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POLICY BRIEF

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From invasive alien species records to better decisions

Practical lessons for regional and national authorities from South Africa and Flanders

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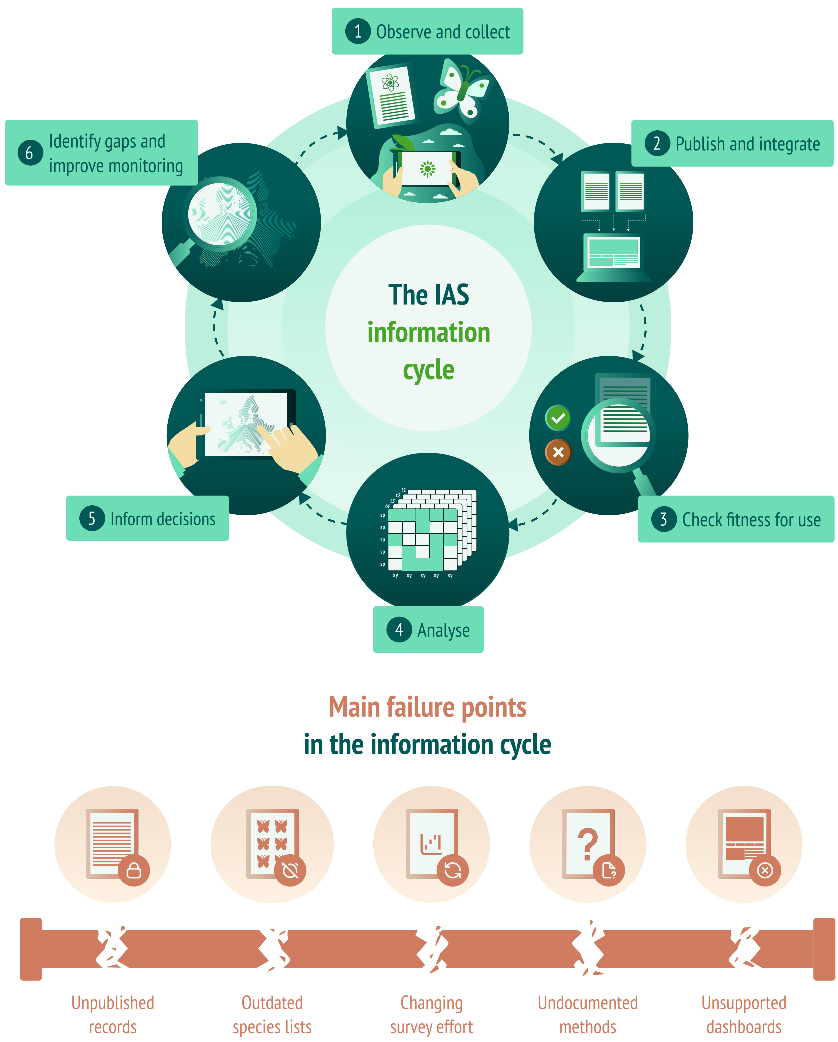
Authorities need to know which alien species are present, where they occur, whether they are spreading, what impacts they are having and whether management is working.

In many countries and regions, much of the necessary information already exists. It is held in citizen science platforms, monitoring programmes, grey literature, research projects, museums and herbaria, reports from government departments and management authorities, and scientific publications. The problem is that these sources are often fragmented, are not FAIR (Findable, Accessible, Interoperable, and Reusable) [1], and are not regularly updated. As a result, considerable effort is spent reconstructing the evidence base for each new assessment or reporting cycle, there are often substantial delays between the collection of data and their incorporation into assessments, and, despite such efforts, existing evidence is often not considered in the decision-making and management related to biological invasions [2].

Case studies undertaken through the B-Cubed project in South Africa [3] and Flanders [4], Belgium, show how regional and national authorities can improve this situation. Although the two places differ greatly in size, biodiversity, demography, institutional frameworks and data availability, they point to the same conclusion:

Better invasive alien species information depends on the organisation, publication and maintenance of data.

