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Early warning systems for biodiversity in southern Africa – How much can citizen science mitigate imperfect data?

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ABSTRACT

It is a hard reality that virtually all countries, no matter how well resourced, take conservation and land use decisions based on highly patchy and imperfect data - if indeed any data at all. Despite a mushrooming of scientific evidence and journals in the past decade, and open-access provision of many expensive global datasets, developing countries in particular often have to make do with inaccurate and coarse-scale global data, in the absence of targeted, local data to solve immediate conservation problems. To what extent can citizen science data compensate for the patchiness of conventional government-gathered scientific data in order to support planning, policy and management? We demonstrate how southern Africa's citizen science-based "early warning system for biodiversity" is used to support land-use planning and conservation decisions, including Red List, strategic and project-based environmental impact assessments and national protected area expansion and implementation strategies. This system integrates volunteer-based species atlases such as the Protea Atlas Project and Southern African Bird Atlas Project (SABAP), species population monitoring such as the Custodians of Rare and Endangered Wildflowers (CREW) project, and site-based rapid assessment and monitoring such as MyBirdPatch and BioBlitz. Countries in southern Africa are on a sharp continuum of research capacity, funding, political engagement and own datasets. Yet there is the capacity for adaptive management systems based in significant part on civil society volunteerism. Crucially, these must be underpinned by statistically sound, simple, repeatable scientific protocols, which are still rare in Africa.

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1. Introduction

It is a fundamental tenet of many societies that development decisions are based on evidence rather than decree, that management is adaptive rather than fixed, and that policies are informed by complex information about the world around us. For many developing countries, however, this tenet has been more aspiration than reality. Environmental decision-making in much of our world, including many African countries, has been informed by many processes, values and criteria, other than scientific evidence (e.g. McQueen and Puska, 2003; Bromell, 2012). But although these other criteria and values may remain crucial components of public policymaking, it is in every country's interests to design a platform of evidence for decisions and adaptive management, based on local, robust data that enable early identification of trends and problems. Increasingly, such platforms are used even in countries with relatively weak histories of evidence-based development planning, such as many least-developed and developing countries (e.g. Barnard and Henschel, 2002). And importantly, they can be developed with widespread public participation, which tends to be a thoroughly democratizing and empowering process (Wright et al., 2015).

1.1. Early warning systems for biodiversity change

While complex and well-organized societies are accustomed to thinking of early warning systems for tsunamis, economic shocks, disease outbreaks or wildfires, we have curiously not much applied this systems thinking to biodiversity change. Pivotal changes in species ranges, populations or community composition may be unnoticed by the public and conservation authorities until too late to take meaningful action, and may seem more gradual than sudden episodic events like tsunamis or disease outbreaks. Yet all early warning systems involve

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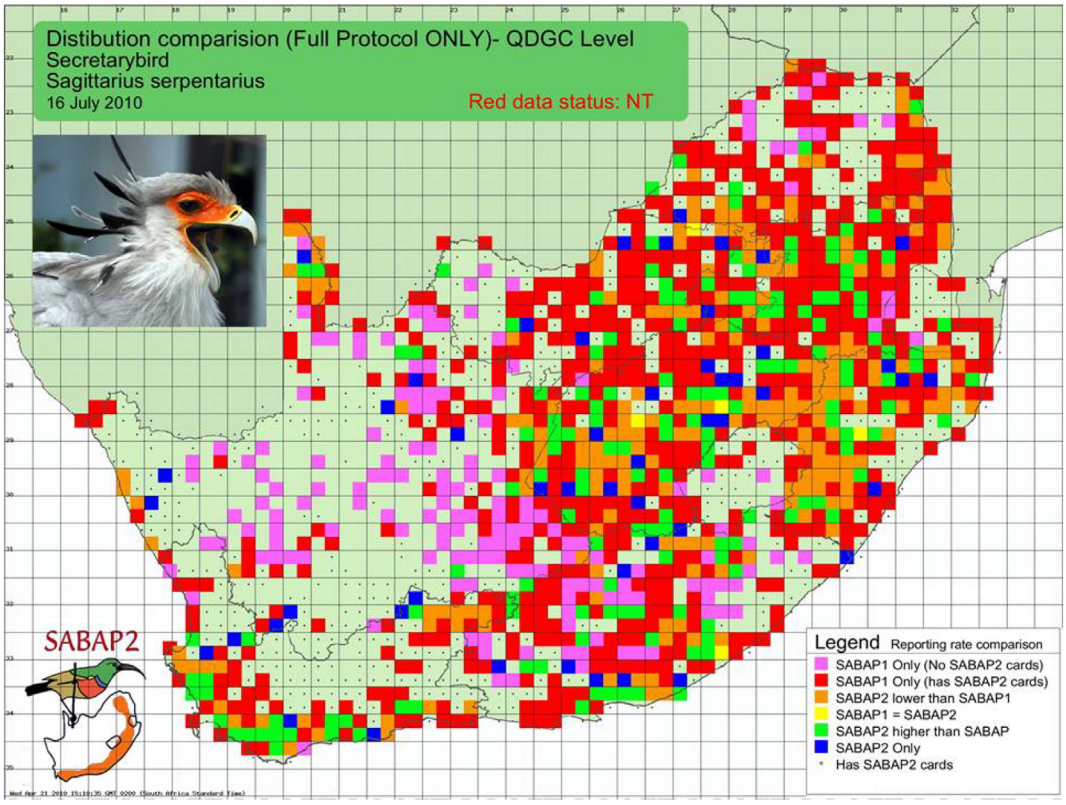

