BIODIVERSITY OBSERVATIONS
RESEARCH PAPER (CITIZEN SCIENCE)

Odonata of the Kruger National Park

Author(s):
Underhill LG, Loftie-Eaton M and Navarro R

Journal editor:
Pete Laver

Manuscript editor:
Pete Laver

Received: September 9, 2018; Accepted: November 13, 2018; Published: November 13, 2018

Citation: **Underhill LG, Loftie-Eaton M and Navarro R. 2018. Odonata of the Kruger National Park. Biodiversity Observations 9.11:1-16**

Journal: https://journals.uct.ac.za/index.php/BO/
Manuscript: https://journals.uct.ac.za/index.php/BO/article/view/634
PDF: https://journals.uct.ac.za/index.php/BO/article/view/634/563
HTML: http://thebdi.org/blog/2018/11/13/odonata-of-the-kruger-national-park

Biodiversity Observations is an open access electronic journal published by the Animal Demography Unit at the University of Cape Town, available at https://journals.uct.ac.za/index.php/BO/

The scope of Biodiversity Observations includes papers describing observations about biodiversity in general, including animals, plants, algae and fungi. This includes observations of behaviour, breeding and flowering patterns, distributions and range extensions, foraging, food, movement, measurements, habitat and colouration/plumage variations. Biotic interactions such as pollination, fruit dispersal, herbivory and predation fall within the scope, as well as the use of indigenous and exotic species by humans. Observations of naturalised plants and animals will also be considered. Biodiversity Observations will also publish a variety of other interesting or relevant biodiversity material: reports of projects and conferences, annotated checklists for a site or region, specialist bibliographies, book reviews and any other appropriate material. Further details and guidelines to authors are on the journal website (https://journals.uct.ac.za/index.php/BO/).

ISSN 2219-0341

Odonata of the Kruger National Park

Les G. Underhill *Animal Demography Unit, Department of Biological Sciences, University of Cape Town, Rondebosch, 7701 South Africa; Biodiversity and Development Institute, 25 Old Farm Road, Rondebosch, 7700 South Africa*
Megan Loftie-Eaton *Animal Demography Unit, Department of Biological Sciences, University of Cape Town, Rondebosch, 7701 South Africa; Biodiversity and Development Institute, 25 Old Farm Road, Rondebosch, 7700 South Africa*
Rene Navarro *Animal Demography Unit, Department of Biological Sciences, University of Cape Town, Rondebosch, 7701 South Africa; FitzPatrick Institute of African Ornithology, Department of Biological Sciences, University of Cape Town, Rondebosch, 7701 South Africa*

The number of species of dragonflies and damselflies recorded in the Kruger National, South Africa, was 103 in April 2018. This figure was based on a database containing 2,817 records of Odonata, made since 1980, from the 52 quarter degree grid cells which intersect with the Kruger National Park. Records were available for 41 of the 52 grid cells. The most frequently recorded species were Red-veined Dropwing *Trithemis arteriosa* (167 records) and the Orange-veined Dropwing *Trithemis kirbyi* (144 records), both recorded in 33 grid cells, and Southern Banded Groundling *Brachythemis leucosticta* (175 records) and Broad Scarlet (141 records) both in 29 grid cells. Based on records up to April 2018, the median date of the most recent record for species was September 2017, so that half of the 103 species had been recorded during summer 2017/18. This report could be used to motivate the proclamation of the river and wetland systems of the Kruger National Park as a 'Wetland of International Importance' in terms of the Ramsar Convention. Two-thirds of the Odonata of South Africa, and one-eighth of the Odonata of Africa, have been recorded in the Kruger National Park.

Keywords: dragonfly, damselfly, citizen science

Dragonflies and damselflies are important indicators of water quality and ecosystem health (Figure 1)

Introduction

This document is experimental. It aims to provide a model for the presentation of biodiversity data that can be used by managers and policy makers, by researchers, and by citizen scientists. For these groups of people it aims (1) to provide a snapshot, at a point in time, of the quality and volume of data available for a locality, and (2) aims to provide links to the relevant databases, so they have access to useful summaries of the ongoing data collection effort. In this case the

Biodiversity Observations is an open access electronic journal published by the Animal Demography Unit at the University of Cape Town, available at https://journals.uct.ac.za/index.php/BO/. A permanent link for an online version of this manuscript can be found at https://journals.uct.ac.za/index.php/BO/article/view/634, which includes the PDF: https://journals.uct.ac.za/index.php/BO/article/view/634/563. An HTML version can be found at http://thebdi.org/blog/2018/11/13/odonata-of-the-kruger-national-park.
Journal editor: Pete Laver; **Manuscript editor**: Pete Laver; **Corresponding author**: les.underhill@uct.ac.za
Received: September 9, 2018; **Accepted**: November 13, 2018; **Published**: November 13, 2018
Recommended citation: Underhill LG, Loftie-Eaton M and Navarro R. 2018. Odonata of the Kruger National Park. Biodiversity Observations 9.11:1-16
Manuscript subject: Citizen Science

Figure 1: A Barbet Percher *Diplacodes luminans* recorded by Craig Peter on the southern bank of the Luvuvhu River near Pafuri, Kruger National Park. OdonataMAP record 46300 http://vmus.adu.org.za/?vm=OdonataMAP-46300

locality is the Kruger National Park, South Africa, and the component of biodiversity under consideration is the Odonata, the dragonflies and the damselflies.

We are looking for suggestions that will improve the usefulness of this product. We are primarily hoping that this review will be on value to managers and policy makers, so it is their information needs which we primarily want to meet.

Study area: Kruger National Park, South Africa

The Kruger National Park (KNP) is the flagship national park of South Africa. The KNP, located in the north-eastern corner of South Africa, was established as a government reserve in 1898 and became South Africa's first national park in 1926. It was first established to control over-hunting and to protect the dwindling number of herbivores in the Lowveld (Stevenson-Hamilton 1993). The KNP is currently nearly two million hectares in size (19,485 km^2). It is a national conservation icon of South Africa and considered to be a safe haven for many fauna and flora. KNP is home to approximately 2,000 species of plant, 53 fish, 34 amphibians, 118 reptiles, 517 birds and 147 mammal species (SANParks 2016).

KNP is about 360 km long from north to south, and about 65 km wide on average, from west to east. Its widest point is 90 km (Paynter & Nussey 1986). The park is bordered by the Limpopo River in the north and the Crocodile River in the south, forming natural park boundaries. Several other rivers run through the park from west to east, including the Sabie, Olifants, Letaba and Luvuvhu Rivers. The Lebombo Mountains lie on the eastern park boundary with Mozambique and to the west the KNP is fringed with many other private nature reserves (forming part of the Greater Kruger National Park) and local communities, villages and towns. The park's altitude ranges from 200 m to 800 m. The highest point is Khandzalive Hill in the south-west of the park near the Berg-en-Dal rest camp (Paynter & Nussey 1986).

