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Contributions to the National Status Report on Biological Invasions in South Africa

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South Africa has committed to producing a National Status Report on Biological Invasions by October 2017 and thereafter every three years. This will be the first status report at a national level specifically on biological invasions. As part of soliciting input, a workshop was held in May 2016 that led to this special issue of 19 papers in the journal *Bothalia: African Biodiversity and Conservation*.

This editorial introduces the symposium, discusses the special issue and summarises how each contribution provides an estimate of 'status'. Papers focus on key pathways, taxa, areas, and evaluations of interventions, specifically the movement of taxa between South Africa and neighbouring countries; the dispersal pathways of amphibians; a review of alien animals; a report on changes in the number and abundance of alien plants; in-depth reviews of the status of invasions for cacti, fishes, fungi and grasses; an assessment of the impact of widespread invasive plants on animals; reviews on invasions in municipalities, protected areas and sub-Antarctic Islands; assessments of the efficacy of biological control and other control programmes; and recommendations for how to deal with conflict species, to conduct scientific assessments and to improve risk assessments.

The papers in this special issue confirm that South Africa is an excellent place to study invasions that can provide insights for understanding and managing invasions in other countries. Negative impacts seem to be largely precipitated by certain taxa (especially plants), whereas invasions by a number of other groups do not, yet, seem to have caused the widespread negative impacts felt in other countries. Although South Africa has effectively managed a few biological invasions (e.g. highly successful biological control of some invasive plants), the key challenge seems to be to establish and maintain a strong link between implementation, monitoring, reporting and planning.

Introduction

The state of a nation's health, wealth and happiness is measured by a wide variety of indicators. Such background information is essential for policy-makers. Data on the levels of disease prevalence, education and social cohesion all provide crucial background information to determine the demand for schools, hospitals and community facilities. Governments need to know how much to spend, where to spend it, what to spend it on and whether spending is effective or not. Setting, and obtaining agreement on, particular goals is a key approach taken to stimulate action. For example, eight Millennium Development Goals were set to focus and coordinate efforts to reduce extreme poverty over the period 2000–2015. Although the goals have not been fully met, they have arguably had a significantly positive impact at global, national and local levels (United Nations 2015).

South Africa has committed to several international environmental agreements, and to achieve their goals it has developed national policy frameworks and legislation to manage biodiversity loss. In particular, South Africa has produced a series of National Biodiversity Assessments (e.g. Driver et al. 2012). Although these includesections on the impact of the drivers of global change, biological invasions have not been a core focus of the reports.

In October 2014, the Regulations on Alien and Invasive Species (A&IS Regulations 2014) were made into law in terms of Section 97(1) of the *National Environmental Management: Biodiversity Act* (NEM:BA, Act 10 of 2004). Section 11(1)(a)(iii) of the regulations mandates the South African National Biodiversity Institute (SANBI) to submit a report on the status of biological invasions

Note: This paper was initially delivered at the 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa, Goudini Spa, Western Cape, South Africa on 18-20 May 2016.

every three years (Box 1). The aim of the national status report is to consolidate information on the extent and impact of biological invasions as well as the effectiveness of interventions in a way that can be used to inform policy responses.

As part of initial efforts to gain input into the national status report, the DST-NRF Centre of Excellence for Invasion Biology and the SANBI convened a 3-day symposium (18–20 May 2016) in the Western Cape (Figure 1).

The 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa

The symposium was one in a long line of very valuable and fruitful annual meetings. The first in this series of meetings was held in 1973 at Rhodes University and was attended by five people who discussed the science and practice of the biological control of weeds (Moran, Hoffmann & Zimmermann 2013). These symposia have expanded in size over time, and, particularly in the last decade, the scope of meetings has expanded – from an initial sole focus on biological control to research on the management of plant invasions more generally. The 2016 meeting was the first to cover all aspects of biological invasions, but it still included talks on technical aspects of the biological control of alien plants (Moran, Hoffmann & Hill 2011) and, to a lesser extent, alien plant incursion response planning (Wilson et al. 2013; Wilson, Panetta & Lindgren 2017).

