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## Introduction

Developing an effective and efficient conservation effort for any form of wildlife requires a good understanding of the current distribution of the species in question (Gibbons et al. 2007; Harrison et al. 2008). Simply put, knowing where a species is found is the first and most basic information needed to protect it.

The Kenya Bird Map project (http://kenyabirdmap.adu.org.za) builds upon the knowledge base gathered from the Bird Atlas of Kenya (Lewis & Pomeroy 1989) and seeks to determine the current distribution of all the bird species of Kenya in order to provide a foundation for their conservation. This ambitious and important initiative is made possible by the valuable input of volunteer birders, or citizen scientists, across the country.

Data collection for Kenya Bird Map applies the same protocol and methodology used by the Second Southern African Bird Atlas Project (SABAP2) (Underhill 2016). This robust but simple methodology allows easy comparison between years or regions and provides a standardised dataset which can be manipulated to answer many relevant conservation questions. In particular, data from Kenya Bird Map will highlight changes in distribution from that recorded in the Bird Atlas of Kenya. The fieldwork for this project was conducted mainly between 1970 and 1984, more than three decades ago. Kenya Bird Map will also provide a firm basis for making informed land management decisions for conservation.

Three years have passed since the Kenya Bird Map office opened at the beginning of 2014. This progress report reviews what the project has achieved from its inception up to 31 December 2016 with a focus on the coverage achieved, the number of records submitted and the engagement of citizen scientists.

## Coverage and Progress

By the end of 2016, Kenya's bird mappers had visited and filled at least one 'full protocol' species checklist[1] for 11.4% of the 6,817 pentads[2] covering Kenya. A total of 2,607 full protocol checklists had been submitted containing 113,371 records of bird distribution (Table 1). The landmark of 10% pentad coverage was achieved on 16 September 2016. The 5% mark had been reached almost exactly a year earlier, on 15 September 2015. This first milestone took approximately one year and nine months at an average rate of about 16 new pentads per month. The second 5% therefore took nine months less than the first at a rate of approximately 28 pentads per month.

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[1] A 'full protocol' checklist is a checklist of all bird species positively identified in a period of at least two hours of focused birding within a single pentad. The species are listed in the order in which they were encountered. The two-hour minimum can be reached in several sessions spread over a maximum of five days.

[2] Kenya Bird Map uses a grid cell system based on latitude and longitude. A pentad is the area enclosed by a grid cell consisting of five minutes of latitude north-south by five minutes of latitude east-west. On the equator, the side of each pentad measures c. 9 km.

*Table 1: Summary statistics for Kenya Bird Map at the end of 2014, 2015 and 2016. The percentage pentad coverage achieved within each respective year is also shown.*

| Year | No. of obser-vers | Check-lists | Records | Pen-tads | Average checklists per observer | Aver-age records per checklist | % Cover-age |
|---|---|---|---|---|---|---|---|
| 2014 | 84 | 463 | 22,610 | 182 | 5.5 | 49 | 2.7% |
| 2015 | 93 | 870 | 36,365 | 310 | 9.4 | 42 | 4.6% |
| 2016 | 109 | 1,189 | 50,362 | 554 | 9.2 | 42 | 8.1% |
| Total† | 186 | 2,607 | 113,371 | 777 | 7.1 | 43 | 11.4% |

†*includes some records from earlier years*

Annual pentad coverage within each year has increased annually, from 2.7% in 2014 to 4.6% in 2015 and to 8.1% in 2016 (Table 1). Notably, 2016 coverage was almost double that of 2015 and almost triple what was achieved in 2014 (Table 1). On average, 46.2 pentads were visited in each month of 2016.

The increase in pentad coverage was largely made possible by the introduction of the BirdLasser mobile app for Android devices in January 2016. The app has made it easier to identify pentad boundaries and to keep a note of the time spent observing. It also reduced the time and cost spent by observers in submitting records via a computer, a notable issue for many of Kenya's citizen scientists.