The South African case shows how standardised species lists, repeatable workflows and a clear reporting framework strengthen national assessments of biological invasions. The Flanders case shows how openly published occurrence data can be transformed into maps and indicators. Together, the case studies demonstrate that changes in survey effort and data-publication practices can easily be mistaken for ecological change, both must therefore be addressed explicitly in assessments.



Regional and national authorities do not need to build the necessary infrastructure from scratch. Existing services such as GBIF provide shared standards, data-publishing infrastructure, persistent identifiers and tools for accessing and processing biodiversity data [5]. These can be connected to national species lists, monitoring programmes and reporting systems to produce information tailored to regional and national needs.

The lessons from the two case studies are therefore about making better use of existing infrastructure and filling the gaps that remain. The starting point is to organise these resources around the decisions they need to support.

Build the Information System Around Decisions

An invasive alien species information system should begin with the questions that authorities and managers need to answer:

- **Which alien species are present?**
- **Which species are newly detected or changing status?**
- **Where are they spreading?**
- **What impacts are alien species having?**
- **Are prevention, control and eradication measures working?**
- **Where are the most important gaps in surveillance?**
- **Which pathways, species and sites require more attention?**

These questions require more than occurrence records. They require connected information on species identity, introduction and establishment status, distribution, impacts, pathways and management.

South Africa's reporting framework illustrates the value of organising information around pathways, species, sites and interventions [6]. This provides a clearer link between the evidence collected and the decisions it is intended to support. It also helps identify what information is missing and what is needed to improve management – a single headline indicator can provide an important summary statistic, but more detailed indicators are needed to guide specific action.

Recommended action

Authorities should agree on the decisions the information system must support and identify the minimum data needed for each indicator.

Maintain an Authoritative and Living Species List

The backbone of an effective information system is a regional or national list of alien species [7], [8]. It provides the reference against which occurrence records can be selected, checked and interpreted.

The list should contain more than scientific names. Where evidence allows, it should include (or link to) information on accepted taxon names and synonyms, presence within the territory, introduction and establishment status, pathways of introduction and spread, introduction date, last recorded date, known distributions, evidence of impacts, management or regulatory status, sources and the date of the most recent assessment.

South Africa's experience shows the value of consolidating information from many sources into a standardised list and documenting how names and statuses have been assessed [9], [10]. It also shows that such a list is never finished. New species are detected, evidence changes and taxonomic names are revised. The aim should therefore be a maintained and versioned resource, rather than a static table. For Flanders, this reference function is provided by the Belgian GRIIS checklist [11], which offers a standardised and reusable basis for identifying alien species in the region.

Recommended action

Assign clear institutional responsibility for maintaining the list, including procedures for submitting evidence, reviewing changes, resolving uncertainty and publishing updated versions.

Make Data Publication Part of Monitoring

Collecting data is not enough. Records must reach the information systems used for analyses and decision-making. Publication delays, incomplete mobilisation and changes in data-sharing practice can create misleading patterns, meaning that the information used for an assessment does not accurately reflect what is actually happening [12], [13].

In Flanders, publication of native species records from citizen science platforms lags behind, causing biases in observation effort patterns [2]. Also, a change in the records published by a citizen science source produced a marked break in the time series. Records of recent years are also incomplete because of publication delays. Such changes can resemble genuine increases or declines in species occurrence unless the history of the data flow is understood.

The South African case similarly found that usable digital occurrence data were not available for many taxa on the national alien species list. Some records remained in literature, institutional databases or monitoring programmes and had not reached shared data infrastructures. This limits both spatial assessments and the capacity to update lists efficiently.

Recommended action

Publicly funded surveillance and research programmes should include data publication in their work plans, budgets and deliverables. The drafting of data management plans and the inclusion of data deposition requirements in public tendering procedures can improve this situation. Publication should use recognised biodiversity standards and should take place regularly, not only at the end of a project or reporting cycle.