The 173 delegates who attended the 2016 symposium represented 30 institutions including universities, governmental and non-governmental organisations, commercial partners and private individuals from across South Africa (Figure 1). Seventy-four presentations were given on topics ranging from pathogens to invasive birds to introduction pathways. Keynote talks focussed on scientific assessments, reporting on biological invasions and risk analyses. See Online Appendix 1 for the full programme and list of delegates (also available at http://www.invasives.org.za/events#abstracts).

BOX 1: Regulatory requirement for a national status report as per South Africa's Alien and Invasive Species Regulations.

In terms of Section 11 of the Alien and Invasive Species Regulations promulgated under the *National Environmental Management: Biodiversity Act* (NEM:BA, Act 10 of 2004), the South African National Biodiversity Institute (SANBI) is mandated to draw up a status report on biological invasions. The wording of the relevant section of the regulations is as follows:
'11. National status reports

1) The Institute [i.e. SANBI] or a body designated by the Institute must, for the purpose of reporting as contemplated in section 11(1)(a)(iii) of the Act, submit a report on the status of listed invasive species to the Minister within three years of the date on which these regulations come into effect, and at least every three years thereafter.

2) A report contemplated in sub-regulation (1) must contain a summary and assessment of-

   a. the status of listed invasive species and other species that have been subjected to a risk assessment; and

   b. the effectiveness of these regulations and control measures based inter alia on information from-

      i. notifications received from owners of land regarding listed invasive species occurring on their land;

      ii. permits issued for listed invasive species;

      iii. Invasive Species Monitoring, Control and Eradication Plans received from organs of state and management authorities of protected areas; and

      iv. emergency interventions and enforcement actions involving listed invasive species issued by the Minister.

In preparing a report contemplated in sub-regulation (1), the Institute must carry out the research and monitoring necessary to identify the matters contemplated in sub-regulation (2)'.

