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COMPARING REPORTING RATES BETWEEN THE FIRST AND SECOND SOUTHERN AFRICAN BIRD ATLAS PROJECT

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Introduction

A key issue in species conservation is a knowledge of the geographic ranges of species, and how these are changing through time. Accurate distribution maps and population size estimates are essential for effective conservation of species (Underhill and Gibbons 2002). We cannot conserve species properly if we do not understand their geographic range dynamics, therefore the conservation status of a species centers around three questions: "Where are they?", "How many are there?" and "What is their trend?" (Underhill and Gibbons 2002). The first bird atlas project for a region provides an answer to the first question "Where are they?" and provides data on spatial patterns of species distributions. When there is a second bird atlas project, it is possible to provide an initial answer to the third question. Trends in range can be discovered, and to some extent trends in abundance. Bird atlases are important tools in conservation and have become an influential demonstration of the power of citizen science (Greenwood 2007). Birds are useful indicators of biodiversity. Monitoring birds through atlas projects can provide information on the distribution of biological diversity and it can signal changes occurring in ecosystems.

For birds in southern Africa there is a special opportunity to undertake studies of range changes, making use of the data collected by the first and second Southern African Bird Atlas Projects (SABAP1 and SABAP2), which are separated in time by about two decades. Loftie-Eaton (2014) and Underhill and Brooks (2014) demonstrated that many species had undergone large changes in distribution over this period.

Data collected from the first Southern African Bird Atlas Project (SABAP1: 1987–1991) and the second Southern African Bird Atlas Project (SABAP2: 2007–ongoing) have shown that many of the bird species in South Africa have undergone range changes in the past 20–30 years. The objective of the bird atlas projects is to provide insight into the changing biogeographical scene (Harrison *et al.* 1997). Bird atlasing is a form of biodiversity and biological research as well as citizen science, and it should be viewed as an active and continual monitoring exercise rather than a once-off, single "snapshot" survey.

One example of a bird species for which the two bird atlas projects, SABAP1 and SABAP2, were critical in discovering that the species had undergone a major range contraction is the Secretarybird *Sagittarius serpentarius* (Hofmeyr *et al.* 2014). These authors demonstrated that the Secretarybird had shown decreases in reporting rates across much of South Africa between the two atlas projects, and that these decreases were linked to a decline in the overall population size in South Africa. Hofmeyr *et al.* (2014) developed a method for inferring changes in abundance from atlas reporting rates, with a measure of statistical significance of reporting rates. The analyses provided important insights into the conservation status of the Secretarybird in South Africa in 2013. This would not have been possible without the data collected by citizen scientists for SABAP1 and 2, highlighting the importance of projects like these.

Fig 1 – Natal Spurfowl *Pternistis natalensis*

The problems of making comparisons between SABAP1 and SABAP2 are proving more difficult than envisaged at the start of SABAP2 (Loftie-Eaton 2014, Underhill and Brooks 2014). To a large extent, the problems in the comparison between SABAP1 and SABAP2 relate to the change in scale at which data is collected, from the quarter degree grid cell (15-minute grid) to the pentad (5-minute grid) so that there are nine pentads per quarter degree grid cell. Up to now, all analyses have simply lumped the nine pentad lists together, and treated them as equivalent to the lists from SABAP1 for the quarter degree grid cell. There are multiple, but inter-related problems with this approach.

Four papers have been published in the online journal, **Ornithological Observations**, comparing data between the first and second Southern Africa Bird Atlas Projects (McKenzie 2011, De Swardt 2012, Carter 2012, Retief 2013). Each of these papers highlighted difficulties in making comparisons between the SABAP1 and SABAP2 data. Some of the difficulties relate to a change in protocol between SABAP1 and SABAP2. For SABAP1, a checklist could cover a full calendar month or less (Harrison and Underhill 1997), whereas for SABAP2 a maximum of five days is allowed and a minimum of two hours of intensive birding is required for a full protocol card. In this paper I will synthesise the problems with comparisons between the two bird atlas projects.

