Semi-automatic prioritization of species for pest risk analysis using the CABI Horizon Scanning Tool

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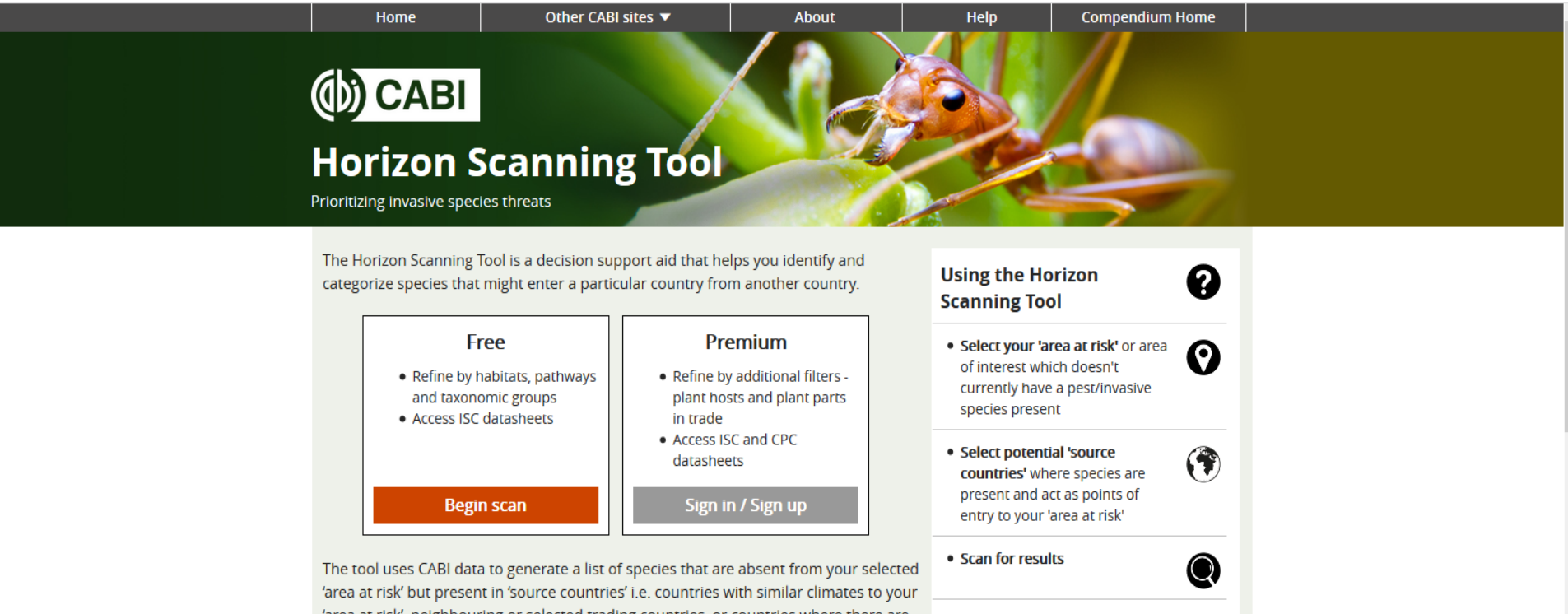
KNOWLEDGE FOR LIFE

Horizon Scanning Tool

Prioritizing invasive species threats

Targeted users: risk assessors, plant protection officers, quarantine officers, protected area managers and researchers

The tool provides: user-friendly means of accessing a large volume of relevant data for categorizing and prioritizing potential invasive species threats to a country, state or province.