Source: Department of Environmental Affairs 2014

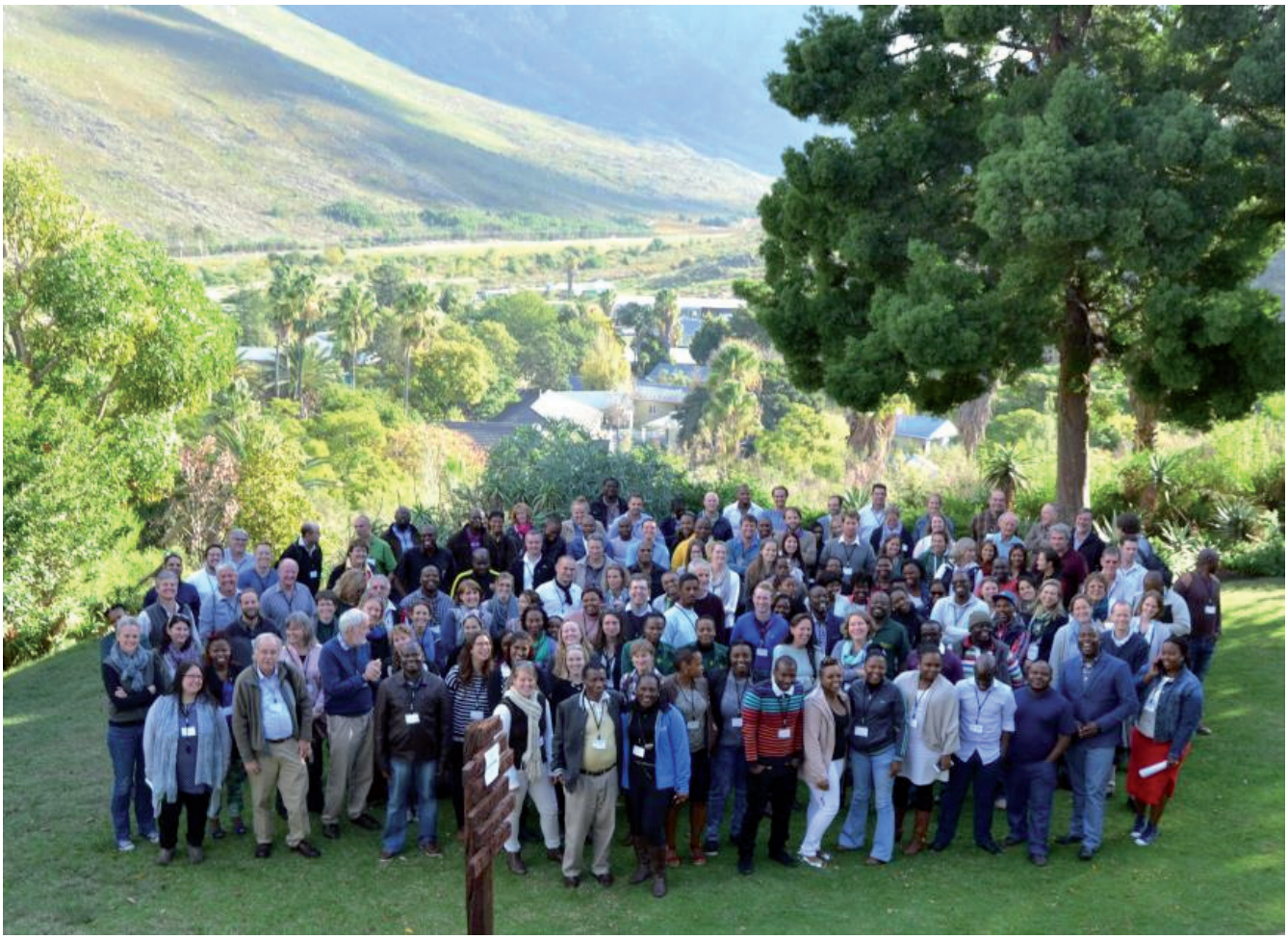
Not since the inaugural research meeting of the Working for Water programme in 2003 (Macdonald 2004; van Wilgen 2004) has there been a national gathering that addressed the full spectrum of issues pertaining to the research and management of biological invasions across all taxa. Meetings like these bring special challenges, but they also provide unique opportunities for the exchange of ideas. Presenters were required to communicate their information to others from different and often unfamiliar disciplines, and to emphasise the implications of their work for managers. The focus on providing material and syntheses for the upcoming status report assisted in this process, resulting in a series of productive exchanges that promises to take the science forward in more trans-disciplinary ways.

Although the '43rd Annual Research Symposium on the Management of Biological Invasions in South Africa' was somewhat of a departure from previous versions of this meeting, these meetings have always provided valuable opportunities to network and engage, and should remain a cornerstone in South Africa's efforts to improve our understanding of biological invasions and their management. It remains to be seen whether such meetings would be more productive and cohesive if they were to revert to concentrating on alien plants or whether a wider remit of biological invasions (which includes non-plant taxa and aspects of policy development and management effectiveness) would be more valuable.

The symposium is, of course, not the only forum for discussing biological invasions in South Africa. Over time, there have been various regional meetings, including the C.A.P.E. Invasive Animal Working Group (Wilson et al. 2014) and the KZN Invasive Alien Species Forum. Two taxon-specific national working groups have also been established to focus research efforts and provide fora for stakeholders to discuss issues: the Cactus Working Group (Kaplan et al. 2017) and the Alien Grass Working Group (Visser et al. 2017). Such groups have been very effective in stimulating applied research and its uptake (e.g. both groups resulted in papers in this special issue), and there is an urgent need for other taxon- or theme-focussed groups (Packer et al. in press) that are also sustainably funded and facilitated.

The special issue as an input to the national status report

In the initial planning of the national status report, it was clear that the report would need to be a collaborative exercise



Source: Photo by Travor Xivuri

FIGURE 1: The delegates of the 43rd Annual Research Symposium on the Management of Biological Invasions in South Africa, Goudini Spa, 18–20 May 2016.

relying heavily on partnerships to deliver content. Although much relevant data on particular issues had been collected, much of it was not collated or published. It was decided to use a journal special issue as a means by which input into the status report could be facilitated. The aim of the special issue was to collate reports on as broad a range of topics relating to invasions in South Africa as possible. In particular, we felt it was important to gain insights from a range of approaches encompassing work on pathways, taxonomic groups, particular geographical areas and interventions at the various stages of the invasion process.