The Lowveld, and consequently the KNP, has a subtropical climate. Subtropical climates are characterised by warm, humid summers and mild, dry winters. Summer temperatures can rise above 38 ∘C. The rainy season starts around November and lasts until May. The driest period is September and October (SANParks 2016).

Data resources

This document provides information related to the Odonata for the Kruger National Park as well as a selection of species distribution maps. It makes use of the open access database developed by a project funded by the JRS Biodiversity Foundation which generated the Odonata Database of Africa (Clausnitzer *et al.* 2012, Dijkstra 2016, available online as African Dragonflies

and Damselflies Online at http://addo.adu.org.za) and the citizen science database generated by the OdonataMAP project (Underhill *et al.* 2016, available online at http://vmus.adu.org.za). Both databases are open access. This report is based on species recorded in 52 quarter degree grid cells which fall entirely or partly within the KNP (Table 1, Figure 2). Search queries made to the OdonataMAP database can be extended to include a search of the Odonata Database of Africa, which includes almost all of the museum specimen records for the region. This has been done for this report.

OdonataMAP data for the Kruger National Park

On 23 April 2018, there were 2,817 records of Odonata in the combined database of OdonataMAP and the Odonata Data Base of Africa, recorded since 1980. Of these, 2663 had been identified to species level, and the remainder to genus level. The number of species recorded for the Kruger National Park was 103 species from eight families (Table 2). Within Table 2, the ordering is first alphabetically by family, and then by genus and species.

The Red-veined Dropwing *Trithemis arteriosa* (167 records) and the Orange-veined Dropwing *Trithemis kirbyi* (144 records) were both recorded in 33 of the quarter degree grid cells of the Kruger National Park, and Southern Banded Groundling *Brachythemis leucosticta* (175 records) and Broad Scarlet (141 records) in 29 grid cells (Table 2). These four dragonflies were the most widely distributed species.

The dataset is commendably "young" (final column of Table 2). Based on records up to April 2018, the median date of the most recent record for species was September 2017. In other words, half of the 103 species had been recorded during the most recent eight-month period, i.e. in summer 2017/18. The lower quartile was in March 2015, indicating that three-quarters of the species have been recorded in the most recent three years.

Special attention needs to be focused on "refreshing" the records of the species in oldest quartile; in this case, it is species not recorded since 2015. Of species recorded since 1980, nine have not been recorded for more than 10 years, i.e. prior to 2008 (Table 2). Common Thorntail *Ceratogomphus pictus* was last recorded on 12 December 2006, Two-striped Skimmer *Orthetrum caffrum* was last recorded on 27 January 2007, and Spectacled Skimmer *Orthetrum icteromelas* was last recorded on 7 March 2011 (Table 2). For a further six species, only the year of the last record is available: Pygmy Basker *Aethriamanta rezia* (1992), Steam Hawker *Pinheyschna subpupillata* and Little Wisp *Agriocnemis exilis* (2001), and Spotted Spreadwing *Lestes tridens*, Lined Claspertail *Onychogomphus supinus* and Little Duskhawker *Gynacantha maderica* (2002). Eight of these nine species have been recorded only once in the Kruger National Park since 1980, and the Spotted Spreadwing twice (Table 2). The presence of these species needs careful evaluation. Six species were last recorded in 2012, four in 2013, and 11 in 2014.

Of the species in the "oldest" quartile, three had been recorded in more than 10 grid cells: Black Sprite *Pseudagrion commoniae* (18 grid cells, 43 records), Ringed Cascader *Zygonyx torridus* (16 grid cells, 24 records) and Ferruginous Glider *Tramea limbata* (10 grid cells, 13 records) (Table 2). The current status of these three species should be investigated. They were last recorded in 2014 (Table 2).

The maximum number of species of Odonata in any of the 52 quarter degree grid cells of the Kruger National Park was 60 (Figure 3). The median was 12 species. Eleven grid cells had no records of Odonata. Most of these grid cells have only a small percentage of their area within the Kruger National Park, and those on the eastern edge of the park are mostly in Mozambique and are virtually inaccessible even from within that country (Peter Lawson *pers. comm.*). If these grid cells are excluded from the calculation, the median number of species per grid cell is 21.

What is immediately clear from Figure 3 is that the species richness within the park appears