Horizon Scanning Tool

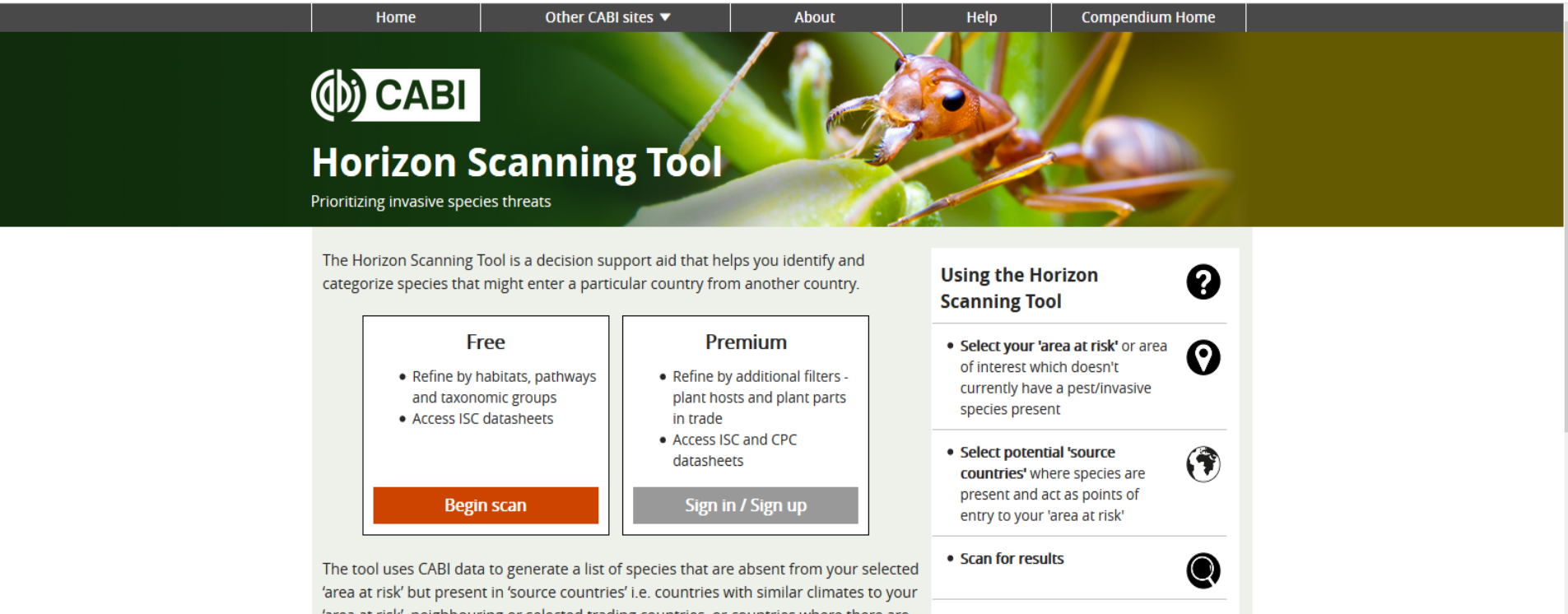
Prioritizing invasive species threats

Open source - available the Invasive Species Compendium (ISC)

- https://www.cabi.org/isc/
- https://www.cabi.org/horizonscanningtool

Premium version - available on the Crop Protection Compendium (CPC)

- Additional filters: Hosts and Plant parts in trade
- Access also to CPC datasheets



Horizon Scanning Tool

Prioritizing invasive species threats

1. Select ‘area at risk’
2. Information from CABI **Compendia datasheets** is used to generate a list of species that are absent from the selected ‘**area at risk**’ but present in ‘**source areas**’.

Area at risk: Can be a country, UKOT or Compendia subnational region.

