

Invasiveness and the Atlas of Living Australia

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Summary As of February 2014, the Atlas of Living Australia (ALA: <http://www.ala.org.au>) had approximately 45 million records of over 111 thousand native and alien species, 400+ ‘environmental layers’, approximately 39 million pages of biological literature, 40 thousand species images and other integrated biological data. What the Atlas doesn’t have however is a systematic framework for dealing with invasive species.

The lack of consistent, comprehensive and agreed definitions of invasive status is a hurdle for the effective management of invasive species. This is surprising given the international economic and ecological impact of invasive species. The inclusion of invasion status into information management systems would add significant value for practitioners, researchers and policy makers. The Convention on Biological Diversity’s Global Invasive Alien Species Information Partnership (GIASIP: <http://giasipartnership.myspecies.info/>) is ideally placed internationally to improve data integration, quality and access across a highly fragmented environment with key gaps in biogeography, taxonomy and standards.

The ALA is well positioned to help identify information gaps such as this. For example, lists could be created for species considered to have a particular invasive status (<http://lists.ala.org.au>). Such lists on the ALA are created and maintained by any one or more ALA-registered users or groups of users and can be used by anyone. Species names are checked against the National Species List and then linked to all related Atlas data. The ALA has multiple features and capabilities that illustrate the value of effective, sustainable management of information on invasive species for use across education, research, land management and policy sectors.

Keywords Invasive status, lists, atlas, data management, data integration, open access, species lists, species profiles, black list, data gaps, standards, jurisdiction, criteria, GIASIP, citizen science, area management, education, fragmentation.

INTRODUCTION

Invasive species remain amongst the top threats to human and animal health and wellbeing, agriculture and

to biodiversity (McGeoch *et al.* 2010). This problem is increasing and can be exacerbated by other drivers such as disturbance, climate change and pollution. One of the fundamental challenges in this domain remains information management (Roy *et al.* 2014, Gato *et al.* 2013). For example, knowing the suite of species present in a particular region is an essential first step for prioritising management actions. Such a list ideally requires comprehensive survey data, accurate species identifications, standard nomenclature, information of species indigenous ranges and degree of invasiveness; data that is often unavailable or readily accessible (McGeoch *et al.* 2012). Effective management is dependent on all of this information being openly available and current.

The Atlas of Living Australia is integrating diverse information about species and their environment. This integration is highlighting the value standardised information about species and also the gaps that exist in data, services and processes. For example, the Atlas details State, Territory and Federal information on species conservation status, but it became apparent that there is no equivalent for invasive species. A ‘Black List’ would be a valuable complement to the International Union for Conservation of Nature (IUCN) Red List. As a result, multiple initiatives are continuously needed to prioritise species for management attention at various scales and for various specific purposes. Although WoNS (Weeds of National Significance: <http://www.weeds.org.au/WoNS>) provides a national list, similar lists are essential at multiple scales and to meet multiple management objectives such as protecting threatened species and ecosystems, water quality and fire management.

This problem is not unique to Australia (e.g. Genovesi *et al.* 2013, Roy *et al.* 2014). Ideally, agreement is needed to integrate and provide standardised, easily accessible information across borders (McGeoch *et al.* 2012). An online ‘black-listing’ process has been considered in central Europe to provide a comprehensive, flexible tool as part of the overall strategy against invasive species (Essl *et al.* 2011). The life of a land manager is made easier if there is agreement on issues such as terminology, taxonomy and locally-relevant invasive status. What is needed is

less fractured governance, infrastructure and data for invasive species. The concept of invasiveness and the need for an operational definition may act as a catalyst for integrating and addressing these shortcomings. The urgent need for a Black List raises a suite of information management challenges and requirements peculiar to invasive species.

A BLACK LIST

If we wanted to move toward such an Australian Black List, what would be necessary? There are features that are unique to invasions and to invasive species data that need to be considered. For example, currently, species are either listed as invasive or not, significant or not: There is no counterpart to the relative conservation status that exists through the IUCN Red List (<http://www.iucnredlist.org/>) and national and State/Territory lists. Although formal risk assessments are routinely conducted to assess potential threat, there is no system for assigning realised impact (invasive status) equivalent to current conservation status.

There are taxonomic challenges to achieving a Black List. The primary issue is the multiple names of species, both scientific and common (Kowarik and Pysek 2012). A taxon may have multiple scientific names that may be accepted in different geographic regions (synonymy), while common names like 'Red algae' can refer to multiple species. Ninety percent of the species incorporated into the Global Invasions Indicator (McGeoch *et al.* 2012) had a least one synonym and some species had over 100. The Atlas has supported the building of National Species Lists (NSL, see <http://www.iucnredlist.org/>) – a nationally supported list of Australian species that includes synonymy, and name change tracking across scientific and common names. All observations and trait data in the Atlas are linked to the NSL infrastructure.

Information on the geographic range of species is also required to evaluate the degree to which a species is a part of the 'natural system' or not. Baseline information on species ranges can be incomplete and geographic range edges too coarse to inform local management decisions (Catford *et al.* 2012). The Atlas has over 45 million records of observations of more than 111 thousand species from all States, Territories and the marine environment. While the Atlas is the largest source of integrated species-related data in the Australian region, it is far from comprehensive on most species, and that is more likely of invasive species. A resource such as the Atlas does however provide an extremely valuable service as a data aggregator by publically exposing gaps in data, functions and services. Lists of species such as WoNS are supported (<http://lists.ala.org.au>), but determining the true

geographic range of these species will only be as good as the associated observations. By exposing the data, gaps in geographic ranges of species can not only be identified, but filling them is readily facilitated using applications and services built by the Atlas for field and desktop data entry.