During the latter half of 2015, experts were asked if they would be prepared to write a paper on a particular topic, and an open call for paper proposals was distributed (to core team members of the Centre for Invasion Biology, to attendees of the previous symposium and through the South African invasives-l server, invasives@wordlink.co.za, see Online Appendix 2). Proposals for papers were evaluated by the editorial team, and submissions that were deemed relevant to the status report were accepted for inclusion in the symposium programme (34 out of 51 proposed papers were presented at the symposium). After the symposium, presenters were invited to submit manuscripts for consideration as papers in the special issue of *Bothalia: African Biodiversity and Conservation*. All papers were subjected to standard peer review. Of 23 papers that were eventually submitted, 4 were either withdrawn or rejected during review stage, leaving 19 papers in this special issue (Table 1).

There were several reasons that certain topics were not included. Firstly, some topics had already been recently comprehensively reviewed [e.g. marine invasions (Griffiths et al. 2010; Robinson et al. 2016) and the impact of invasive plants on water resources (Le Maitre et al. 2016)]. Secondly, some of the work presented at the symposium was published elsewhere (e.g. on management effectiveness, Fill et al. 2017; van Wilgen et al. 2016). Thirdly, although several proposals involved interesting case studies on particular species (e.g. Shackleton et al. 2017), these were not included as one of the main aims of the status report is to look broadly across groups or areas. However, we look forward to case studies being used extensively to test the proposed framework for monitoring and reporting on biological invasions. Finally, many issues were identified as critical for a status report, but there was simply not enough time to solicit a contribution for this special issue. We have

TABLE 1: Papers in the special issue and their insights on status in South Africa in the context of similar initiatives elsewhere in the world.