The difficulties with comparisons between SABAP1 and SABAP2

In SABAP1 there was no incentive to undertake complete coverage of a QDGC. In the editorial of the newsletter to SABAP1 participants that was produced four months after the start of the project there is a section of questions about participation and answers (Harrison 1988). One question asked was, "Is it worth filling in a card for a square which I only see a small part of?" and the answer was "Yes! Your card, as incomplete as it may be, will help build up a complete picture together with other cards from that square" (Harrison 1988). In other words, checklists ("cards") were welcomed even if they covered only a small part of the area of a QDGC ("square"). In reality, the "complete picture" for the QDGC did not necessarily emerge from this process, and much of the SABAP1 data for a grid cell tended to come from a subset of good birding spots within the grid cell, or the most accessible parts of it and not from the area as a whole (L.G. Underhill pers. comm.). In contrast, the primary fieldwork instructions for SABAP2 is "Spend at least two hours recording as many different species in the pentad by visiting all (or as many different) habitats as possible" (http://sabap2.adu.org.za/howto.php#4). Thus there was a fundamental shift in fieldwork protocol between the two projects.

There was no measure of observer effort in the SABAP1 data, and it is known that some lists were made from cars travelling through QDGCs at 120 km/h (30 km of road through a QDGC would therefore take 15 minutes to traverse). In addition, lists were made covering a full month, but these frequently related to a single locality within the QDGC. However, it is known that the overwhelming majority of SABAP1 lists were made during the period of a single day, and most represented several hours (1–6 hours) of intensive birding. Not having a measure of observer effort does create problems in data comparisons, however, it seems that most SABAP1 checklists are in fact compatible with SABAP2 checklists in terms of time spent doing fieldwork.

One of the ways to compare the two bird atlas projects with one another is to look at a direct comparison of the number of species recorded in QDGCs between SABAP1 and SABAP2. One can also compare the reporting rates of species between the two atlases, but it is imperative to take into account the influence that the differences in protocols, especially the time span (time spent birding) and the differently sized areas (nine pentads to one QDGC) has on the collected bird checklists.

The news item of 21 March 2013 on the SABAP2 website regarding the African Marsh-Harrier *Circus ranivorus* indicates that this species has a lower reporting rate in QDGC 3218CC for SABAP2 as compared to SABAP1. The reporting rate is the proportion of checklists on which a species is recorded, out of the total number of checklists submitted for that specific QDGC. The lower reporting rate might be true, but there could be a diluting effect of cards submitted for pentads within a QDGC where a habitat-specific species cannot be found anywhere else within the QDGC except for a very specific site.