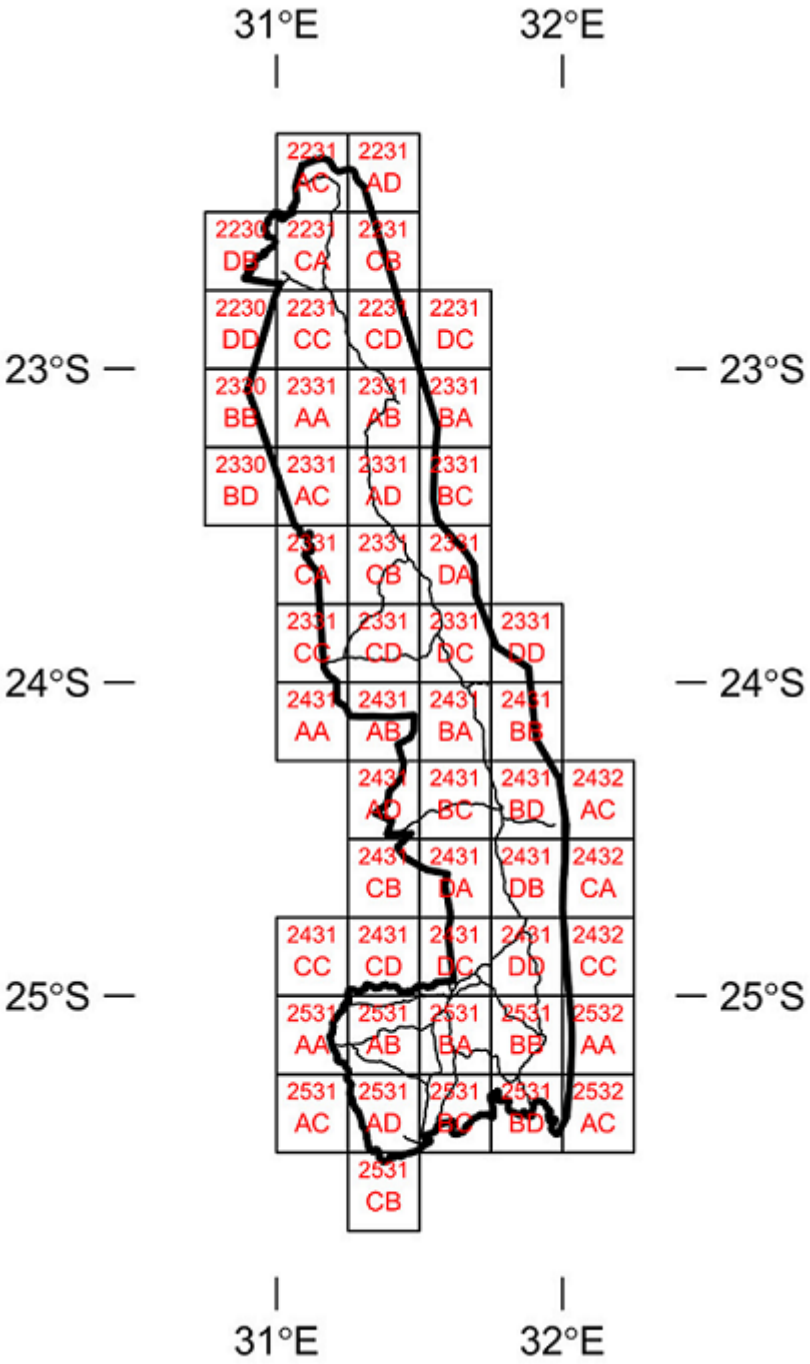

Figure 2: Locations of the 52 Quarter Degree Grid Cells (QDGCs) which intersect with the Kruger National Park. These are listed in Table 1. The naming convention follows the tradition that has been used in South Africa for almost a century. There are 16 QDGCs in a one-degree grid cell. Each one-degree cell is numbered by the coordinates, latitude first, then longitude, of the northwest corner of the cell. The subdivisions of the one-degree grid cell have an alphabetic notation, as shown.

to be spatially uneven, with no strong geographical pattern (such as a decrease from north to south, or east to west). Figure 3 is the result of two confounded processes: the fieldwork behaviour of the observers (technically, the observer process) and the truth on the ground (the biological process). Although there is likely to be variation in the number of species per grid cell, due to the uneven distribution of suitable wetland habitat for Odonata, the true variation is unlikely to be as large as depicted in Figure 3. The challenge for fieldwork in the Kruger National Park is that the dragonflies and damselflies share their habitat with Nile Crocodiles *Crocodylus niloticus*, Common Hippopotamuses *Hippopotamus amphibious* and other life-threatening animals. As a result, and in accordance with the SANParks code of conduct for visitors to the Kruger National Park, most river systems and wetlands are out of bounds; this makes consistent recording of especially the damselflies difficult, and introduces a bias into the data.

In spite of this, it is probably feasible, now that the unevenness of the observer effort is displayed (Figure 3), that the citizen scientists who are the primary contributors of data to OdonataMAP will find a way to reduce as much of the bias introduced by the observer process as feasible.

Distribution maps, generated in May 2018, are provided for a sample of four species, selected to illustrate various levels of occurrence in the Kruger National Park (Figures 4 and 5). Up-to-date distribution maps (i.e. for use in the future) for all species can be obtained from the following link:

http://vmus.adu.org.za/vm_map_afr.php?spp=668670&database=odonata&grid=1&key=1&map=24&cell_m=15&outline=1.

This gives the map for the species with species code number 668670, the Red-veined Dropwing (Figure 4). The species codes are provided in the first column of Table 2.

Up-to-date lists of the species recorded in a quarter degree grid cell can be obtained from the following link. The list of grid cell codes is provided in Table 1. In the link below, replace the "locus" with the code for the QDGC required (consult also Figure 2):

http://vmus.adu.org.za/vm_locus_map.php?vm=OdonataMAP&locus=2230DB.

These lists are constructed to the same format as that of Table 2, including the provision of the most recent record of each species in the grid cell. The list can be copied and pasted to Excel, where they can be sorted and manipulated as needed. These list include numbers of records for which the expert panel was unable to make an identification to "species" level.

Earlier studies of the Odonata of the Kruger National Park

Three key papers have been written which focus on the Odonata of the Kruger National Park (Table 4). The first was a list of 21 species recorded by Balinsky (1965). Three decades late, Clark & Samways (1994) generated a list of 80 species, based on three sources: the 21 species by Balinsky (1965), their own list of 59 species from along the Sabie River, and a list of 61 species generated by "other collectors" in the period between Balinsky's fieldwork and their own. Clark & Samways (1994) noted that there were three species which had only been recorded by Balinsky (1965); these are included in the list of Table 2; i.e. their presence has been confirmed. They also noted that there were 11 species which were only on the list made by "other collectors". All except one of these species is included in Table 2; the exception is Cryptic Syphontail *Neurogomphus vicinus*, a species which has only been recorded from its type locality in the Democratic Republic of Congo (Schouteden 1934); so this species represents an error.

It is remarkable how the list of Odonata species has grown in the past five decades, from 21 to 80 and currently 103 (Tables 2 and 4). It is even more remarkable that two-thirds of South Africa's species of Odonata (Tarboton & Tarboton 2015) have been recorded in the quarter degree grid cells which intersect with the Kruger National Park.

