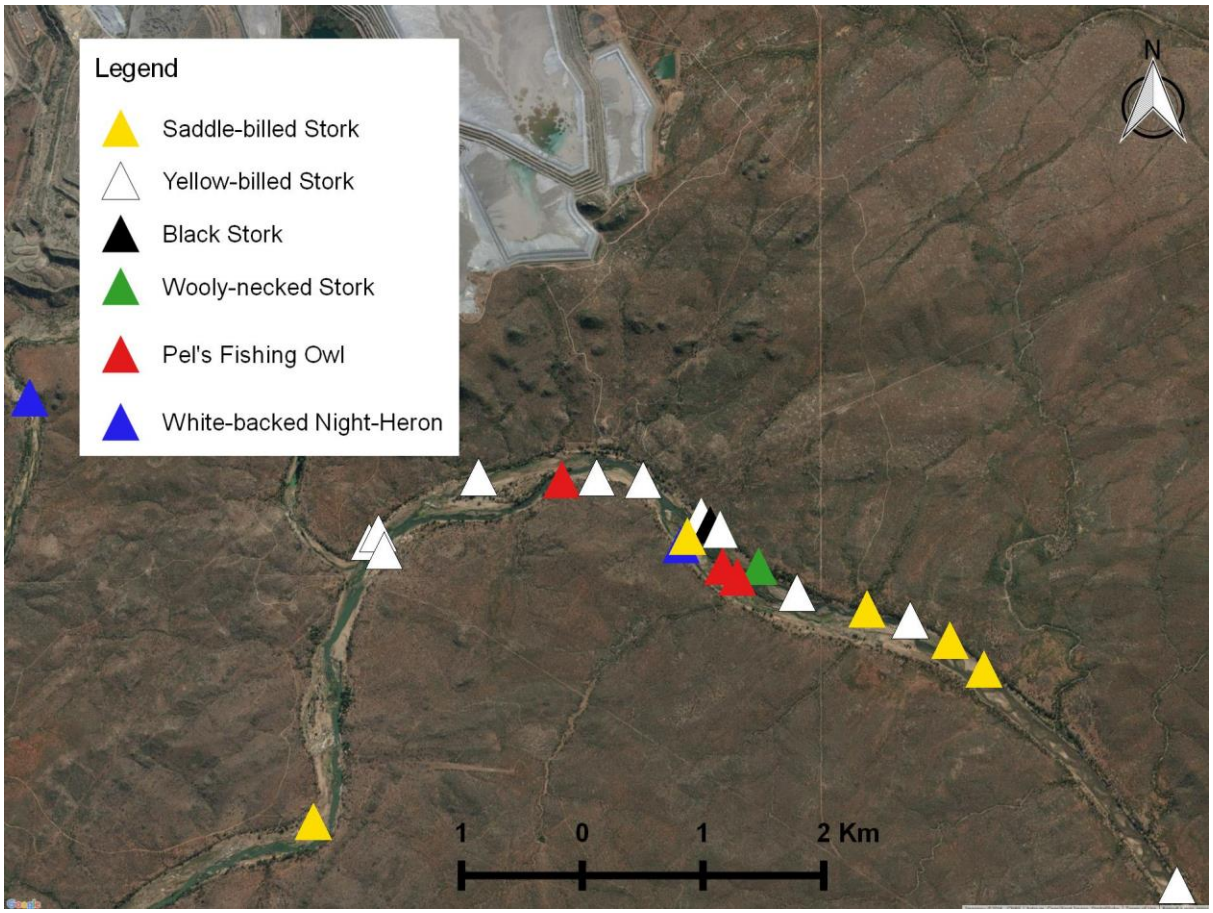

Figure 10: 2012-2015 *ad hoc* sightings of the Species of Conservation Priority (from PMC's BAP) and an additional two species encountered during 2015: the Black Stork *Ciconia nigra* (Red Data species) and the Wooly-necked Stork *Ciconia episcopus*. The additional sighting of two Wooly-necked Stork during 2015 are included for interest's sake as it is not considered a water-dependent species.

- Generally uncommon and localised, the Pel's Fishing-Owl is estimated at 15 pairs/100 kilometre on the Olifants River, Kruger National Park. It is dependent on tall riparian trees near rivers and swamps and mostly catches fish between 100-250 grams. The nest is placed 3-12 meters above ground, less than 200 meters from the water inside a cavity or at a junction of branches. Some of the probable greater threats include human disturbance, water abstraction and silting or pollution of rivers (Hockey *et al.*, 2005). Consequently, in South Africa it has been up-listed from Vulnerable (Barnes, 2000) to Endangered (Taylor, 2015). There were two separate sightings of this species confirmed by André Botha

(EWT; two birds) and Joris Bertens (Sefapane; single bird) of birds that flushed from the Eastern of the two islands inside the Olifants River bordering Cleveland'.