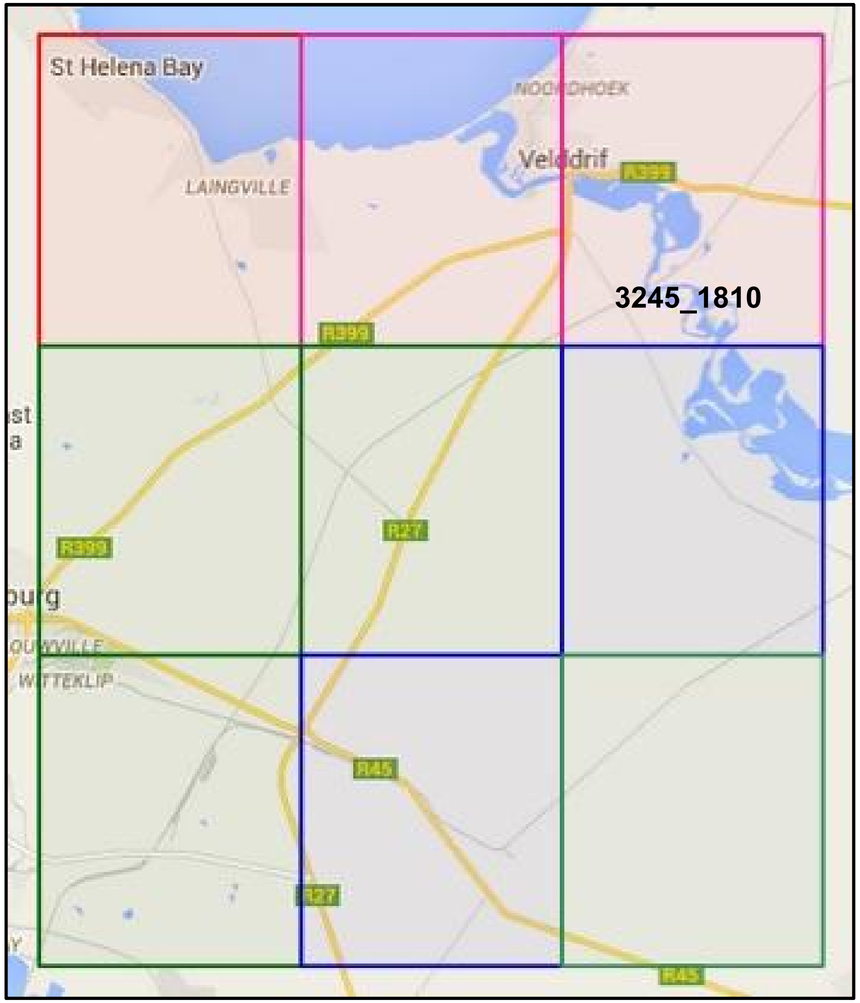

Fig 2 – Pentad 3245_1810 in relation to the other pentads within the Quarter Degree Grid Cell 3218CC (Source: www.sabap2.adu.org.za)

Example 1: African Marsh-Harrier in QDGC 3218CC near Velddrif, Western Cape Province

According to SABAP1, this QDGC had a reporting rate of 19% for the species, whereas SABAP2 indicates 13.3%. The bulk of the recordings in SABAP2 come from pentad 3245_1810 (47 records, with a 22.5% reporting rate) (cf Fig 2). This pentad within the QDGC was most likely the main hub where observations in SABAP1 for African Marsh Harrier, and other species, came from. According to observers that have been to this area before SABAP1 started, the reed beds in specific parts of this pentad near Velddrif have increased in density and have become almost inaccessible for humans, and as a consequence has in fact created more suitable habitat for the African Marsh-Harrier. There are SABAP2 records for African Marsh-Harrier in two other pentads within this QDGC, but these areas are peripheral habitat. The other six pentads within the QDGC have no records of African Marsh-Harrier and therefore play diluting roles in the comparisons between SABAP1 and SABAP2 reporting rates. It is probably not unrealistic to use the 22.5% reporting rate for African Marsh-Harrier in pentad 3245_1810 as the QDGC reporting rate for SABAP2, since this pentad is the area where atlasers in SABAP1 would have observed it.

Example 2: African Black Oystercatcher *Haematopus moquini* in QDGC 3218CB

For QDGC 3218CB the reporting rate for the African Black Oystercatcher was 68% in SABAP1. For SABAP2 the reporting rate has dropped considerably to 40.5%. This decreased reporting rate, however, can also be due to dilution of the data. There are 34 records of African Black Oystercatcher for SABAP2 in this QDGC and they are all from pentad 3235_1815 (Rocher Pan Nature Reserve, Western Cape Province). Within this pentad the African Black Oystercatcher has a 73.9% reporting rate. Observations for this species in SABAP1 were most likely made in this pentad and therefore one could argue that the 73.9% reporting rate should be used for making comparisons between SABAP1 and SABAP2.