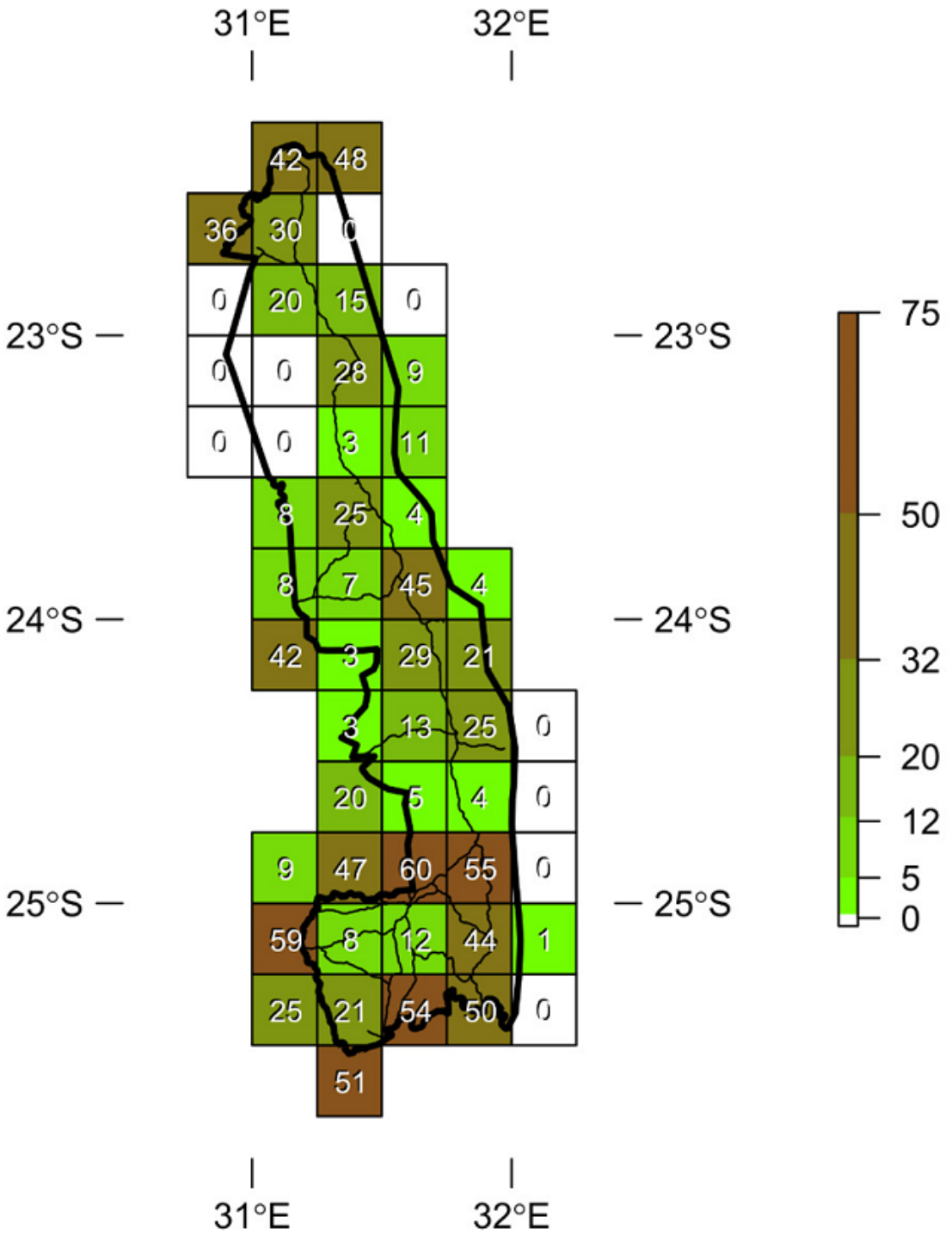

Figure 3: Species richness of the Odonata (dragonflies and damselflies) in the Quarter Degree Grid Cells (QDGC) which intersect with the Kruger National Park. Refer to Figure 2 and Table 1 for the naming conventions of each QDGC.

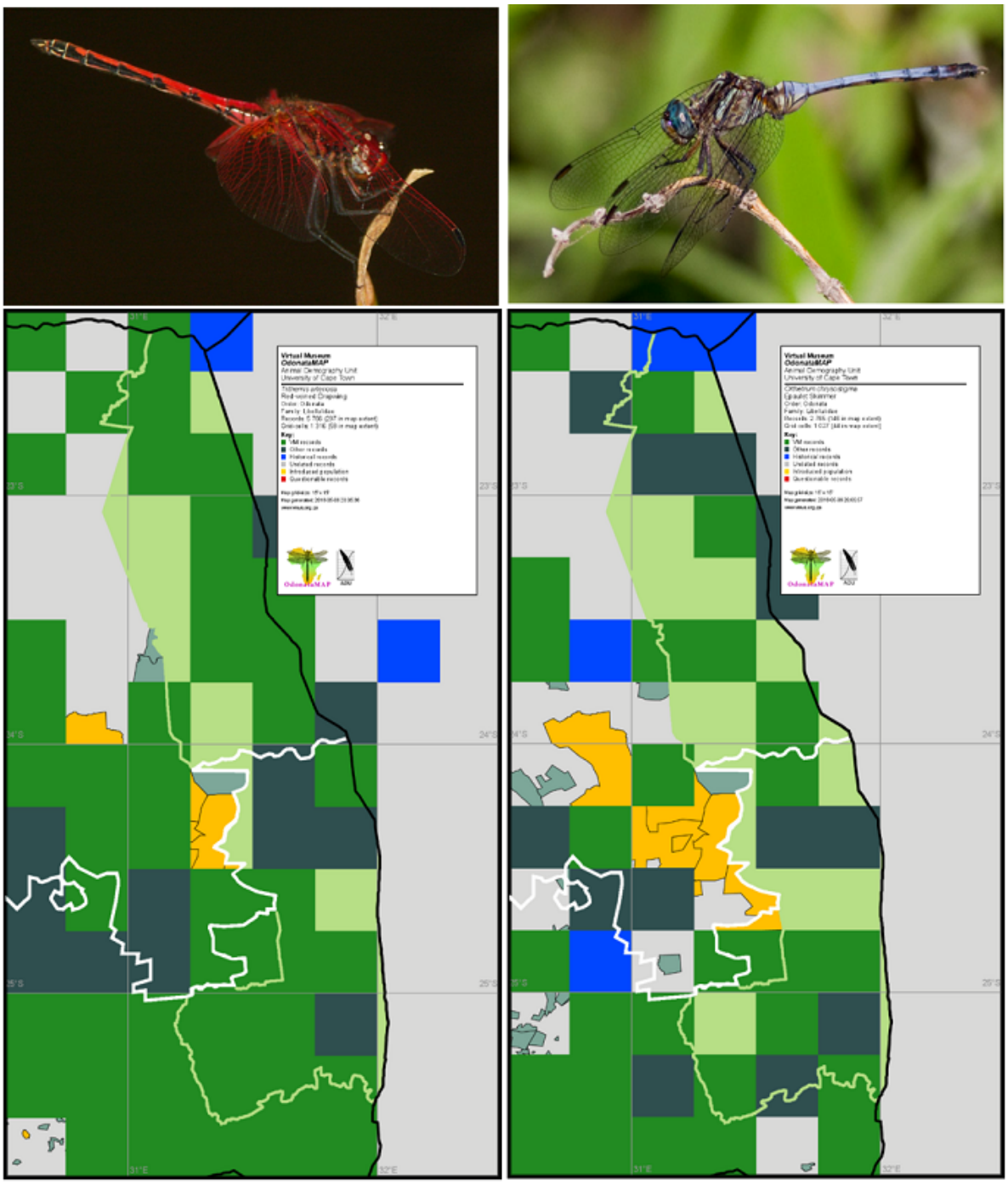

Figure 4: Distribution maps for the Red-veined Dropwing *Trithemis arteriosa* and the Epaulet Skimmer *Orthretrum chrysostigma* in the Kruger National Park and surrounding areas. The Red-veined Dropwing has been recorded in 33 of the 52 QDGCs which intersect with the Kruger National Park, the most widespread species, and the Epaulet Skimmer in 24. The distribution beyond the Kruger National Park is displayed on these maps.