The average number of checklists submitted per observer was 5.5 in 2014 and increased to 9.4 in 2015 (Table 1). The number of checklists per person in the first nine months of 2016 peaked at 9.7 but fell away to 9.2 by the end of December. There was therefore a strong increase in submissions between 2014 and 2015 and, in spite of a larger number of participants in 2016, mapping effort remained the same.

The increase in checklists per person would be even more striking but for the boost to mapping in 2015 from grants generously provided by the Swiss Embassy and Imarisha Naivasha. This enabled several mapping expeditions which increased the number of checklists submitted between August and September 2015.

In 2016 marked peaks in numbers of checklists submitted occurred in April, July, September and to a lesser extent in November (Figures 1 and 2). The April peak is likely to have been a result of the Fundamentals of Ornithology Course where a lot of effort was put into training and enthusing birders to get involved with the atlas. The effect was an immediate increase followed by a drop in submission rate. The later peaks resulted from competitions that were organised by the Kenya Bird Map office with rewards for the atlaser who submitted the most checklists in the month. The immediate effect was again clearly successful but it led to an immediate post-competition 'drought' in record submission.
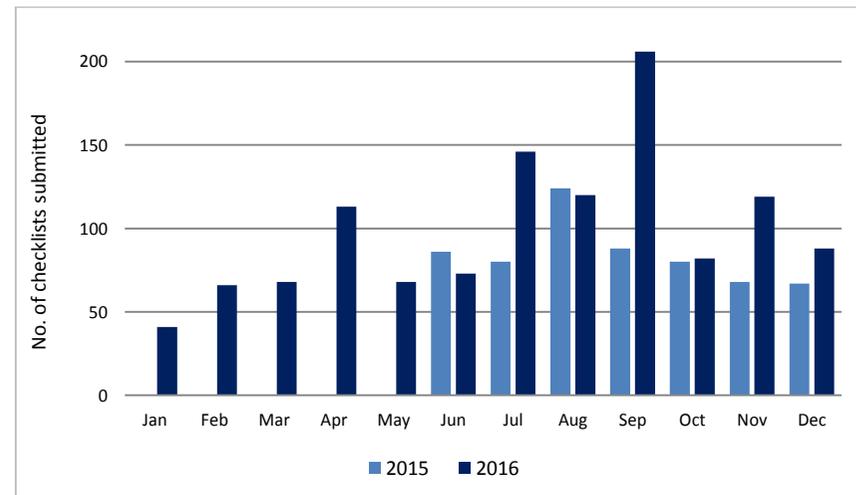


*Figure 1. Monthly submission of checklists to Kenya Bird Map between September 2015 and December 2016*
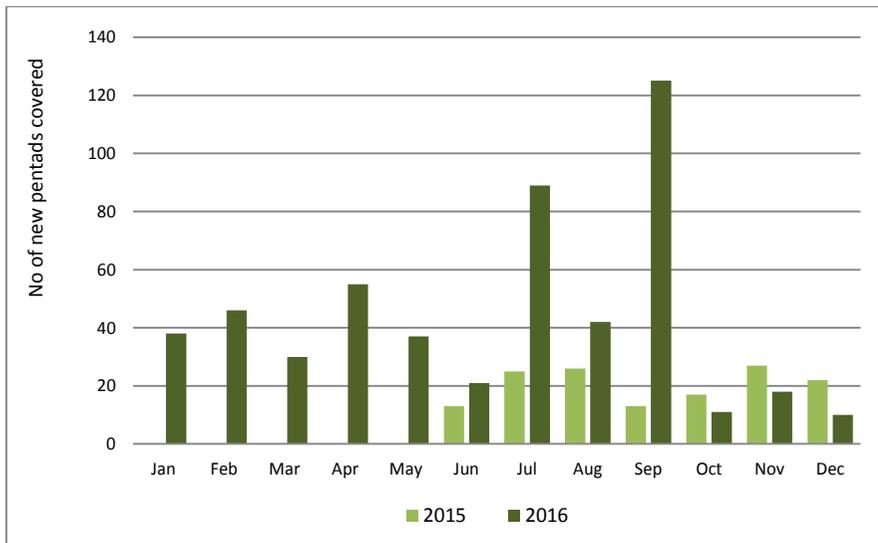
*Figure 2. Monthly number of pentads in Kenya visited between September 2015 and December 2016*