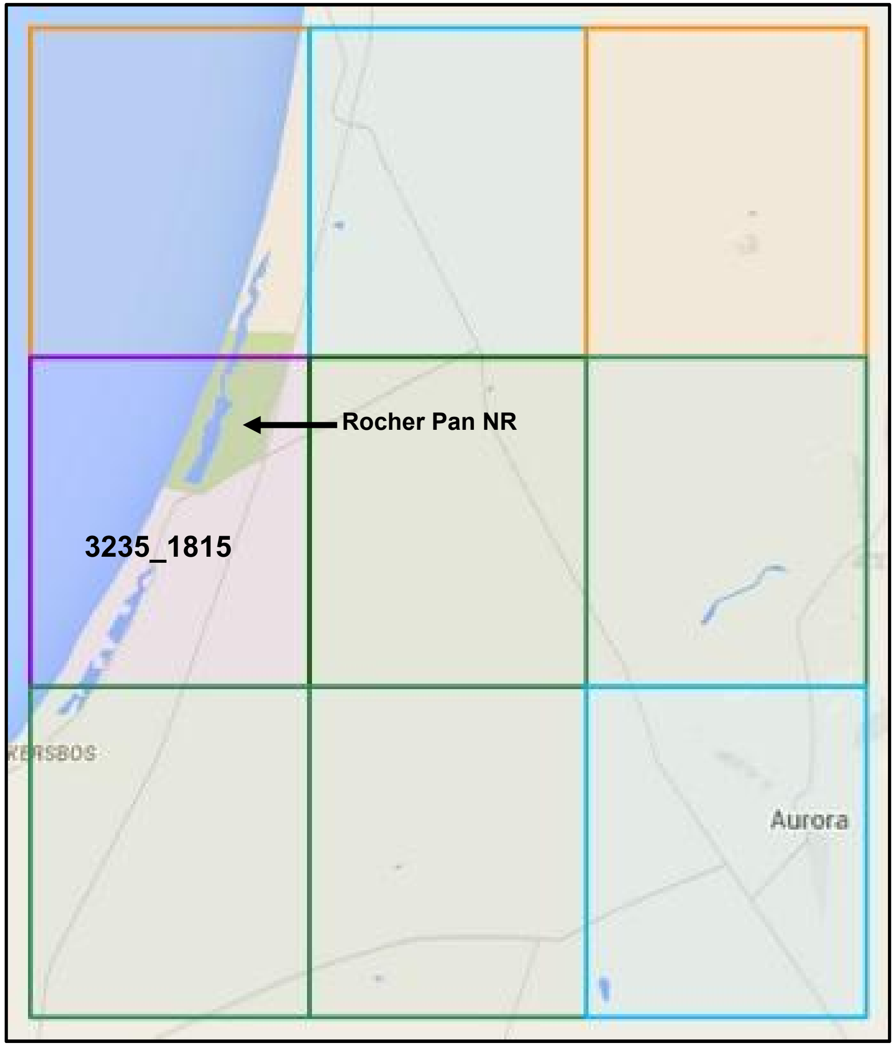

Fig 3 - Pentad 3235_1815 in relation to the other pentads within the Quarter Degree Grid Cell 3218CB (Source: www.sabap2.adu.org.za)