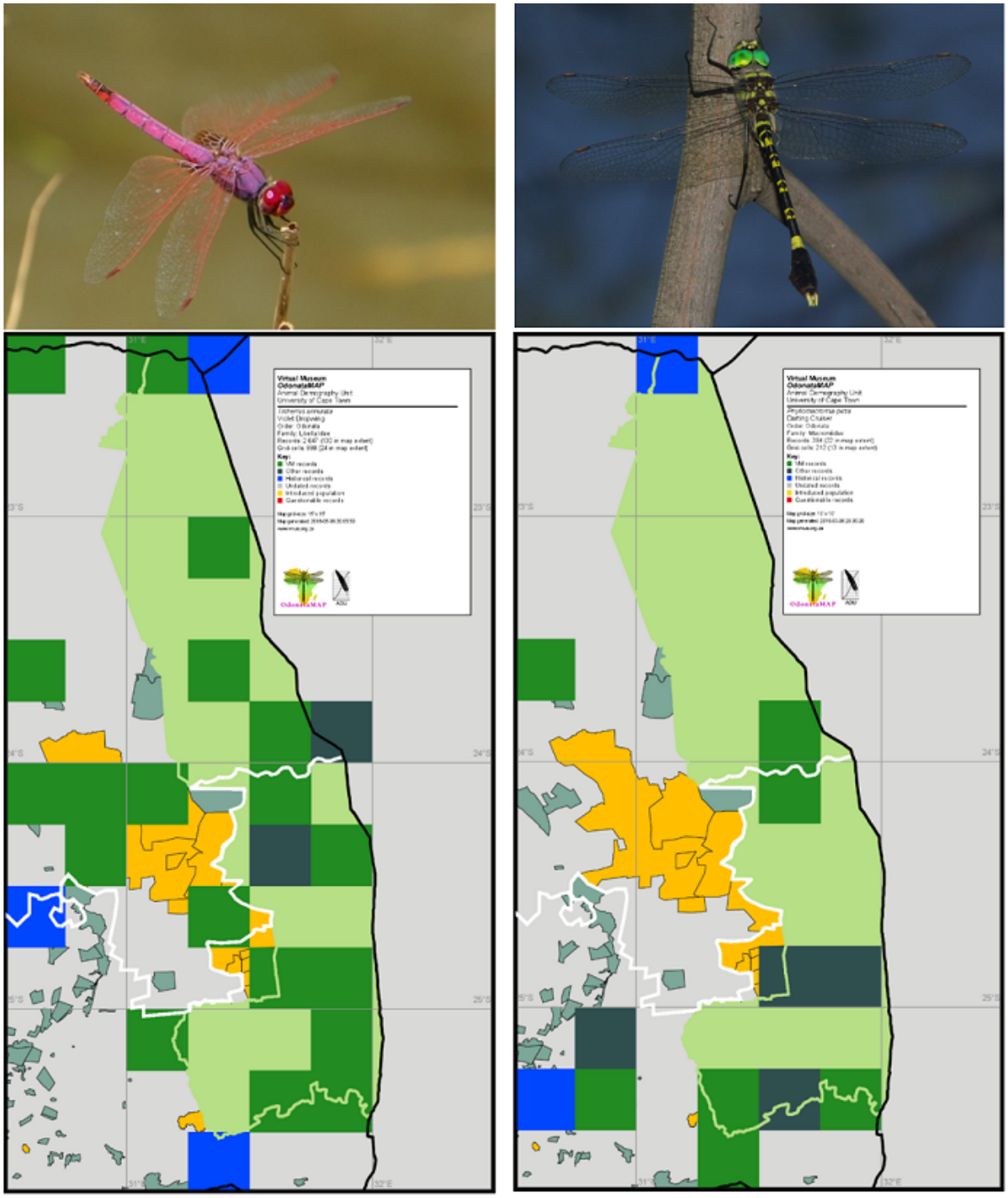

Figure 5: Distribution maps for the Violet Dropwing *Trithemis annulata* and the Darting Cruiser *Phyllomacromia picta* in the Kruger National Park and surrounding areas. The Violet Dropwing has been recorded in 16 of the 52 QDGCs which intersect with the Kruger National Park and the Darting Cruiser in eight. The distribution beyond the Kruger National Park is displayed in these maps.

Conclusions and recommendations

This paper has aimed to highlight the contents of the OdonataMAP database, in relation to the Kruger National Park, providing a snapshot from April-May 2018. But it also provides the tools to enable users (1) to obtain up-to-date species distribution maps for the dragonflies and damselflies of the Kruger National Park, and (2) to obtain up-to-date species lists on the scale of the quarter degree grid cell. These maps and lists are extracted "on the fly" from the live database for the project when the queries are made.

These distribution maps and species lists can only be comprehensive if the OdonataMAP database contains the entire knowledge base. One of the concerns of the second decade of the 21st century is the proliferation of a variety of biodiversity data collection initiatives. This serves to split (and confuse) the citizen scientist community, which is in any event small, and to generate a diversity of databases which do not communicate with each other, and ultimately result in products such as those produced within this system being incomplete. The OdonataMAP database (supplemented by the Odonata Data Base of Africa (Clausnitzer *et al.* 2012, Dijkstra 2016) which contains the overwhelming majority of specimen records in museum collections, and the observations of taxon specialists), is currently the most reliable and up to date database of the Odonata in Africa, and growing rapidly (Underhill *et al.* 2016).

We are seeking suggestions for additional resources which would be perceived valuable. For example, both managers and citizen scientists might be interested in a species map which shows the time elapsed, in appropriate units, since the species was recorded in each grid cell. From a management perspective, if a pattern emerges, it is a warning that a species is becoming hard to locate in an area, and that it might be going extinct there. From the citizen scientist perspective, this knowledge provides an incentive of which species need to be "refreshed" in each grid cell. Another example might be a table which shows the median date of the records from each quarter degree grid cell. From both management and citizen scientist perspective, this provides guidance as to where observer effort should be focused.

How can these data be used for annual monitoring of Odonata in the Kruger National Park? Because the bulk of the records are made by citizen scientists it is difficult to impose a strict protocol on data collection. However, with some ingenuity, it ought to be feasible to encourage citizen scientists, cumulatively, to visit as many grid cells as they are able, and to use these data some form of occupancy modelling to estimate changes in distribution and seasonality through time. There is a natural annual pattern to the occurrence of adult dragonflies and damselflies, with a winter lull. This annual cycle can be used to plan citizen scientist data collection strategies for the upcoming summer.

Given the hazards of doing fieldwork in the presence of dangerous wild animals (and in fact the understandable prohibition on this by SANParks for citizen scientists), it is not going to be feasible to undertake a complete survey of the distribution of dragonflies and damselflies of the Kruger National Park. It is therefore sensible to think in terms of using species distribution models to achieve this (Elith & Leathwick 2009, Franklin 2009, Guisan *et al.* 2013). Although in this paper, the data have been summarized in terms of quarter degree grid cells, the overwhelming majority of the individual records are georeferenced. This means that it is possible to use a species distribution model system such as MaxEnt to generate plausible distributions of species (Elith *et al.* 2011).

Finally, this paper ends up effectively being a motivation for the proclamation of the Kruger National Park, or at least its river and wetland systems, as a "Wetland of International Importance" in terms of the Ramsar Convention (Ramsar Convention on Wetlands 2016). About two-thirds of the Odonata ever recorded in South Africa have been recorded here. About one-eighth of the Odonata of the continent of Africa have been recorded in the Kruger National Park.

Acknowledgements

The primary acknowledgement needs to be attributed to the people who collected the data, both professional entomologists and citizen scientists. We acknowledge funding support from the JRS Biodiversity Foundation. Many people commented on earlier drafts.

References

Balinsky BI 1965. A preliminary list of the dragonflies (Odonata) of the Kruger National Park. Koedoe 8: 95-96.