Article reference and DOI URL	Topic	Status in South Africa	Future needs	Comparison with elsewhere in the world
Clusella-Trullas and Garcia (2017) https://doi.org/10.4102/abc.v47i2.2166	**Taxa** Impacts of invasive plants on ectotherm animals	The current state of knowledge of the impacts of alien plants derives from a few studies (primarily on arthropods). The impact of most invasive plants assessed under international standard methods (Blackburn et al. 2014) would be data deficient.	More research on the impacts of widespread invasive plants is required if management is to be prioritised.	The dearth of knowledge in South Africa is similar to that in other countries.
Faulkner et al. (2017) https://doi.org/10.4102/abc.v47i2.2157	**Pathways** Introduction pathways between South Africa and the rest of Africa	There is a dynamic interchange of species between South Africa and the rest of Africa (with South Africa being a net donor of some taxa and a net recipient of others). This poses a serious challenge to biosecurity.	Improved regional co-operation in biosecurity is needed to prevent introductions to the region and spread within the region, although preventing inter-regional spread will be very difficult in many cases.	The problems are the same for continents that are composed of many nation states.
Foxcroft et al. (2017) https://doi.org/10.4102/abc.v47i2.2158	**Areas/Interventions** Invasive species in South African National Parks	There are hundreds of invasive species in South Africa's National parks, and there is substantial investment in their control, but not enough is being done to address all species everywhere, both across parks and within a park.	Control efforts will need to be prioritised and more consistently resourced. Monitoring the efficacy of interventions will need to be substantially improved if control is to be effective.	South Africa has invested more effort than most other countries into the research and management of biological invasions in protected areas. However, the situation in South Africa reflects the fact the even remote protected areas are threatened by biological invasions (Foxcroft et al. 2013).
Greve et al. (2017) https://doi.org/10.4102/abc.v47i2.2143	**Areas/Interventions** Invasions on South Africa's sub-Antarctic Islands (i.e. Marion Island and Prince Edward Island)	Marion Island is fairly heavily impacted by alien species, with effects on native species and ecosystem functioning. Prince Edward Island is currently invaded by fewer alien species. Biosecurity and management plans are in place.	Climate change and biological invasions are the two greatest threats to biodiversity on these islands. Strict biosecurity regulations aimed at reducing propagule introductions should be implemented.	The Prince Edward Islands are comparable to many other remote sub-Antarctic Islands in terms of the numbers of invasive species, their impacts and their management (Shaw 2014).
Henderson and Wilson (2017) https://doi.org/10.4102/abc.v47i2.2172	**Taxa/Interventions** Invasive and naturalised plants	South Africa has a substantial alien plant invasion debt, with a high rate of new records of naturalisation and spread. The southern African Plant Invaders Atlas (SAPIA) has recorded 773 alien plant taxa as escaped from cultivation (a ~30% increase since 2006) with a roughly 50% increase in the broad-scale range occupied by these taxa since 2000. Most taxa are under-sampled, but it is clear that regulated taxa have spread much faster than non-regulated taxa, and there is no evidence of mechanical control operations having reduced spread rates. Several plant taxa under biocontrol, however, have not shown much range expansion and in some cases have contracted in range extent.	A more systematic approach to surveying is required perhaps with long-term monitoring sites set up, although long-term sustainable funding and hosting of the SAPIA is a priority. More taxa should be considered for listing under the regulations; some taxa, which are mainly associated with disturbance and agricultural lands, should be removed; proof of sterility for horticultural cultivars of invasive taxa is needed; and ultimately more needs to be done to ensure management is strategic and effective.	South Africa has a very high number of recorded naturalised plants. However, in South Africa's case this is based on long-term surveys that are often missing elsewhere. SAPIA is one of the best atlas projects for alien plant species anywhere in the world and a major national asset for monitoring biodiversity threats.