Fig. 1. Southern African Bird Atlas Project map of range changes in the Secretarybird *Sagittarius serpentarius*, where red = likely local extinctions, orange = declines in relative abundance since the 1990s, green = increases in relative abundance and blue = range expansion. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

tracking long-term patterns and perturbations, interpreting risk, and issuing forecasting alerts to inform action. Population collapse and local extinction, for example, are at least as episodic and catastrophic as stock market crashes or volcanic eruptions. Yet they can be predicted, and perhaps sometimes averted, given adequate local monitoring and feedback to planning, policy, and management action.

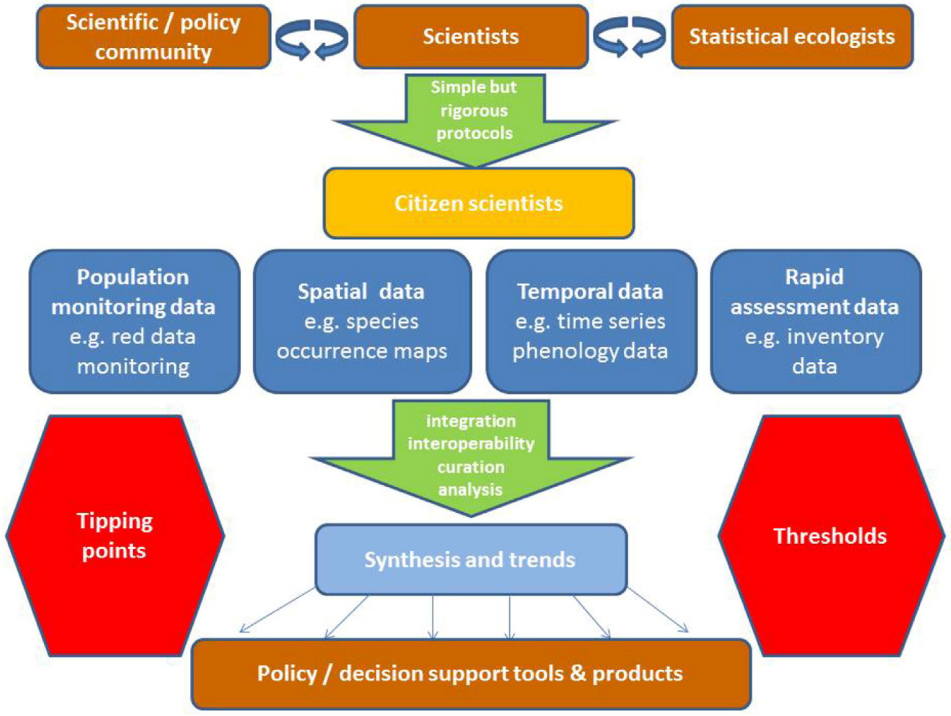

Fig. 2. Citizen science data in South Africa's early warning system for biodiversity, gathered according to sound scientific protocols and integrated with conventional global and local datasets, is delivering targeted policy tools for decision-making.

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