A major challenge faced by Kenya Bird Map is to maintain an increasing rate of data submission to at least a substantial threshold of submission and then to sustain that level. Offering rewards for submission has been recognised as not being effective in producing the sustained high level of submission required to produce a dataset of sufficient coverage to allow for full analysis. Rather it tends to lead to a sharp peak of activity followed by a marked trough. Furthermore, there is the greater risk of competitors inventing species just in order to win with a longer list. These are the key reasons competitions have been avoided with the Second Southern African Bird Atlas Project (SABAP2) (M. Brooks pers. comm.).
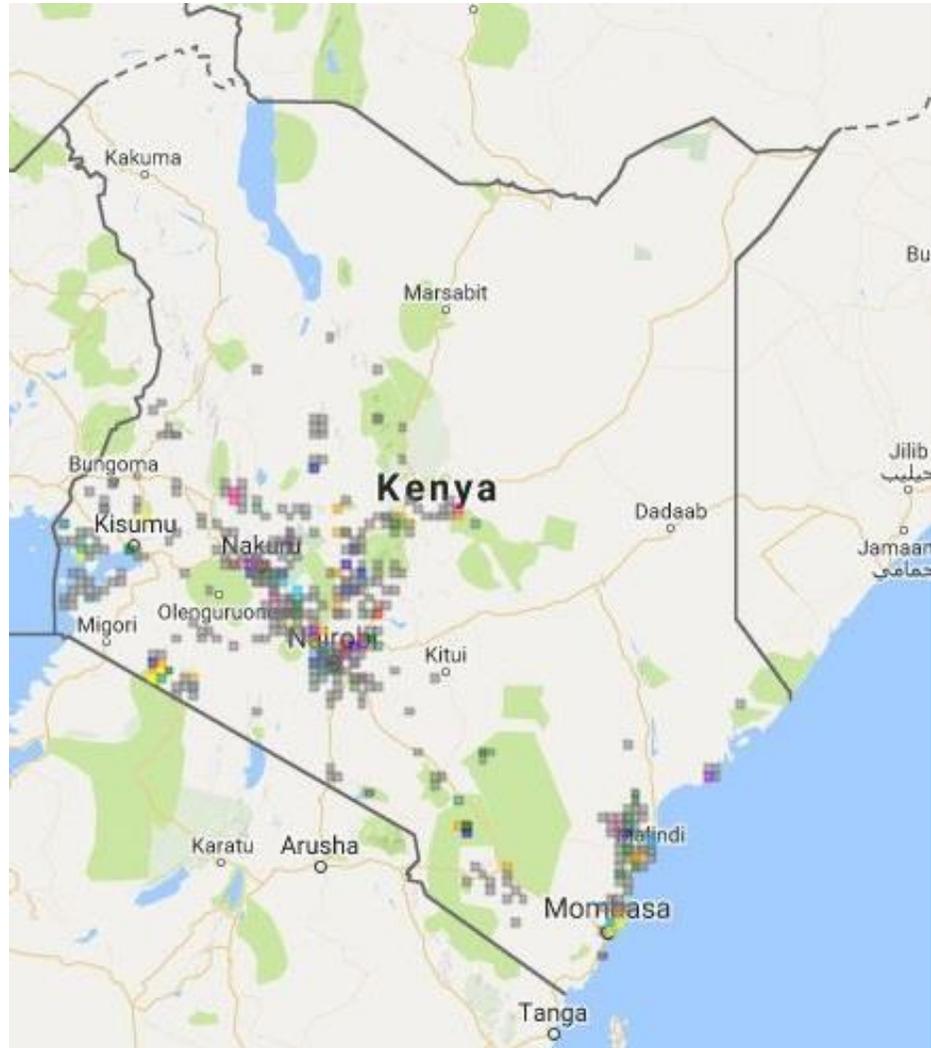


