How to use international data standards in national and regional databases containing information on invasive alien species

The Kunming-Montreal Global Biodiversity Framework has 23 action-oriented global targets for urgent action over the decade to 2030, and one of these, target 6, aims to address threats posed by invasive alien species (Box 1).

Box 1. What are invasive alien species?

An alien species is a species, subspecies or lower taxon, introduced outside its natural past or present distribution; this includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce.[1] An invasive alien species is an alien species whose introduction and/or spread threaten biological diversity.

Invasive alien species are one of the major drivers of biodiversity loss, and cause dramatic, and in some cases irreversible changes to ecosystems[2]. They have contributed solely or alongside other drivers to 60 per cent of recorded global extinctions and are the only driver in 16 per cent of documented global extinctions[3]. Their impacts occur through different interactions, such as out-competing or predating upon native species, hybridisation, transmission of diseases, or biofouling.

The target aims to eliminate, minimize, reduce and/or mitigate the impacts of invasive alien species on biodiversity and ecosystems. To achieve this, the target sets out three overarching actions, two of which aim to prevent introductions and establishments of new invasive alien species, and the third aims to eradicate or control existing invasive alien species, especially in priority sites, such as islands.

Data is fundamental for identifying and prioritising invasive alien species, pathways of introduction and management actions as required for meeting target 6. It also enables the establishment of baselines and progress towards targets and goals or interventions to be monitored. One of the essential requirements for countries to assess, manage and monitor biological invasions is an inventory or checklist of alien and invasive alien species present in the country.

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1   CBD/COP/DEC/VI/23 Alien species that threaten ecosystems, habitats or species
2   IPBES. (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E.S. Brondízio., H.T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K.A. Brauman, S.H.M. Butchart, K.M.A. Chan, L.A. Garibaldi, K. Ichii, J. Liu, S.M. Subramanian, G.F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y.J. Shin, I.J. Visseren-Hamakers, K J. Willis, and C.N. Zayas eds.. IPBES secretariat, Bonn, Germany. https://zenodo.org/records/3553579
3   IPBES. (2023). Summary for policymakers of the thematic assessment report on invasive alien species and their control of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Roy, H.E., Pauchard, A., Stoett, P., Renard Truong, T., Bacher, S., Galil, B.S., Hulme, P.E., Ikeda, T., Sankaran, K.V., McGeoch, M.A., Meyerson, L.A., Nuñez, M.A., Ordonez, A., Rahlao, S.J., Schwindt, E., Seebens, H., Sheppard, A.W., and Vandvik, V. (eds.). IPBES secretariat, Bonn, German. https://doi.org/10.5281/zenodo.7430692

Developing an inventory or checklist of alien and invasive species

An inventory or checklist is a catalogue and summary of a set of organisms, it includes the organism's scientific name, common name, location, citation and other annotations related to the purpose of development of the checklist, (e.g. status as an invasive alien species). Ideally, such an inventory is dynamic, with new alien species added as they are reported on the territory.

Information and data, to derive baseline information for the region of interest, can be collated from authoritative and reliable resources including results of vegetation and faunal surveys, field guides, biodiversity reports, results of research published in peer-reviewed literature, customs inspection data, or taxonomic experts. Also, citizen science portals can provide valuable contributions to species checklists in an area. For example, global platforms like iNaturalist[4], eBird[5] and Observation.org[6] have built-in species checklist functionality.

What are Data Standards?

Data standards refer to shared rules and conventions to describe, record and structure datasets. Implementing data standards help maintain a proper flow and use of data across institutions and agencies.

In the case of data related to alien and invasive alien species standards for some key data components have been developed over the past two decades through initiatives led by global data providers such as the IUCN Invasive Species Specialist Group (ISSG), GBIF and CABI International (Table 1). Some of these data standards have been widely adopted for example, terminology related to

pathways of introduction of alien and invasive species[7], and terminology to describe mechanism and magnitude of impacts[8]. Data standards to facilitate sharing of biodiversity data have been set by the Darwin Core Standards, maintained by the Darwin Core Maintenance Group and published by the Biodiversity Information Standards (TDWG)[9].

Minimum information required for a baseline inventory of invasive alien species

The **minimum information** required to develop a baseline inventory or checklist to manage and monitor biological invasions, includes **the scientific and common name of the species, its provenance or origin, its pathway of entry or introduction, its occurrence status (presence/absence), its degree of establishment (invasion status), and information on impacts on natural areas and native species**. See Table 1 for a list of data components that may be recorded in the baseline inventory or checklist.

Baseline information should be maintained and updated on a regular basis if possible. Since data and information on invasive alien species is often held by different institutions for various purposes (i.e. customs, animal and plant health), collating this information may require engagement across ministries. Databases and resources can be national or sub-national, regional, or global.