Hill and Coetzee (2017) https://doi.org/10.4102/abc.v47i2.2152	**Interventions/Taxa** Biological control of aquatic plants	Invasive aquatic weeds have had major impacts in South Africa that have been alleviated very efficiently by biological control. Often, however, invasions by aquatic weeds are a result of water quality issues that also need to be addressed.	Ongoing work is needed to integrate biological control with other control measures. Efforts at preventing the import of new species are required.	South Africa has been at the fore-front of the biological control of aquatic weeds for many years.
Irlich et al. (2017) https://doi.org/10.4102/abc.v47i2.2156	**Interventions/Areas** Dealing with biological invasions in municipalities	Only 4% of municipalities are compliant with existing regulations. It is not clear, however, what the scale of invasions are or the effectiveness of interventions.	Realistic, prioritized goals are needed, but the capacity to achieve these is severely limited.	All developing countries face similar problems, but South Africa has a regulatory framework and a relatively high level of research and management capacity.
Kaplan et al. (2017) https://doi.org/10.4102/abc.v47i2.2149	**Interventions/Taxa** Strategic framework for the management of Cactaceae	There has been a long history of major invasions with significant impacts that have in many cases been reduced through control measures (in particular biological control). Several groups of stakeholders have interest in using cacti.	Recommendations for permitting new introductions need to be implemented, new incursions need to be eradicated where possible, and research and implementation on biological control should be ongoing. Coordination and buy-in from stakeholders needs to be entrenched through the implementation of a national strategic framework.	South Africa is (along with Australia and Spain) a global hotspot of cactus invasions (Novoa et al. 2015), and a global leader in the management of invasive cacti.
Keller and Kumschick (2017) https://doi.org/10.4102/abc.v47i2.2136	**Interventions** Pre-border species risk assessment	Recent legislation presents a framework for risk assessment of species introductions to South Africa, but this does not leverage recent advances in risk analysis tools.	There is potential for proven risk-assessment approaches to be applied to ensure more cost-effective assessments of species introductions.	South Africa's capacity in terms of risk assessment for biological invasions is on par with developing countries, but is way behind developed countries.
Kraaij et al. (2017) https://doi.org/10.4102/abc.v47i2.2105	**Interventions** Management of invasive plants in a protected area	Implementation has been poorly aligned with management plans, and the quality of many treatments was inadequate. Field assessments of cover, on which contracts were based, were also poorly done. This means that successive follow-up treatments had little apparent effect in reducing invasive plant cover.	Compulsory, in-field assessment of invasive plant cover prior to contract allocation, and assessment of treatments quality prior to contractor payment are needed to improve the effectiveness of control operations.	Assessments of the costs and effectiveness of control operations are seldom done, and this is recognised as an area where scientists need to focus more effort globally (Kettenring & Adams 2011).