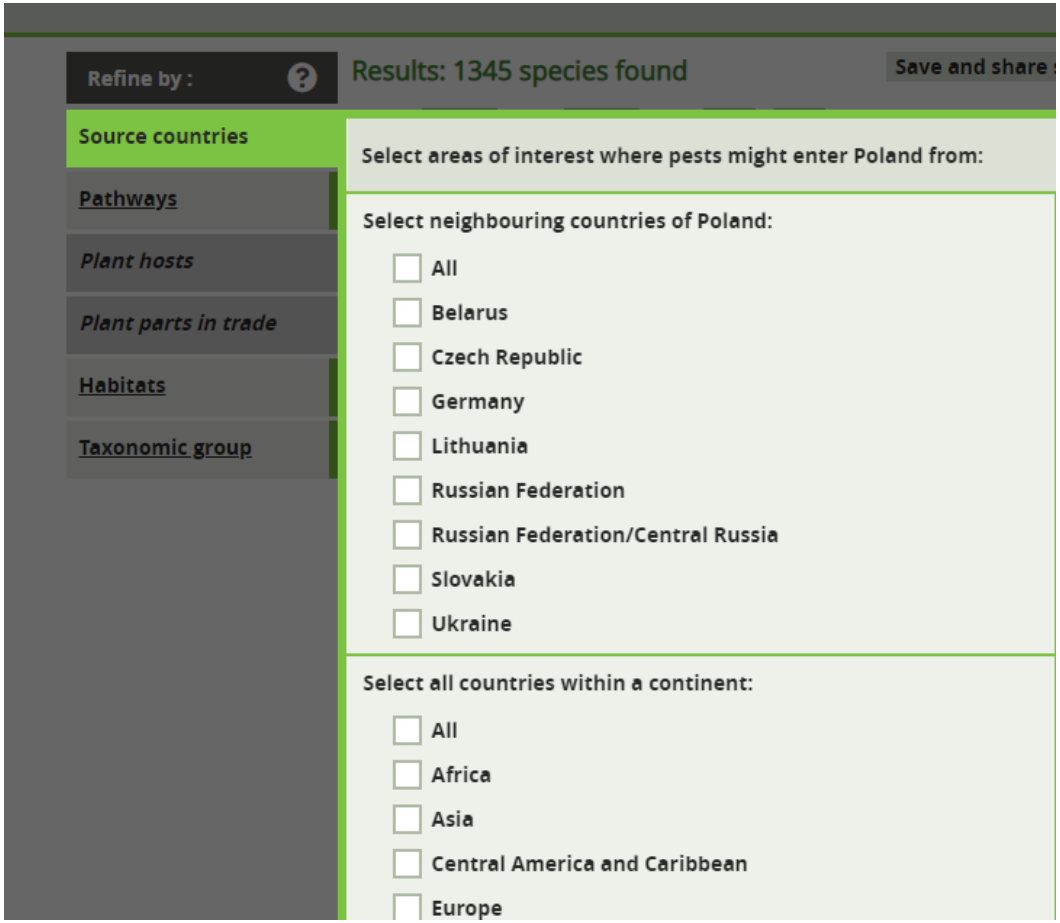
Horizon Scanning Tool – Refine Search

Source Country:

Species in the scan results are recorded as ‘present’ in the ‘source countries’.

Can be selected using:

- Neighbouring countries (by land border)
- Countries with matching climates (Köppen-Geiger climate classification)
- Top 10 countries based on trade