A list of invasive alien species that are currently known or suspected to have impacts on biodiversity and ecosystems within the geographic location of interest is usually the most accessible information with which to start. This can be extended to include alien species known to have been recorded in the country. As a starting point there

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4   iNaturalist https://www.inaturalist.org/, also see 'places' https://www.inaturalist.org/places
5   eBird https://ebird.org/home
6   Observation.org https://observation.org/
7   A hierarchical framework of pathways of introduction of alien and invasive alien species at two levels of class and subclass, was developed in response to a request from Parties to the CBD (CBD/COP/XI/28). The pathways classification scheme can be found here CBD/SBSTTA/18/9/ Add.1
8   Impact data standards- The Environmental Impact Classification for Alien Taxa (EICAT) is the IUCN global standard for measuring the severity of environmental impacts caused by animals, fungi and plants living outside their natural range https://iucn.org/resources/conservation-tool/ environmental-impact-classification-alien-taxa
9   Darwin Core https://www.tdwg.org/standards/dwc/#darwin-core-list-of-terms

are freely available global and regional databases including the Global Register of Introduced and Invasive Species (GRIIS)[10] which provides national checklists of alien species and is openly available on the Global Biodiversity Information Facility (GBIF). These can be supplemented by additional information from a variety of sources, including reports, surveys and consultation with local experts.

Alien species lists do not need to be complete to be useful, partial lists can provide a good starting point for an action plan. **Recognising knowledge gaps in the baseline data is important**.

Table 1: Data components to consider including when developing an inventory or checklist of alien and invasive alien species. Data components and Descriptors in italics are optional

Data component	Descriptor	Data Standards
Taxon ID. [11]	Index number or Record ID	
Geographic location such as country, island, protected area, lake etc.	Geographic location which is the subject of the inventory or checklist	Use of the ISO Code[12]; Darwin Core standards
Species name (including sub species, varieties, forms where relevant)	Scientific name	Darwin Core standards
Taxonomic status (if the scientific name is an accepted name or synonym)[13]	Use a selected taxonomic backbone for example GBIF Species matching tool.	Darwin Core standards
Higher taxonomy	Kingdom, Phylum, Class, Order, Family	Darwin Core standards
Habitat or Environment	Terrestrial, freshwater, brackish, marine or host	Darwin Core Standards; IUCN Red List Habitat Classification scheme[14]
Occurrence status	If the species is present, absent, eradicated or if its presence is uncertain	Darwin Core Standards; GRIIS
Provenance or Origin	If the species is alien, cryptogenic (of uncertain origin), or a native | alien (native to the country and introduced by humans outside its native range in that same country)	Darwin Core Standards; GRIIS
Native range	The native range of the species (natural distribution area).	World Geographical Scheme for Recording Plant Species Distribution (WGSRPD), UN geoscheme for other spp.
Invasiveness	Status – invasive (If the species has displayed any negative impacts in that country)	GRIIS; Darwin Core Standards

10 The Global Register of Introduced and Invasive Species (GRIIS) presents inventories or checklists of introduced and invasive species for a suite of geographical entities such as countries, islands, protected areas etc. GRIIS which is maintained by the IUCN ISSG was developed as a product of the Global Invasive Alien Species Information Partnership (GIASIP) of the CBD. GRIIS inventories or checklists, that can be accessed through country profiles on the CBD website were intended to support countries to achieve Aichi Target 9 https://griis.org/
11 In a database, it is important that each name has a unique identifier to support querying and analysis of the data.
12 ISO Codes https://www.iso.org/iso-3166-country-codes.html
13 When looking for information on a species, it is important to consider taxonomic changes, as valuable information could be published under an "old" name that is now considered a synonym
14 IUCN Red List Habitat Classification Scheme https://www.iucnredlist.org/resources/habitat-classification-scheme

Data component	Descriptor	Data Standards
Degree of establishment	The stage in the invasion process a species has reached.	Darwin Core Standards
Date of introduction or first report	*This data is useful to map trends of species introductions and is often used for policy indicators*	GRIIS; Darwin Core Standards
Pathways of introduction	*If the species was introduced intentionally or unintentionally and the type of introduction pathway*	CBD Hierarchical pathway schema;[15] Darwin Core Standards
Impact data including mechanisms of impact and outcome of the impact	*Mechanisms can include predation, hybridisation resulting in outcomes such as population decline*	The Environmental Impact Classification for Alien Taxa (EICAT) and Socio-economic impact classification of alien taxa (SEICAT)[16]
Citation or Reference	Source of data	Darwin Core standards (preferably DOI)
Date of recording	To record the history of any modifications made	Darwin Core standards
Other data	Other data can include for e.g. if the species is managed	

The full toolkit developed to support Parties in the implementation of Target 6 can be accessed here
www.cbd.int/invasive/cbdtoolkit

Additional reading

GBIF (2017) Best Practices in Publishing Species Checklists, version 2.1. Copenhagen: GBIF Secretariat. https://ipt.gbif.org/manual/en/ipt/3.0/best-practices-checklists

An Essential Biodiversity Variable Approach to Monitoring Biological Invasions: Guide for Countries. GEO BON Technical Series (2) <https://www.geobon.org/downloads/biodiversity-monitoring/technical-reports/GEOBON/2015/Monitoring-Biological-Invasions.pdf>

IUCN Red List categories and criteria, version 3.1 <https://portals.iucn.org/library/node/7977>

European Commission, Directorate-General for Environment, Harrower, C., Scalera, R., Pagad, S. et al., *Guidance for interpretation of the CBD categories of pathways for the introduction of invasive alien species*, Publications Office, 2020, https://data.europa.eu/doi/10.2779/6172

Pagad S, Genovesi P, Carnevali L, Schigel D, McGeoch MA (2018) Introducing the Global Register of Introduced and Invasive Species. Scientific Data, 5, 170202. <https://www.nature.com/articles/sdata2017202>

15   CBD/SBSTTA/18/9/Add.1
16   Socio-economic impact classification of alien taxa (SEICAT) <https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/2041-210x.12844>