Fig 4 – African Black Oystercatcher © M Loftie-Eaton

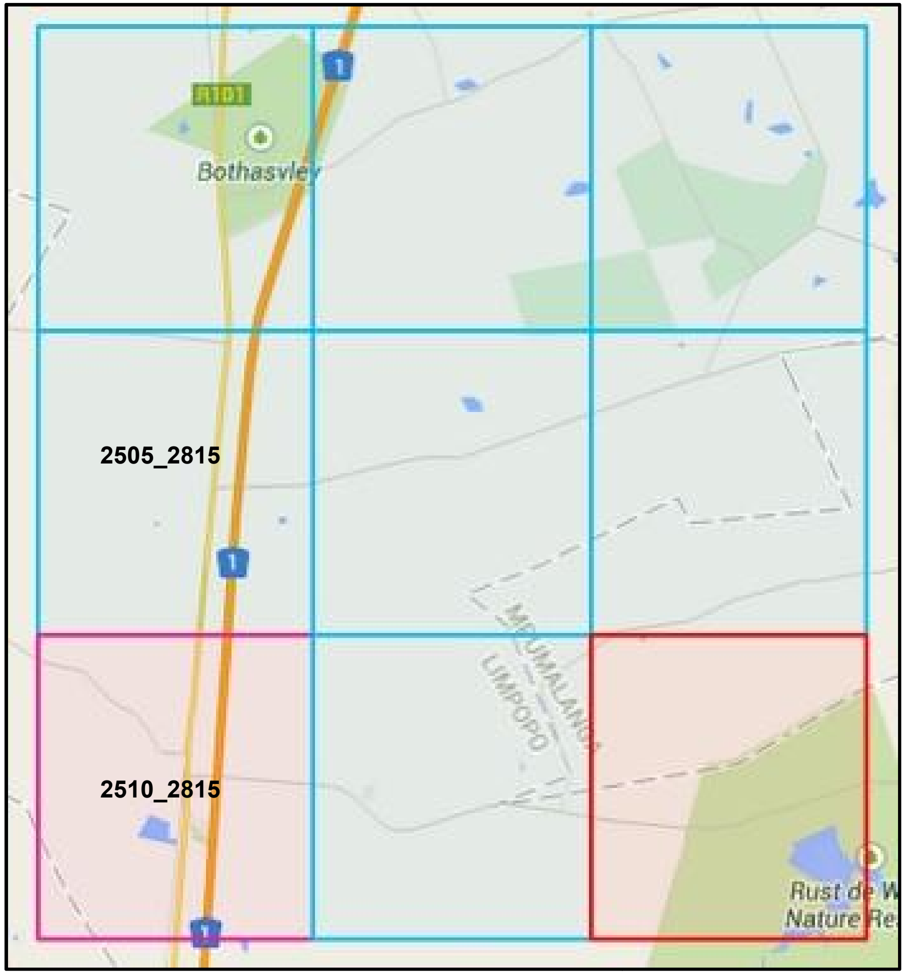

Fig 5 - Pentads 2505_2815, 2510_2815 in relation to the other pentads within the Quarter Degree Grid Cell 2528AB (Source: www.sabap2.adu.org.za)

Example 3: Pienaarsrivier QDGC 2528AB

This QDGC is located about 50 km north of Pretoria. During SABAP1, 146 checklists were submitted for this QDGC. For SABAP2, when combining the nine pentads in 2528AB, 173 checklists were submitted (Retief 2013). Fifty four species recorded in SABAP1 have not been recorded in SABAP2. Of the 54 species, only two, Rock Kestrel *Falco rupicolus* and Common Quail *Coturnix coturnix*, have a SABAP1 reporting rate of over 10%. Twenty three species have been recorded during SABAP2 but not during SABAP1 (Retief 2013). Reporting rates have increased for Red-billed Oxpecker *Buphagus erythrorhynchus* and Yellow Canary *Crithagra flaviventris*. The range expansion of Red-billed Oxpecker is attributed in part to the phasing out of harmful livestock acaracides in favour of products that are not harmful to this species. This change therefore reflects a genuine change in the abundance of this species (Retief 2013). Yellow Canary has also been reported regularly by birders in northern Gauteng and southern parts of Limpopo, and increase in reporting rate is likely to reflect an increase in abundance. In contrast Natal Spurfowl *Pternistis natalensis* (Fig 1) which shows increase in reporting rate of 36.0%, was recorded 73 times in the QDGC but in only three pentads. One of these pentads (2510_2815) was the most intensively surveyed in the QDGC (57% of 146 checklists) and 61% of all records of Natal Spurfowl came from this pentad. It is therefore possible that the increase in abundance suggested by the change in reporting rates might be an artefact of the uneven distribution of checklists in the pentads of the QDGC.

Example 4: QDGC 3318CD Cape Town

The Cape Town QDGC 3318CD has only six pentads, the remaining three of the usual nine contain no land and are not included in SABAP2. One of these six pentads is 3345_1820 which contains Robben Island, which was not accessible during SABAP1 (1987–1991, when the island was still a prison). A total of 317 checklists had been made for the QDGC by the end of July 2014 and 174 of these (55% of the total for the QDGC) were for the Robben Island pentad. The set of species on the island (Sherley *et al.* 2011) is not representative of the QDGC as a whole. Thus, for many species, the SABAP2 reporting rates for this QDGC are likely to be very different between SABAP1 and SABAP2. Comparisons between SABAP1 and SABAP2 for this QDGC should therefore be made using reporting rates omitting the checklists for the Robben Island pentad.