Clark TE, Samways MJ 1994. An inventory of the damselflies and dragonflies (Odonata) of the Kruger National Park, with three new South African records. African Entomology 2: 61-64.

Clark TE, Samways MJ 1996. Dragonflies (Odonata) as indicators of biotope quality in the Kruger National Park, South Africa. Journal of Applied Ecology 33: 1001-1012.

Clausnitzer V, Dijkstra K-DB, Koch R, Boudot J-P, Darwall WRT, Kipping J, Samraoui B, Samways MJ, Simaika JP, Suhling F 2012. Focus on African freshwaters: hotspots of dragonfly diversity and conservation concern. Frontiers in Ecology and the Environment 10: 129-134

Dijkstra, K-DB 2016. African Dragonflies and Damselflies Online. (Version 1 July 2016). Available online at http://addo.adu.org.za .

Elith J, Leathwick JR 2009. Species distribution models: ecological explanation and prediction across space and time. Annual Review of Ecology, Evolution and Systematics 40: 677-697.

Elith J, Phillips SJ, Hastie T, Dud KM, Chee YE, Yates CJ 2011. A statistical explanation of MaxEnt for ecologists. Diversity and Distributions 17: 43-57.

Franklin J 2009. Mapping Species Distributions: Spatial Inference and Prediction. Cambridge University Press, Cambridge, UK.

Guisan A, Tingley R, Baumgartner JB, Naujokaitis-Lewis I, Sutcliffe PR, Tulloch AIT, Regan TJ, Brotons L, McDonald-Madden E, Mantyka-Pringle C, Martin TG, Rhodes JR, Maggini R, Setterfield SA, Elith J, Schwartz MW, Wintle BA, Broennimann O, Austin M, Ferrier S, Kearney MR, Possingham HP, Buckley, YM 2013. Predicting species distributions for conservation decisions. Ecological Letters 16:1424-1435.

Paynter D, Nussey W 1986. Die Krugerwildtuin in Woord en Beeld. Macmillan Suid-Afrika, Johannesburg.

Ramsar Convention on Wetlands 2016. An Introduction to the Ramsar Convention on Wetlands. Ramsar Convention Secretariat, Gland, Switzerland.

SANParks 2016. South African National Parks. Kruger National Park: Introduction. Retrieved from https://www.sanparks.org/parks/kruger/ on 5 October 2016.

Schouteden H 1934. Les Odonata des Congo Belge. Annales Musée Congo Belge. Zoologie Serie 3 Section 2. Catalogue Raisonnés de la Fauna Entomolgique du Congo Belge Tome 3, Fascicule 1: 1-84.

Stevenson-Hamilton J 1993. South African Eden: The Kruger National Park 1902-1946. Struik Publishers, Cape Town.

Tarboton W, Tarboton M 2015. A Guide to Dragonflies and Damselflies of South Africa. Struik Nature, Cape Town.

Underhill LG, Navarro R, Manson AD, Labuschagne JP, Tarboton WR 2016. OdonataMAP: progress report on the atlas of the dragonflies and damselflies of Africa, 2010-2016. Biodiversity Observations 7.47: 1-10. Available online at http://bo.adu.org.za/content.php?id=240

Elith J, Leathwick JR 2009a. Species distribution models: ecological explanation and prediction across space and time. Annual Review of Ecology, Evolution and Systematics 40: 677-697.

Franklin J 2009. Mapping Species Distributions: Spatial Inference and Prediction. Cambridge University Press, Cambridge, UK.

Table 1: The codes for the Quarter Degree Grid Cells (QDGC) which fall fully or partly within the Kruger National Park (KNP). The column headed "% in KNP" provides an estimate of the percentage of the QDGC which lies inside the KNP.

QDGC and name	% in KNP
2230DB HAMAKUYA	17
2230DD KA-XIKUNDU	16
2231AC MABILIGWE	44
2231AD PAFURI	12
2231CA PUNDA MARIA	99
2231CB MACHAYIPAN	50
2231CC DZUNDWINI	100
2231CD SHINGOMENI	83
2231DC	0
2330BB SHANGONI	28
2330BD NSAMA	2
2331AA SHIGOMANE	100
2331AB SHINGWIDZI	100
2331AC NALATSI	91
2331AD DZOMBO	100
2331BA SHINGWIDZI (EAST)	16
2331BC KOSTINI	22
2331CA MAHLANGENI	50
2331CB NGODZI	100
2331CC PHALABORWA	35
2331CD MASORINI	100
2331DA SHILOWA	67
2331DC LETABA	97
2331DD GORGE	19
2431AA GRIETJIE	5
2431AB ROODEKRANS	53
2431AD ORPEN	37
2431BA BALULE	100
2431BB BANGU	62
2431BC MASALA	100
2431BD SATARA	96
2431CB MANYELETI	7
2431CC BOSBOKRAND	0
2431CD NEWINGTON	9
2431DA RIPAPE	77
2431DB LINDANDA	100
2431DC SKUKUZA	63
2432CC TSHOKWANA	5
2531AA KIEPERSOL	14
2531AB PRETORIUSKOP	100
2531AC WITRIVIER	0
2531AD GUTSHWA	85
2531BA DUBE	100
2531BB ONDER-SABIE	100
2531BC HECTORSPRUIT	67
2531BD KOMATIPOORT	46
2531CB KAAPMUIDEN	3
2532AA ONDER-SABIE	12
2532AC KOMATIPOORT	4

Table 2: Species of Odonata recorded in the 52 quarter degree grid cells (Table 1) which intersect with the Kruger National Park, South Africa. The cut-off date is 1980; i.e. records prior to this are not included in this analysis. The number of quarter degree grid cells in which each species has been recorded is given, and n refers to the number of records in joint ADDO-OdonataMAP database for the species. The table lists 103 species.