Table 1 continues on the next page →

TABLE 1 (Continues...): Papers in the special issue and their insights on status in South Africa in the context of similar initiatives elsewhere in the world.

Article reference and DOI URL	Topic	Status in South Africa	Future needs	Comparison with elsewhere in the world
Marr et al. (2017) https://doi.org/10.4102/abc.v47i2.2177	**Interventions/Taxa** Evaluating of invasion risk for freshwater fishes	Retrospective calibration of a trait-based scoring system (FISK; Fish Invasiveness Scoring Kit) for invasiveness of fish showed that a score of 14 signifies high risk. All taxa with a higher score have become invasive in South Africa.	FISK needs to be applied and integrated with other tools as part of standard risk-assessment protocols for evaluating new introductions and for elucidating the invasion risk for already introduced species.	FISK is used in an increasing number of countries around the world (Copp 2013).
Measey et al. (2017) https://doi.org/10.4102/abc.v47i2.2117	**Pathways** A review of invasive amphibians	Frogs are mainly moved around southern Africa through 'jump' dispersal, although there are a number of records of 'cultivation', 'leading-edge' and 'extreme long-distance' dispersal types. Important pathways include trade in fruit and vegetables, horticultural products and shipping containers.	There is evidence that southern Africa is likely to suffer more amphibian invasions due to an increase in trade, agricultural and domestic impoundments and global climate change. Preventing new introductions is a key challenge for the future.	South Africa has been much less affected by alien amphibian invasions than many other parts of the world.
Picker and Griffiths (2017) https://doi.org/10.4102/abc.v47i2.2147	**Taxa** Introduction status, and distribution of alien animals	There are at least 571 introduced faunal species, but few are under management or study. The number of alien animals recorded in marine ecosystems increased from 22 in 2009 to 79 in 2016.	Most animal taxonomic groups (notably invertebrates) are under-surveyed and understudied. Inventory requires continuous updating.	South Africa has fewer vertebrate invasions than many other regions, and the impacts seem relatively low, but impacts of most invasive animals (especially invertebrates) are poorly studied. Numbers of recorded alien animal species in marine systems is very low compared to some others areas (e.g. 79 species in South African waters compared to 986 in European waters).
Scholes, Schreiner and Snyman-Van der Walt (2017) https://doi.org/10.4102/abc.v47i2.2144	**Interventions** Scientific Assessments (not specifically of biological invasions)	Scientific assessments, as conducted both in South Africa and internationally, offer a model for how to go about the compilation of a status report on biological invasions. Following this process will increase the quality of information and the legitimacy of findings.	It will be critical to document current protocols for the development of future status reports. Identification of specific biological invasions issues where a scientific assessment approach would be valuable to resolve a dispute.	Scientific assessments are well-established internationally, though as yet are rarely used in the field of biological invasions.
Visser et al. (2017) https://doi.org/10.4102/abc.v47i2.2136	**Taxa** Introduction status, distribution, impacts, and interventions against grasses	There are 256 alien grass species in South Africa, 37 of them invasive. The fynbos appears to be where the largest impacts due to alien grasses have been recorded.	The identity of many alien grasses in South Africa is uncertain, as is their introduction status. More work is needed to address these shortcomings.	South Africa appears to be less invaded and suffers fewer extreme impacts from alien grasses than comparable regions. This is perhaps because natural fire regimes prevent their establishment and invasion (Africa burns more than other regions), and because there has been in general a lower introduction effort (Visser et al. 2016).
Wood (2017) https://doi.org/10.4102/abc.v47i2.2138	**Taxa** Introduction status, distribution, and impacts of alien fungi	Little is known about alien fungi in South Africa. The regulatory lists have numerous errors in them (e.g. some taxa are listed as not in South Africa when they are and vice versa), and the listed taxa primarily pose agro-economic threats as opposed threats to native biodiversity.	The regulations need to be revised. A scoping exercise is needed to identify what can realistically be done with various levels of investment.	As yet there have been no known large-scale devastating impacts caused by fungi, though it might just be a matter of time.
Woodford et al. (2017) https://doi.org/10.4102/abc.v47i2.2124	**Interventions/Taxa** Invasive fish management in the context of invasive species legislation	The currently promulgated lists and regulations for alien and invasive freshwater fishes provide a practical legal framework under which the further spread of invasive species can be actively discouraged, through the prosecution of parties guilty of illegal transport and stocking. The regulations also provide a legal context for active control.	Given the extremely limited capacity for active management of invasive fish populations within provincial conservation agencies, it is crucial to prioritise control efforts against alien fish populations with high conservation risk, and those that are logistically feasible to manage.	South African legislation relating to invasive fish is among the most comprehensive globally. However, conflicts of interest and poor implementation of legislation reduce the effectiveness of such measures.
Zachariades et al. (2017) https://doi.org/10.4102/abc.v47i2.2142	**Interventions/Taxa** Biological control of invasive plants	Biological control contributes significantly to the control of 34 of the 59 alien plant species on which biological control agents are established. Fourteen of these target species are considered to be under complete control, with no need for any other control intervention. No significant non-target impacts have been recorded and a strong independent regulatory system overseeing releases is in place and functioning.	Implementation efforts, and integration of biological control with other control methods need to be improved. Increased investment is required to maximise benefits from biological control, particularly in implementation and post-release evaluation, as well as in targeting additional invasive alien plants.	South Africa is a world leader in the biological control of alien plants.
Zengeya et al. (2017) https://doi.org/10.4102/abc.v47i2.2160	**Interventions** Conflict of interest species	Of the 552 alien species assessed (including most NEM:BA-listed species), most were classified as inconsequential (55%) or destructive (29%). Some species (10%) were regarded as more beneficial than harmful, and (6%) of species were considered to be conflict-generating (both harmful and useful). Managing these species will be challenging, and trade-offs will need to be made.	There is an urgent need to identify all stakeholders when considering the regulation of conflict-generating species, and to recognise that these stakeholders might hold very divergent perceptions on the problem posed by the invasive species.	Conflicts over invasive species are common globally, especially for trees (Dickie et al. 2014) and freshwater fishes (Woodford et al. 2016).