Invasive species parallel their protected species counterparts in having heightened degrees of information sensitivity. Accurate locations of rare and endangered plants and animals may not be publically available so as to minimise the chance of disturbance or eradication. Once a species is flagged as potentially invasive, information may be withheld from segments of the community. For example, several *Bactrocera* fruitfly species are highly significant to agricultural trade routes in many parts of the world, including Australia and New Zealand. Information on the presence or absence of these species is therefore sensitive, particularly while new records are being verified. Unlike protected species, invasives have no status other than a black/white flag such as 'pest' or 'weed' and this restricts the refinement that could be applied to sensitivity of the data. The Atlas has a Sensitive Data Service that is capable of differentiating rules for the delivery of information about a species by jurisdiction. For example, information about a protected species that has a distribution across political boundaries can be provided in accordance with that jurisdiction. If there was an agreed international and national set of criteria for defining degree of invasiveness, the Atlas could deliver information controlled by any combination of invasiveness and jurisdiction.

Fragmentation in the community dealing with invasive species is also an impediment to creating a Black List. At least 40 agencies and groups in Australia have some interest in invasive species. Like biological data generally, stratification is first seen at the State, Territory and Federal level. There are national initiatives such as WoNS, but there are also State and Territory lists of weed species. There are separate cooperative research centres for plant biosecurity and invasive animals. There is a biosecurity section in the Federal Department of Agriculture and a State and Territory equivalents, a Weeds of Australia list that is supported by the Australian Weeds Committee and 'State and Territory Weeds Management Arrangements' published by the Federal Department of the Environment. The Atlas could help to integrate core information about invasive species across the many agencies through its existing infrastructure. The Atlas already provides a wide range of information about plants, animals, fungi, terrestrial species and environmental information at all scales from all States and Territories, and marine species and associated

environmental information from waters in the Australian region. More importantly, the Atlas has the information infrastructure, functions and services that could support the concept of a Black List. The Atlas already provides services such as the NSL, field data entry (<https://fieldcapture.ala.org.au/>, <http://bowerbird.org.au/>, <https://m.ala.org.au/>), citizen science programs (e.g., <http://volunteer.ala.org.au/>), images (<http://images.ala.org.au/>) and other trait data, species lists (<http://lists.ala.org.au/>), data sensitivity (<http://sds.ala.org.au/>), mapping and analytical tools (<http://spatial.ala.org.au/>) and extensive range of interfaces to support all communities, from primary school education through research to area management.

The Global Invasive Alien Species Information Partnership (GIASIP) was formed to address ‘...a lack of coordination between the information producers and [what] they make their information available in different places and in different ways’. The partnership further suggest that ‘This has led to unfilled gaps in knowledge, duplication of work, and problems for users in navigating to the web sites and publications to find the data they need’.

The Partnership, mandated by the CBD, includes an extensive and inclusive list of relevant organisations, including for example the Invasive Species Specialist Group of the IUCN Species Survival Commission, the Global Biodiversity Information Facility (GBIF), Asia-Pacific Forest Invasive Species Network (APFISN), and CABI. To meet new global targets for managing invasions (Aichi Target 9; <http://www.cbd.int/sp/targets/rationale/target-9/>), knowledge compilation and dissemination must be as efficient as possible, and tailored to the needs of the users (<http://giasipartnership.myspecies.info/node/18>). In short, GIASIP recognises the same gaps that we identify here and therefore the requirement for consistent data supported by effective and interconnected information infrastructure. The Atlas, the national node for GBIF, provides a foundation based on international standards and as noted above, an extensive information architecture supporting species information.

On a positive side, the rapid recent growth of citizen science brings great potential to the management of invasive species (Dickinson *et al.* 2012). As noted by the European Union report on Environmental Citizen Science (Science Communication Unit, University of the West of England, 2013), successful projects that engage the public depend on clear and consistent guidelines developed by scientists and practitioners. Such guidelines however represent a fundamental problem in the domain of invasive species. The diversity of interests including ‘political sensitivities’, inconsistent terminology, taxonomy issues, lack of

species information including geographic distributions and a multitude of information silos make community engagement and education a difficult proposition.

CONCLUSIONS

The Atlas of Living Australia’s integrated data, functions and services highlighted the need for the concept of invasiveness. There is no invasive equivalent to conservation status; a Black List that would help to promote internationally agreed terms and criteria against invasive species. A lack of consistency in terminology, and the fragmentation of inadequate available data into information silos with various levels of access makes the management of invasive species a more difficult proposition than it should be.

Australia would do well to engage with GIASIP to work toward agreed criteria and process that would enable information and infrastructure gaps to be recognised and addressed. It is well-positioned to provide global leadership in this regard. In Australia, the Atlas already provides an information architecture that supports full and free access to the widest variety of information about species and their environments in the Australian region. The Atlas supports most species-related information, a wide range of user communities, data entry and validation, mapping and analysis among other functions and services. Profiling the Atlas to demonstrate the benefits of effective information management on invasive species, and to illustrate effective approaches for dealing with the problems outlined above will serve both national and international interests.

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