*Figure 3: The preliminarily distribution map for the Red-eyed Dove* Streptopelia semitorquata *in Kenya, as at December 2016.*

## Current species distribution maps

With 11.4% pentad coverage at the end of December 2016, new distribution maps of Kenya's birds have started to take shape and show the range and the extent of distribution for at least the more common species. As a result, a 'Species summaries' option was added in late 2016 to the main menu of the Kenya Bird Map website. This allows the user to view a current distribution map of any bird species in Kenya with regard to records that have so far been submitted and accepted to the project. Under the 'Species summaries' menu, species are arranged alphabetically to make it easy to track those of interest. Clicking on the species of choice brings up a map of Kenya with coloured pentads/squares where the species have been reported (Figure 3). Zooming out on the website reveals a distribution map of all accepted records for that species elsewhere in Africa.

Currently many pentads are coloured grey for even a common species such as Red-eyed Dove (Figure 3) because most pentads have been covered only once. Once at least four checklists are submitted from the a pentads, it is displayed in a colour representing a reporting rate. This will allow the production of a reporting rate map showing 'hot spots' and 'cold spots' for that species.

## Pattern of Coverage

Unsurprisingly, coverage is stronger in some areas than in others, with many records submitted from around major settlements and birding 'hot spots' such as the national parks and the more accessible lakes such as Naivasha. As would be expected, the Nairobi area with the highest concentration of birders in Kenya, is well covered with most of the pentads having more than four checklists each. Nairobi thus forms the focus of coverage for central Kenya. The weekly Nature Kenya Wednesday Bird Walk led by Fleur Ng'weno has also played a major role in contributing to the Nairobi area coverage. Pentad 0115_3645, which covers most of the city is one of the most intensively mapped

pentads in Kenya with more than 100 full protocol checklists. 203 bird species have been recorded within the boundaries of this single pentad.

Excellent progress has also been made at the coast of Kenya, and especially within the major Important Bird Areas, which are also birding 'hot spots' (Dakatcha Woodland, Arabuko-Sokoke Forest, Mida Creek, Gede Ruins and Sabaki River Mouth). Most of the pentads within these Important Bird Areas have at least one checklist. Pentad 0355_3940 (Mtwapa) has 142 full protocol checklists submitted, the highest number in the country. More than half have been submitted by a single observer, Doris Schaule. This level of coverage is extremely valuable, because it enables changes in the bird community composition to be detected through time. As mapping efforts improve each year for all pentads falling within Important Bird Areas, the Kenya Bird Map will become an important tool for monitoring bird populations in relation to habitat change in these conservation areas.

In Western Kenya, the Bondo and Siaya areas north of Lake Victoria are also well covered. Most of the mapping of this region has been carried out by three observers (Rick Ludkin, Dan Odhiambo and Brian Ochiango) from the Matangwe Bird Club.

Several major national parks or birding sites have 100% coverage, with some pentads having more than four checklists which is the preferred foundational level of coverage to allow for robust statistical analysis of the data. These include Nairobi National Park, Lake Nakuru National Park and Lake Naivasha. Continued repeat submissions of full protocol checklists for these sites will create a substantial dataset for monitoring avian populations in the parks in addition to providing a comprehensive list of species occurring there.

Coverage in poorly populated and inaccessible areas especially in the north and northeast of Kenya remains a key challenge for the Kenya Bird Map. These areas have received close to zero mapping attention.