From these examples it is clear that we need to be cautious when comparing reporting rates between the two atlases, but it is unclear whether there is a systematic direction of bias in reporting rates between SABAP1 and SABAP2. The direction of the "bias" effect on reporting rates in a particular grid cell between the two projects is unpredictable. For some QDGCs reporting rate would have gone up and for others it would have gone down. If, in spite of this, there is a

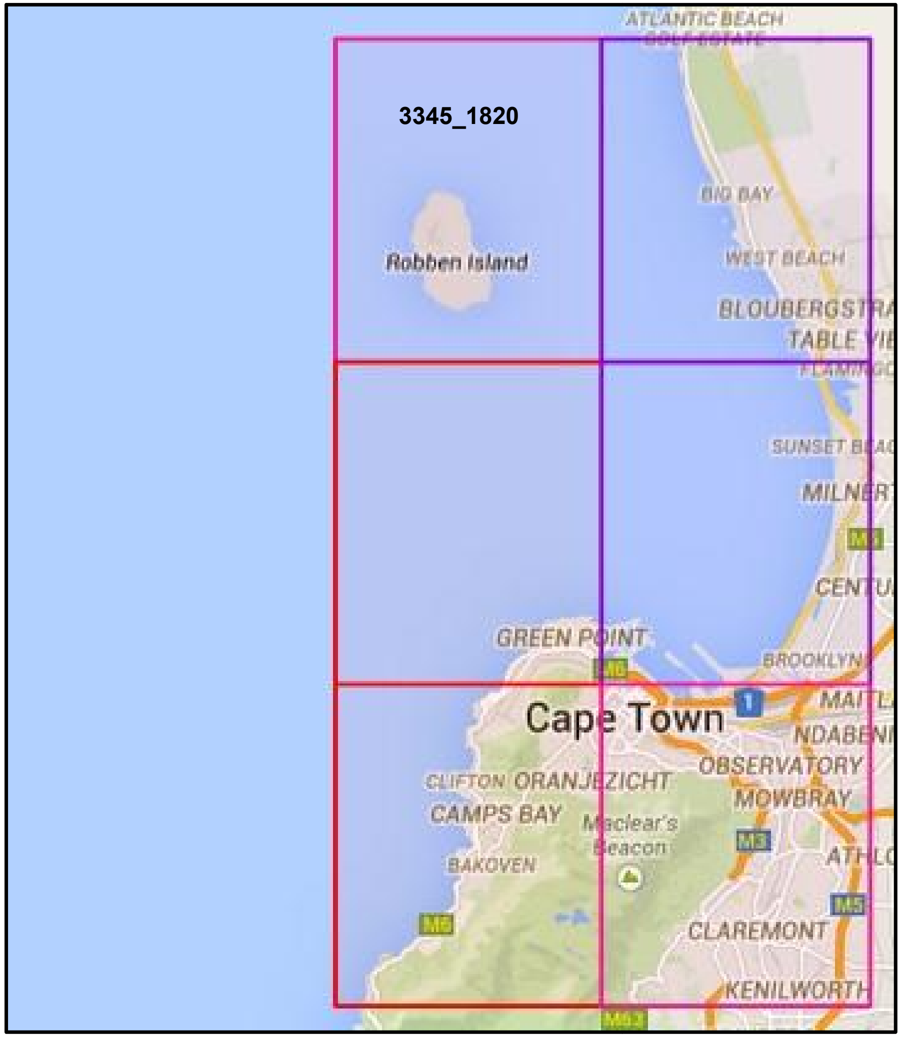

Fig 6 – Pentad 3345_1820 in relation to the other pentads within the Quarter Degree Grid Cell 3318CD (Source: www.sabap2.adu.org.za)

dominance of changes in a single direction (such as for the Southern Masked Weaver *Ploceus velatus*, which has a range-change map where most QDGCs show increased reporting rates for SABAP2), then the comparisons are still meaningful.