Authorities should also maintain a simple register of the principal datasets used, who is responsible for each dataset, how often it is updated, known gaps or interruptions, and important changes in collection or publication methods.

Use Repeatable Workflows Rather than Rebuilding Assessments

National and regional biodiversity assessments are often produced through a sequence of manual steps known only to a small number of specialists. This creates substantial work at each reporting cycle and makes it difficult to explain why results have changed.

Both B-Cubed case studies demonstrate the advantages of documented and repeatable workflows. These can standardise taxonomy and data-quality rules, retrieve and aggregate records consistently, retain the queries and source datasets used, produce comparable results at different spatial scales, be rerun when data are updated, and provide citable and auditable analytical products [5], [14]. Factsheets for indicators explain the methodology and what the indicator does, and does not show [15].

In South Africa, the use of occurrence cubes reduced the processing of hundreds of thousands of records from a task lasting weeks to one that could be completed in hours. The same approach also made it possible to apply consistent filters and aggregate results from grid cells to provinces, biomes, catchments and other reporting units.

Repeatability does not mean that methods can never change. It means that changes are deliberate, documented and distinguishable from changes in the underlying environment. It also reduces the reliance on a few individual experts who understand the reporting processes, helping to ensure institutional memory and that lessons are retained.

Recommended action

For every regularly produced map or indicator, authorities should retain the source data and their versions, the taxonomic and geographic scope, the filtering and quality-control rules, the analysis code or documented procedure, the resulting data product, and a record of changes from the previous version.

Publish Data Quality Alongside Ecological Results

More observations need not mean more invasive species. They may reflect more observers, better digital tools, targeted projects or increased publication. For effective decision-support, therefore, it is vital to distinguish between better information and more invasions [16], [17], [18].

Both case studies showed large differences in recording intensity among places, years, and data publishers. In the absence of structured surveillance, which is the case for most species and areas, apparent changes in data should not be misinterpreted as changes in nature. Increasing observations may result from growing citizen science activity or the digitisation of historical collections. Furthermore, the apparent richness at a certain location could reflect how often it was visited rather than its ecological condition. The Flanders case study tested ways to expose this problem, including maps of total recording effort, estimates of data completeness and analyses restricted to comparatively well-surveyed cells.

There were also marked differences between taxa. In South Africa, coverage was much better for plants and birds, than for invertebrates, microorganisms, soil organisms and marine taxa.

Data-quality measures are therefore not technical footnotes. They are part of the evidence, and essential if appropriate policy-relevant conclusions are to be made.

Recommended action

Every map, trend or indicator based on occurrence data should be accompanied by information on recording intensity, spatial and taxonomic coverage, publication delays, data completeness, coordinate and temporal uncertainty, confidence intervals or other estimates of uncertainty, and important changes in monitoring or data publication.

Statistical uncertainty needs to be clearly separated from systematic uncertainty, but both need to be addressed.

Use Data Gaps to Direct Surveillance

Data gaps are not merely limitations. When mapped and described, they can help authorities decide where monitoring is most needed.

The Flanders case showed how maps of undersurveyed areas can guide volunteer recording and structured monitoring. For invasive alien species, surveillance can be directed towards: poorly recorded regions, ports and transport corridors, protected areas and vulnerable ecosystems; taxa with little available information; species suspected to be present but not confirmed; and places where management decisions are being made with weak evidence [19], [20].

Recommended action

Authorities should produce a regular surveillance-gap assessment alongside their ecological assessment. Funding for monitoring should be prioritised partly on the basis of these gaps.

Integrate Outputs into Established Information Services

Dashboards can make maps and indicators more accessible. The Flanders case developed a public dashboard to test indicators and demonstrate how they could be communicated. Importantly, the work was carried out with the maintainers of existing biodiversity services to be sustainable beyond the project funding, and outputs were prepared in interoperable formats so that they could be incorporated into other platforms.