- The Saddle-billed Stork is still considered Endangered (Taylor, 2015). In South Africa, most of the population is found in the Kruger National Park, estimated at 50-100 pairs. A resident species of large rivers, it forages mostly on fish weighing up to 500 grams. Nests are usually on top of a tree in full sunlight, up to 500 meters away from water and 20-30 meters above ground (Hockey *et al.*, 2005).
- The Yellow-billed Stork leaped from Near-threatened (Barnes, 2000) to Endangered (Taylor, 2015). This drastic up-listed status is two steps closer to extinction. Rarely singly and often in pairs, this stork species occupy a wide variety of habitats including wetlands, rivers lakes and small pools. It forages in shallow water free of emergent vegetation, on fish up to 150 grams. Frogs and invertebrates make up the remainder of its diet. A colonial nester sharing colonies with other storks, especially the Marabou', it also nests along-side herons ibises and darters amongst others. Nests built above ground or water, 3-7 meters inside a tree (Hockey *et al.*, 2005).
- A generally rare species, the White-backed Night-Heron's status has not changed since Barnes (2000). Currently considered Vulnerable (Taylor, 2015), its movements and diet are little known about. Overhanging vegetation of slow-flowing rivers and streams are its preferred habitats where it forages on small fish, amphibians and a variety of invertebrates. Usually less than 1 meter above water, nests are rarely exposed but rather inside a tree, bush, reeds or rock pile especially on islands (Hockey *et al.*, 2005).
- A species highly dependent on fish and amphibians as a food source, the Black Stork (Figure 11) may catch fish ranging from 120-180mm in length which include Tigerfish *Hydrocynus vittatus*, Sharptooth Catfish *Clarias gariepinus* and mudfishes *Labeo* spp. It is currently regarded as Vulnerable in South Africa (Taylor, 2015), possibly due to its cliff-nesting habit (positioned usually over water). Mostly resident it has complex local movements and may be nomadic during the dry season (Hockey *et al.*, 2005).

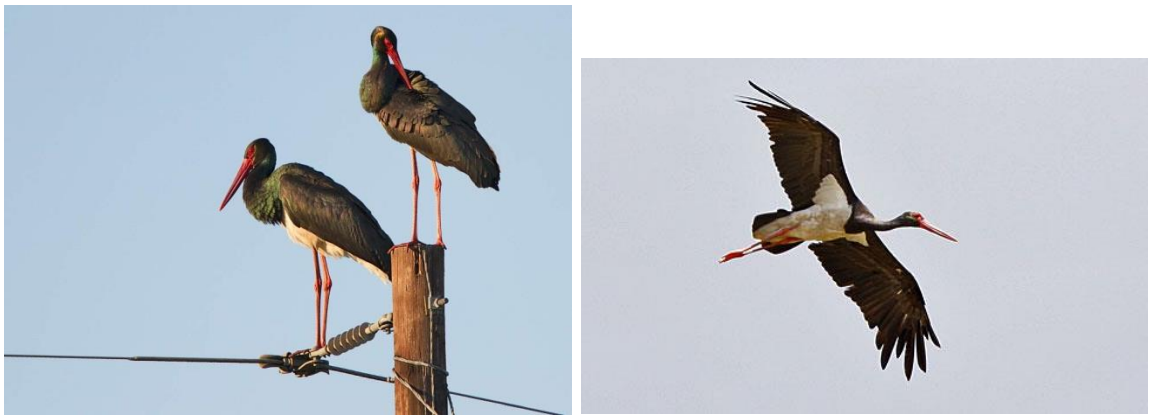

Figure 11: The Black Stork *Ciconia nigra* is considered Vulnerable (IUCN) in South Africa and highly dependent on fish as a food source. Photos: Warwick Tarboton (http://www.warwicktarboton.co.za/; Accessed: 27-10-2015).

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APPENDIX

KRUGOLIF		**ARMYOLIF**
African Jacana		African Fish Eagle
African Pied Wagtail		African Jacana
African Spoonbill		African Pied Wagtail
Blacksmith Lapwing		Blacksmith Lapwing
Black-winged Stilt		Common Greenshank
Common Greenshank		Egyptian Goose
Curlew Sandpiper		Giant Kingfisher
Egyptian Goose		Goliath Heron
Great Egret		Hamerkop
Little Egret		Little Egret
Little Stint		Marsh Sandpiper
Malachite Kingfisher		Pied Kingfisher
Marsh Sandpiper		Reed Cormorant
Pied Kingfisher		Squacco Heron
Reed Cormorant		Striated (Green-backed) Heron
Ruff		Three-banded Plover
Saddle-billed Stork		Water Thick-knee
Striated Heron		White-crowned Lapwing
Three-banded Plover		Wood Sandpiper
Water Thick-knee		**CLEVSELA**
White-crowned Lapwing		African Darter
White-fronted Plover		African Fish Eagle
Wood Sandpiper		African Jacana
Yellow-billed Stork		African Pied Wagtail
CLEVOLIF		Black Crake
African Darter		Blacksmith Lapwing
African Jacana		Black-winged Stilt
African Pied Wagtail		Common Moorhen
African Spoonbill		Common Sandpiper
Black Crake		Egyptian Goose
Blacksmith Lapwing		Giant Kingfisher
Black-winged Stilt		Grey Heron
Common Greenshank		Hamerkop
Common Sandpiper		Little Egret
Curlew Sandpiper		Malachite Kingfisher
Egyptian Goose		Pied Kingfisher
Goliath Heron		Reed Cormorant
Great Egret		Squacco Heron
Grey Heron		Striated Heron
Little Egret		Three-banded Plover

CLEVOLIF		CLEVSELA
Marsh Sandpiper		Water Thick-knee
Pied Kingfisher		White-crowned Lapwing
Reed Cormorant		
Ruff		
Striated Heron		
Three-banded Plover		
White-breasted Cormorant		
White-crowned Lapwing		
White-faced Whistling Duck		
Wood Sandpiper		
Yellow-billed Stork		