Suppose the biological truth is that the species has increased everywhere, then, as a consequence of the biases resulting from the differences between SABAP1 and SABAP2 protocols and sampling variation, we will not have increased reporting rates in every grid cell, so in fact the number of increases will be underestimated. Or, suppose that a species has increased in two thirds of the QDGC, then the biasing processes will shrink the number of observed increases closer towards one half. It is the second scenario which is the critical one. The biological truth is likely, on average, to be more extreme than what we observe.

From the time of SABAP1 to SABAP2 there has been a substantial improvement in bird identification skills. The availability of improved bird books, the internet, and digital photography have all helped to improve observers' identification skills. The book "Chamberlain's LBJs: The definitive guide to Southern Africa's Little Brown Jobs" (Peacock 2012) represents the quality of identification material which became available during the SABAP2 project. This book focuses on 235 species of "Little Brown Jobs" (or LBJs as they are known), a term that birders assign to any smallish, brownish and featureless bird that defies identification. Through its wealth of accurate illustrations, and comprehensive text, the book helps beginners and experienced birders alike to confidently identify LBJs. Part of the increase in the reporting rates for cisticolas might be attributable to improved skills in bird identification.

Because SABAP1 checklists covered a QDGC and a SABAP2 checklist a pentad, one-ninth of the area of a QDGC, it would be predicted that SABAP1 checklists would be longer than SABAP2 checklists. In fact the average lists lengths are 49.7 and 53.0 species respectively; the opposite direction to what was predicted, but nevertheless remarkably similar (calculated from data presented by Harrison and Underhill 1997 and from the SABAP2 website). This point is revisited by Loftie Eaton (2014), where for a subset of the data analysed more intensely, the checklist lengths between projects were even closer. What this also suggests is that the total amount of observer effort per checklist was broadly similar in both projects. It is even possible that the part of the QDGC visited by the average SABAP1 observer was roughly a pentad-sized subset of the QDGC.

Reporting rates provide a way of extracting quantitative information from presence/absence data, like that provided by the bird atlas projects. The observers did not count the actual number of birds they observed, but they recorded the presence of identified species on checklists (Harrison and Underhill 1997). The reporting rate is the proportion of checklists on which a species is recorded. If a species was recorded on 10% of checklists then it has a reporting rate equal to 10% for the specific grid cell. Differences in reporting rate between different geographical areas, and times of year, may be interpreted as pointing to changes in abundance or density of birds (Harrison and Underhill 1997). However, reporting rates are not proportional to birds per hectare (density). Reporting rates provide an index which varies with changes in bird density (Harrison and Underhill 1997).

Reporting rate can be seen as a measure of conspicuousness (how easily a bird is seen or noticed) of a species, which may roughly be defined as the likelihood that the average observer, with an average amount of effort invested in searching for a species, records a species (Harrison and Underhill 1997). Many factors influence reporting rate, only one of which is relative abundance. The sources of bias in reporting rates can be categorized into species, geographic, observer and arithmetic effects (Harrison and Underhill 1997):

(1) Species effects: Some bird species are more easily observed than others. With equal abundance, a conspicuous species will be recorded on checklists more frequently than species that are of a secretive nature. For some species, conspicuousness varies between seasons, because of changes in plumage or behaviour, with no change in abundance. Bright breeding plumage makes birds conspicuous and easy to identify while drab nonbreeding plumages do the opposite.

(2) Geographic effects: Some areas are more easily accessible than others. Species that are habitat specific will only be encountered if the observer goes to this specific habitat. Some grid cells have good networks of roads allowing access to all parts; others have few roads making access to some important habitats difficult.