Species code	Family	Scientific name	Common name	Grid cells	n	Most recent record
664070	Aeshnidae	*Anaciaeschna triangulifera*	Evening Hawker	1	1	2017/09/01
664120	Aeshnidae	*Anax ephippiger*	Vagrant Emperor	6	7	2014/03/29
664140	Aeshnidae	*Anax imperator*	Blue Emperor	20	41	2016/10/06
664170	Aeshnidae	*Anax speratus*	(Eastern) Orange Emperor	6	9	2012/12/06
664180	Aeshnidae	*Anax tristis*	Black Emperor	4	5	2012/12/06
664320	Aeshnidae	*Gynacantha manderica*	Little Duskhawker	1	1	2002/01/01
664470	Aeshnidae	*Pinheyschna subpupillata*	Stream Hawker	1	1	2001/01/01
660580	Calopterygidae	*Phaon iridipennis*	Glistening Demoiselle	14	34	2018/01/28
661180	Chlorocyphidae	*Platycypha caligata*	Dancing Jewel	10	28	2018/01/27
662330	Coenagrionidae	*Africallagma glaucum*	Swamp Bluet	5	8	2013/02/18
662460	Coenagrionidae	*Agriocnemis exilis*	Little Wisp	1	1	2001/01/01
662470	Coenagrionidae	*Agriocnemis falcifera*	White-masked Wisp	1	1	2013/02/18
662630	Coenagrionidae	*Azuragrion nigridorsum*	Sailing Bluet	11	22	2018/02/03
662720	Coenagrionidae	*Ceriagrion glabrum*	Common Citril	21	68	2018/03/16
662790	Coenagrionidae	*Ceriagrion suave*	Suave Citril	1	2	2014/03/29
663100	Coenagrionidae	*Ischnura senegalensis*	Tropical Bluetail	18	56	2018/03/16
663670	Coenagrionidae	*Pseudagrion acaciae*	Acacia Sprite	18	52	2017/08/07
663710	Coenagrionidae	*Pseudagrion coeleste*	Catshead Sprite	2	2	2015/10/13
663720	Coenagrionidae	*Pseudagrion commoniae*	Black Sprite	18	43	2014/05/04
663360	Coenagrionidae	*Pseudagrion gamblesi*	Great Sprite	7	15	2016/07/12
663410	Coenagrionidae	*Pseudagrion hageni*	Painted Sprite	4	10	2017/01/27
663780	Coenagrionidae	*Pseudagrion hamoni*	Swarthy Sprite	23	91	2018/03/16
663460	Coenagrionidae	*Pseudagrion kersteni*	Powder-faced Sprite	16	35	2017/01/23
663820	Coenagrionidae	*Pseudagrion massaicum*	Masai Sprite	17	72	2017/12/01
663560	Coenagrionidae	*Pseudagrion salisburyense*	Slate Sprite	7	10	2015/11/23
663870	Coenagrionidae	*Pseudagrion sjoestedti*	Variable Sprite	6	11	2014/03/28
663880	Coenagrionidae	*Pseudagrion sublacteum*	Cherry-eye Sprite	19	58	2018/01/27
663890	Coenagrionidae	*Pseudagrion sudanicum*	Blue-sided Sprite	5	17	2017/10/07
664550	Gomphidae	*Cerato-gomphus pictus*	Common Thorntail	1	1	2006/12/12
664640	Gomphidae	*Creni-gomphus hartmanni*	Clubbed Talontail	9	16	2016/05/17
664770	Gomphidae	*Gomphidia quarrei*	Southern Fingertail	3	6	2016/12/27
664830	Gomphidae	*Ictino-gomphus ferox*	Common Tigertail	16	51	2018/01/28
664880	Gomphidae	*Lestino-gomphus angustus*	Spined Fairytail	4	5	2012/11/24
665300	Gomphidae	*Neuro-gomphus zambeziensis*	Zambezi Siphontail	4	10	2017/12/08
665480	Gomphidae	*Notogomphus praetorius*	Yellowjack Longleg	1	1	2013/01/25
665640	Gomphidae	*Onycho-gomphus supinus*	Lined Claspertail	1	1	2002/01/01
665740	Gomphidae	*Paragomphus cognatus*	Rock Hooktail	4	6	2017/01/23
665780	Gomphidae	*Paragomphus elpidius*	Corkscrew Hooktail	10	15	2018/01/27
665790	Gomphidae	*Paragomphus genei*	Common Hooktail	17	36	2017/11/18
665840	Gomphidae	*Paragomphus magnus*	Great Hooktail	5	6	2017/03/20
665890	Gomphidae	*Paragomphus sabicus*	Flapper Hooktail	5	9	2018/01/14
666070	Gomphidae	*Phyllogom-phus selysi*	Bold Leaftail	3	4	2018/02/20
660410	Lestidae	*Lestes pallidus*	Pallid Spreadwing	7	8	2017/11/21
660360	Lestidae	*Lestes plagiatus*	Highland Spreadwing	5	10	2018/01/30
660330	Lestidae	*Lestes tridens*	Spotted Spreadwing	2	2	2002/01/01
660370	Lestidae	*Lestes uncifer*	Sickle Spreadwing	5	5	2018/03/23
660300	Lestidae	*Lestes virgatus*	Smoky Spreadwing	1	2	2013/02/18
666750	Libellulidae	*Acisoma inflatum*	Stout Pintail	3	3	2017/01/20
666770	Libellulidae	*Acisoma variegatum*	Slender Pintail	4	12	2018/03/16
666920	Libellulidae	*Aethriamanta rezia*	Pygmy Basker	1	1	1992/01/01
667020	Libellulidae	*Brachythemis lacustris*	Red Groundling	16	50	2018/01/27
667030	Libellulidae	*Brachythemis leucosticta*	Southern Banded Groundling	29	175	2018/03/22
667060	Libellulidae	*Bradinopyga cornuta*	Horned Rockdweller	10	15	2018/03/16
667090	Libellulidae	*Chalcostephia flavifrons*	Inspector	2	32	2018/02/04
667130	Libellulidae	*Crocothemis erythraea*	Broad Scarlet	29	143	2018/03/16
667140	Libellulidae	*Crocothemis sanguinolenta*	Little Scarlet	7	12	2015/10/09