Recommended action

New analytical workflows should feed established species portals, biodiversity information systems and reporting processes wherever possible. Project dashboards should be treated as prototypes unless there is an agreed institution, budget and technical plan for their long-term maintenance. Machine-readable outputs should be published alongside visualisations so that others can reuse the results.

A Practical Programme for Regional and National Authorities

The objective is not simply to collect more records. It is to create a dependable flow of evidence from observation to publication, assessment and action...

1. Establish governance

Identify the authority responsible for the species list, occurrence data, impact information, analytical workflows and publication. Agree how regional agencies, researchers, managers and citizen science organisations contribute.

2. Consolidate the evidence base

Create or update the authoritative alien species list. Identify the main occurrence, impact and management datasets and assess which are publicly available.

3. Improve publication

Agree on standards, update schedules and licensing arrangements. Ensure that data collected with public funding are published promptly.

4. Automate recurring tasks

Develop documented workflows for taxonomy, data retrieval, quality checks, spatial aggregation and production of maps and indicators.

5. Assess fitness for use

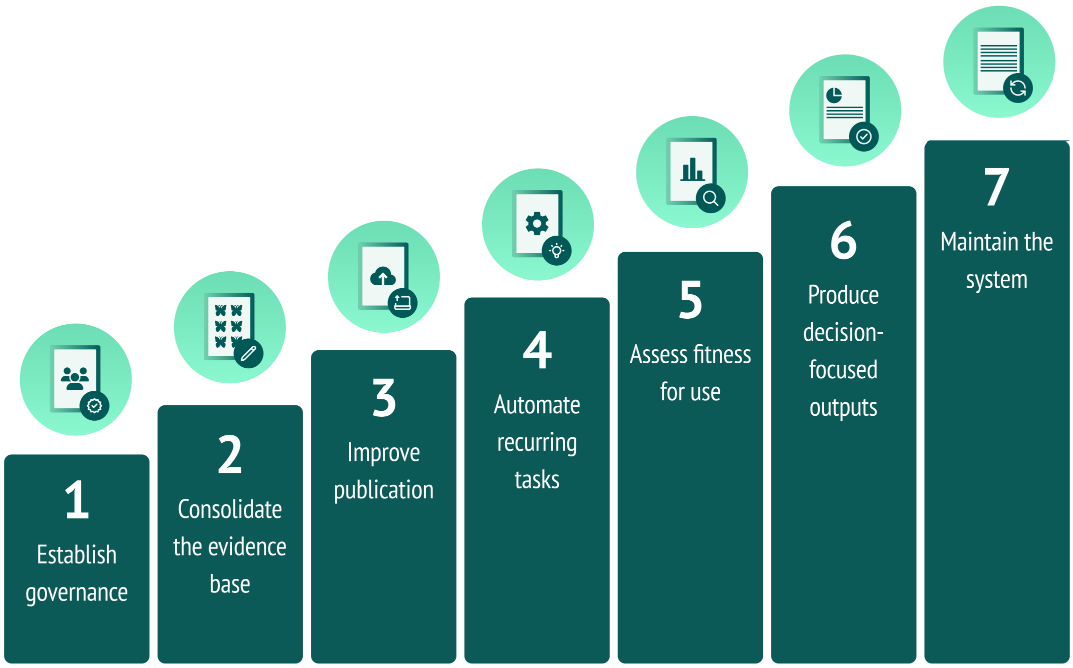
Calculate survey-effort and completeness measures. Identify where the available data support robust interpretation and where they do not.

6. Produce decision-focused outputs

Publish maps and indicators that answer agreed management questions. Include uncertainty, limitations and links to the underlying evidence.

7. Maintain the system

Budget for curation, hosting, software maintenance and regular review between major reporting cycles.



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