(3) Observer effects: Certain species are easily identified by observers and are therefore recorded more frequently than those species that are difficult to identify. The level of observer skill and experience can affect the reporting rate.

(4) Arithmetic effects: the number of checklists collected for a grid cell can influence the reporting rate. If there is one checklist, the only possible values for the reporting rate are 0% and 100%. If there are two checklists, values of 0%, 50% and 100% are possible. If there are 100 checklists, the reporting rate can have any integer value from 0% to 100%. For this reason, observers were urged to revisit grid cells as often as possible, and collect as many checklists as possible.

With all these biases, do reporting rates have any value at all? Its usefulness might be less for certain species (e.g. rare or illusive species), and in certain field conditions, than for others, but it has demonstrated its value in numerous ways (Harrison and Underhill 1997).

Reporting rates have proven to be highly valuable when it comes to describing the phenology of migratory species. The reporting rates show a clear rise and fall with the arrival and departure of migrants (Harrison and Underhill 1997). Reporting rates vary over geographical space and this corresponds with what is predicted for species' ranges. For example, reporting rates are usually highest in the core of a species' distribution and lower towards the periphery (Harrison and Underhill 1997). This is consistent with studies on the structure of distributions (Brown 1984). Likewise, reporting rates for different vegetation types frequently follow the patterns of the known habitat preferences of species and this gives assurance that they are meaningful (Harrison and Underhill 1997). Studies on bird densities have used reporting rates from the SABAP database and related them to independent quantitative measures of species' densities, and found a consistent positive correlation; it has been demonstrated with compelling evidence that reporting rates increase in a continuous manner with increasing population density (Du Plessis 1989, Bruderer and Bruderer 1993, Allan 1994, Robertson *et al.* 1995).

Harrison and Navarro (1994) acknowledged that reporting rates are "crude measures" of relative abundance, yet successfully used them to make an important contribution to the debate about appropriate sizes for protected areas. They demonstrated for example, that there was a positive relationship between body mass and the size of the protected area, with the larger species tending to have larger reporting rates in the larger protected areas. Based on reporting rates, Harrison and Navarro (1994) were able to draw conclusions such as: "This suggests that an area of the order of 2500 ha may be an effective minimum for many small- to medium-sized woodland species (up to 400 g body mass), while considerably larger areas are needed for species of large body size."

Conclusion

In spite of the difficulties in interpretation of changes in reporting rates between SABAP1 and SABAP2, especially at the individual grid cell level, it is likely that if the SABAP2 results for a species shows decreased reporting rates (or complete absence) over large parts of its range, or vice versa, then this may be interpreted as an indication of genuine range change (Underhill *et al.* 2013).

Because average checklist lengths are comparable, the overall average of all reporting rates, across all species and all grid cells, is similar for both SABAP1 and SABAP2 (Underhill *et al.* 2013). Suppose a species has unchanged abundance between projects. Then, because of both sampling errors and comparison issues, roughly equal percentages of grid cells can be anticipated to show increases or decreases in reporting rates. Suppose a species has decreased in abundance in every grid cell between projects. Then sampling errors and comparison issues will result in some grid cells showing increased reporting rates, but the majority will show decreased reporting rates. Suppose a species has in reality decreased in abundance in 75% of grid cells and increased in 25%. Then sampling errors and comparison issues will result in observed decreases in, say, 65% of grid cells and increases in 35%. In other words, it is likely that, for species that have actually decreased, the observed percentage of grid cells with reporting rates that show decreases is likely to be underestimated. And similarly, for species that have increased, the observed percentage of grid cells with reporting rates that show increases is likely to be underestimated. In both cases, the observed change is likely to be "shrunk" towards 50%. Comparisons are thus more likely to be conservative, than to exaggerate increases or decreases.

Reporting rates remain a valuable tool to give broad-brush measures of change in species' geographic ranges. Reporting rates can be, and are being, used as an early warning system to detect range changes. Once these changes are detected, further investigation can be done on a species by species level. Thus, projects like SABAP1 and SABAP2 remain highly valuable.

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