Table continues on the next page

Table 2: Continued

Species code	Family	Scientific name	Common name	Grid cells	n	Most recent record
667200	Libellulidae	*Diplacodes lefebvrii*	Black Percher	15	42	2018/03/22
667210	Libellulidae	*Diplacodes luminans*	Barbet Percher	14	22	2018/03/22
667380	Libellulidae	*Hemistigma albipunctum*	African Piedspot	5	11	2017/09/01
667690	Libellulidae	*Nesciothemis farinosa*	Eastern Blacktail	21	105	2018/02/04
667730	Libellulidae	*Notiothemis jonesi*	Eastern Forest-watcher	3	4	2012/12/06
667760	Libellulidae	*Olpogastra lugubris*	Bottletail	4	5	2017/11/29
667780	Libellulidae	*Orthetrum abbotti*	Little Skimmer	2	2	2012/12/06
667830	Libellulidae	*Orthetrum brachiale*	Banded Skimmer	1	1	2014/03/29
667860	Libellulidae	*Orthetrum caffrum*	Two-striped Skimmer	1	1	2007/01/27
667900	Libellulidae	*Orthetrum chrysostigma*	Epaulet Skimmer	24	91	2018/01/28
667930	Libellulidae	*Orthetrum hintzi*	Dark-shouldered Skimmer	3	4	2017/11/01
667940	Libellulidae	*Orthetrum icteromelas*	Spectacled Skimmer	1	1	2011/03/07
667950	Libellulidae	*Orthetrum julia*	Julia Skimmer	13	45	2018/02/04
668000	Libellulidae	*Orthetrum machadoi*	Highland Skimmer	3	27	2018/02/20
668110	Libellulidae	*Orthetrum stemmale*	Bold Skimmer	9	36	2018/02/20
668120	Libellulidae	*Orthetrum trinacria*	Long Skimmer	19	43	2018/01/30
668180	Libellulidae	*Palpopleura deceptor*	Deceptive Widow	4	16	2014/05/04
668190	Libellulidae	*Palpopleura jucunda*	Yellow-veined Widow	5	7	2014/05/02
668200	Libellulidae	*Palpopleura lucia*	Lucia Widow	22	68	2018/02/20
668210	Libellulidae	*Palpopleura portia*	Portia Widow	10	21	2017/11/26
668230	Libellulidae	*Pantala flavescens*	Wandering Glider	22	61	2018/01/28
668370	Libellulidae	*Rhyothemis semihyalina*	Phantom Flutterer	8	15	2016/04/11
668420	Libellulidae	*Sympetrum fonscolombii*	Red-veined Darter or Nomad	4	4	2014/04/27
668540	Libellulidae	*Tetrathemis polleni*	Black-splashed Elf	8	15	2018/02/03
668600	Libellulidae	*Tholymis tillarga*	Twister	1	1	2012/02/10
668620	Libellulidae	*Tramea basilaris*	Keyhole Glider	13	17	2018/01/31
668630	Libellulidae	*Tramea limbata*	Ferruginous Glider	10	13	2014/11/18
668740	Libellulidae	*Trithemis aconita*	Halfshade Dropwing	6	10	2018/01/30
668660	Libellulidae	*Trithemis annulata*	Violet Dropwing	16	114	2018/03/23
668670	Libellulidae	*Trithemis arteriosa*	Red-veined Dropwing	33	167	2018/01/30
668800	Libellulidae	*Trithemis donaldsoni*	Denim Dropwing	7	8	2017/01/23
668870	Libellulidae	*Trithemis dorsalis*	Highland Dropwing	2	2	2016/02/02
668890	Libellulidae	*Trithemis furva*	Navy Dropwing	3	6	2017/01/27
669120	Libellulidae	*Trithemis kirbyi*	Orange-winged Dropwing	33	144	2018/03/17
668900	Libellulidae	*Trithemis pluvialis*	Russet Dropwing	3	9	2016/06/07
669080	Libellulidae	*Trithemis stictica*	Jaunty Dropwing	5	5	2015/03/14
669130	Libellulidae	*Trithemis werneri*	Elegant Dropwing	7	26	2018/03/15
669180	Libellulidae	*Urothemis assignata*	Red Basker	10	22	2016/05/18
669190	Libellulidae	*Urothemis edwardsii*	Blue Basker	8	13	2016/04/11
669250	Libellulidae	*Zygonoides fuelleborni*	Southern Riverking	9	13	2016/12/27
669390	Libellulidae	*Zygonyx natalensis*	Blue Cascader	7	12	2017/11/29
669420	Libellulidae	*Zygonyx torridus*	Ringed Cascader	16	24	2014/05/04
666420	Macromiidae	*Phyllomacro-mia contumax*	Two-banded Cruiser	7	9	2014/05/01
666620	Macromiidae	*Phyllomacro-mia picta*	Darting Cruiser	8	10	2017/12/01
661480	Platycnemididae	*Allocnemis leucosticta*	Goldtail	2	3	2015/03/14
661810	Platycnemididae	*Elattoneura glauca*	Common Threadtail	13	37	2018/01/30
661640	Platycnemididae	*Mesocnemis singularis*	Common (Forest/ Savanna) Riverjack	9	13	2017/01/23

Table 3: The number of species recorded in each of the 41 quarter degree grid cells intersecting with the Kruger National Park which have Odonata data. The quarter degree grid cell code is provided, the number of species recorded, and the number of records of these species (records identified to species level: "Records to species"). Because of the difficulty of making identifications of species with certainty from photographs, some records are identified to genus or family (Number of taxa: "Taxa"). The final column gives the total number of records for the grid cell in the database.

QDGC and name	No. of species	Records to species	Taxa	Total records
2230DB HAMAKUYA	36	58	37	59
2231AC MABILIGWE	42	69	46	75
2231AD PAFURI	48	122	48	122
2231CA PUNDA MARIA	30	77	31	78
2231CC DZUNDWINI	20	46	21	48
2231CD SHINGOMENI	15	20	16	21
2331AB SHINGWIDZI	28	77	30	79
2331AD DZOMBO	3	7	4	8
2331BA SHINGWIDZI (OOS)	9	11	12	15
2331BC KOSTINI	11	18	12	19
2331CA MAHLANGENI	8	8	8	8
2331CB NGODZI	25	112	27	117
2331CC PHALABORWA	8	16	9	17
2331CD MASORINI	7	10	8	12
2331DA SHILOWA	4	5	5	6
2331DC LETABA	45	194	48	197
2331DD GORGE	4	9	4	9
2431AA GRIETJIE	42	258	48	291
2431AB ROODEKRANS	3	3	3	3
2431AD ORPEN	3	3	5	5
2431BA BALULE	29	88	33	95
2431BB BANGU	21	27	22	29
2431BC MASALA	13	16	13	16
2431BD SATARA	25	52	27	54
2431CB MANYELETI	20	35	24	40
2431CC BOSBOKRAND	9	10	10	11
2431CD NEWINGTON	47	154	53	167
2431DA RIPAPE	5	6	5	6
2431DB LINDANDA	4	4	4	4
2431DC SKUKUZA	60	244	66	253
2431DD TSHOKWANA	55	133	58	138
2531AA KIEPERSOL	59	211	64	218
2531AB PRETORIUSKOP	8	13	9	14
2531AC WITRIVIER	25	49	28	54
2531AD GUTSHWA	21	37	24	47
2531BA DUBE	12	16	12	16
2531BB ONDER-SABIE	44	101	48	105
2531BC HECTORSPRUIT	54	152	58	158
2531BD KOMATIPOORT	50	370	57	394
2531CB KAAPMUIDEN	51	114	51	114
2532AA ONDER-SABIE	1	1	1	1

Table 4: Papers which focus on reviews of the Odonata (dragonflies and damselflies) of the Kruger National Park.

Reference	Summary
Balinsky BI 1965. A preliminary list of the dragonflies (Odonata) of the Kruger National Park. Koedoe 8: 95-96	Based on a total of 84 specimens collected in the Kruger National Park, this paper provided a list of 21 species. At the end of this Balinsky provides reasons why "the present list includes only a small fraction of the dragonfly species occurring in the Park."
Clark TE, Samways MJ 1994. An inventory of the damselflies and dragonflies (Odonata) of the Kruger National Park, with three new South African records. African Entomology 2: 61-64	Using the list by Balinsky (1065) as baseline, made three decades previously, records made by other researchers, and their own data from a study of the Odonata along the Sabie River, the authors extended the list to 81.
Clark TE, Samways MJ 1996. Dragonflies (Odonata) as indicators of biotope quality in the Kruger National Park, South Africa. Journal of Applied Ecology 33: 1001-1012	This paper demonstrated how the Odonata can be used to undertake biomonitoring of the Sabie River. Ten "biotopes" (waterbody types) were identified, and the Odonata species characteristic of each were identified using multivariate statistical methods.