summarised a few of the issues that still need to be addressed in Box 2. Whether these can be dealt with in depth in the first national status report remains to be seen, but they should be prioritised for future reports.

Determining 'status'

One of the key challenges given to authors and reviewers was that the papers should have a clear focus on 'status'. This was particularly difficult as the framework for the status report itself was still in development, as were international standards for monitoring invasions (Latombe et al. in press). But based on our involvement in work conducted in terms of South Africa's National Strategy for Biological Invasions (https://sites.google.com/site/wfwplanning/strategy), a recent book on incursion response planning (Wilson, Panetta & Lindgren 2017) and the development of the concept of invasion debt (Rouget et al. 2016), a logical basic framework has emerged. This framework suggests that any national status report on biological invasions should have sections dedicated to the status of pathways, species, areas and interventions [see also McGeoch et al. (2016)]. Authors were therefore requested to concentrate on producing headline statistics, for example, the number of alien taxa present, the impacts of invasions in terms of formal schemes (e.g. Blackburn et al. 2014) and whether management interventions have actually led to measurable effects on biological invasions. An additional request was to place the topic reviewed in South Africa both in the context of invasions elsewhere and in the context of other types of invasion in South Africa. We have summarised some of the key findings of the papers in this special issue in Table 1.

BOX 2: Selected knowledge gaps that should be prioritised to facilitate the reporting on biological invasions in South Africa.

The National Status Report on Biological Invasions will need to discuss all aspects of biological invasions, the state of knowledge of these in South Africa and how effective interventions are. There is much that could be done so some issues will need to be prioritised. The selection here is based primarily on issues that were identified during consultations with colleagues while soliciting papers for this special issue. In some cases, these were papers that were proposed but were not written, whereas in others they were raised as issues, but substantial dedicated research will be required for status to be determined, and finally, there are issues where there will need to be some theoretical development before it is clear how status should be measured. As such, this list is preliminary and incomplete, but, we believe, useful. Feedback on potential issues that should be included in this and future reports would be very gratefully received (Invasives@sanbi.org.za).
• A quantification of the rates of species introduction into, and spread within, South Africa.
• An assessment of the relative prominence of dispersal pathways within South Africa.
• A consolidated national inventory of introduced taxa, a physical reference specimen of each, and an assessment and regular updating of the status documented according to the Blackburn et al. (2011) classification scheme (cf. Henderson & Wilson 2017).
• Systematic agreed methods for projecting future threats, that is, a method for measuring and reporting on the invasion debt (Rouget et al. 2016).
• A summary of the extent of areas invaded and a method of estimating the overall impacts caused by these various invasions on biodiversity and ecosystem services.
• History, status and effectiveness of pathway, species and area-based management in South Africa.
• History, dynamics, and impact of workshops, forums and working groups that address biological invasions in South Africa.
• The scale and impact of herbicides used (cf. Wagner et al. 2017) as well as the effectiveness of herbicide application in terms of quantity and timing.
• The value and role of ecological restoration in managing biological invasions and contributing to conservation goals.

The next steps

SANBI is required by the NEM:BA A&IS Regulations to compile a status report and to do the necessary research for informing it (Box 1). In reality, SANBI does not have the capacity to do everything required in this regard, and must rely on others, as was the case for the biodiversity assessments (Driver et al. 2012). Luckily, several ongoing initiatives provide strong support for the production of the status report, in particular atlas projects like the southern African Plant Invaders Atlas (Henderson & Wilson 2017) and those run by the University of Cape Town's Animal Demography Unit, and the diverse work undertaken through the DST-NRF Centre of Excellence for Invasion Biology (van Wilgen, Davies & Richardson 2014). What is particularly challenging is measuring the effectiveness of management interventions, as few if any interventions are monitored (van Wilgen & Wannenburgh 2016), and what assessments there are tend to be sporadic and not strategic in nature (Fill et al. 2017; McConnachie et al. 2012; McConnachie et al. 2016; Shackleton et al. 2016; van Wilgen et al. 2012). Although this is not ideal, the fact that South Africa has a nationally mandated biodiversity institute and a government-funded centre of excellence focussing on biological invasions places it in a much better position to compile such a report than most other countries.

The information in the papers from the special issue will be combined with other published literature and substantial contributions from the scientific, management and regulatory communities where this information resides. Taking the 'pathway, species, area, intervention' framework, the data will then be organised into a series of sections of the report, with publication due in October 2017. The papers presented in this special issue therefore represent an important snap-shot in time. In some cases, they provide a base-line, in other cases an additional point in an existing time-series of data. By combining these over time, we can hope to ultimately be able to assess the scale of South Africa's invasion debt (Rouget et al. 2016) and to be able to prioritise resources to the most effective interventions. For this to happen in practice, though, research and implementation should no longer be seen as processes that happen separate to the needs and concerns of the wider society (Toomey, Knight & Barlow in press). For example, if we are to effectively respond to new incursions, we should not have separate institutions mandated to detect the problems, develop the appropriate response and implement control. These functions need to be organised as a single integrated process (Wilson, Panetta & Lindgren 2017).

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Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

J.R.U.W. led the writing with contributions from M.G., D.M.R. and B.W.v.W. The authors contributed equally to the editorial work involved in developing and compiling this special issue.

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