We encourage birders travelling to these regions to make every effort to complete both full protocol and ad hoc checklists whenever they can. Bird mappers owning vehicles are also encouraged to plan group expeditions for such poorly covered areas. In-kind support from hotels and organizations is also welcome and can communicated to the Kenya Bird Map office (kenyabirdmap@naturekenya.org), which will pass it on to the many mappers who are always more than willing to travel to such areas.

## Citizen scientists involved

By the end of December 2016 622 people had registered with the project as citizen scientists. Of these 186 (30%) had actually contributed one or more checklists to the Kenya Bird Map database. The average number of full protocol checklists submitted by each observer is 14, with an average of 43 bird records each (Table 1). Sixteen observers had submitted over 50 full protocol checklists by the end of 2016 totalling 54% of the 2,607 checklists submitted. The top five contributors are Doris Schaule (231 checklists from 47 pentads), Dominic Chesire (145:87), Sidney Shema (125:38), Colin Jackson (104:65), the Nature Kenya Wednesday Bird Walk (87:8) and Peter Wairasho (86:75). The top 30 observers are listed in Table 2.

With 30% of registered observers having actually submitted records to the project, the majority (70%) have shown interest but lacked the motivation, understanding or opportunity to actually get into the field, see, record and submit records of birds. This remains a challenge that has also been reflected in SABAP2 (M. Brooks pers. comm.) and is likely to be a common feature of citizen science projects. The challenge for project management is how to catalyse registered observers who would appear to have some interest to actually begin to contribute data.

*Table 2: The 30 observers (plus Nature Kenya Wednesday Bird Walk) with the largest number of full protocol checklists submitted since the beginning of the Kenya Bird Map up to September 2016*

| Observer | No. of check-lists | Pentads Covered | Observer | No. of check-lists | Pentads Covered |
|---|---|---|---|---|---|
| Doris Schaule | 231 | 47 | Brian Ochiago | 44 | 11 |
| Dominic Chesire | 145 | 87 | Kassim Shitawa | 42 | 28 |
| Sidney Shema | 125 | 44 | Titus Imboma | 39 | 27 |
| Colin Jackson | 104 | 65 | Gabriel Katana | 38 | 16 |
| Nature Kenya Wednesday Bird Walk | 87 | 8 | Robert Muchunu | 35 | 19 |
| Peter Wairasho | 86 | 75 | Michael Ngala | 35 | 7 |
| Stephen Graham | 84 | 31 | Gladys Kung'u | 34 | 22 |
| Washington Wachira | 73 | 31 | Jaap Gijsbertsen | 33 | 10 |
| Dominic Kimani | 67 | 53 | Peter Njoroge | 31 | 25 |
| Dr Darcy Ogada | 65 | 37 | Fox Andreas | 30 | 27 |
| Tiampati Manei | 60 | 19 | Albert Baya | 30 | 26 |
| Elvira Wolfer | 60 | 26 | Rick Ludkin | 30 | 14 |
| Wanyoike Wamiti | 55 | 50 | Robert Lentaaya | 28 | 21 |
| Julio Mwambire | 54 | 45 | Joshua Benjamin | 27 | 19 |
| Paul Wachira | 54 | 31 | Jennifer Oduori | 27 | 6 |
| Mustafa Adamjee | 50 | 43 | | | |

## Future Targets

Kenya Bird Map has set itself three targets for the next few years:

1. To have at least one checklist for pentads in accessible areas by 2018, the fifth year of the project. Birdmappers can help to achieve this target by visiting pentads within their home areas and places of work. Home is the area most familiar to anyone and thus the easiest to move around in and to record as many species as possible.
2. To substantially increase the percentage of already registered citizen scientists who are active contributors of data.
3. To get more than one checklist for 50% of the pentads covered in the next one year. Ideally, each pentad should have a minimum of four checklists for us to have a good list of the species regularly occurring in that pentad. For checklists is also the minimum number of checklists to enable meaningful statistical analysis to be undertaken showing species abundance as well as distribution (Underhill 2016).

## Acknowledgements

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