Horizon Scanning Tool – Refine Search

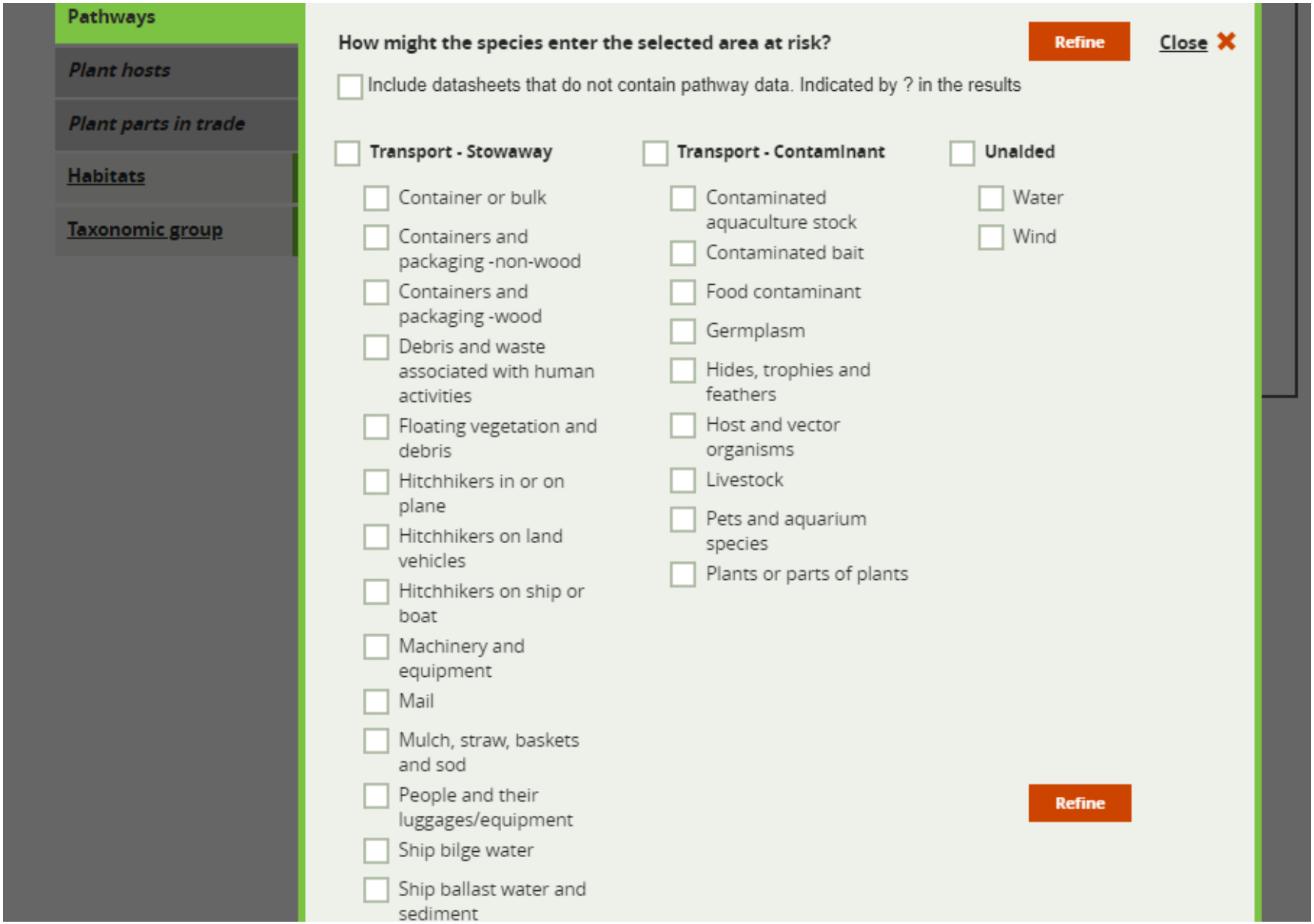
Pathways:

The pathway of introduction - the physical means by which the species can be transported (as a ‘stowaway’, ‘contaminant’, or ‘unaided’).

Classification based on *Carlton JY, Ruiz GM, 2005. Vector science and integrated vector management in bioinvasion ecology: conceptual frameworks. In: Invasive Alien Species: A New Synthesis (ed. by Mooney HA et al.). Island Press, Washington, USA* .

In the Horizon Scanning Tool, the Compendia pathways have been mapped under the main headings of the Convention on Biological Diversity (CBD) scheme.

The ***CBD*** scheme is now widely accepted. *https://www.cbd.int/doc/meetings/sbstta/sbstta-18/official/sbstta-18-09-add1-en.pdf).*


Pathways
Plant hosts
Plant parts in trade
Habitats
Taxonomic group
How might the species enter the selected area at risk?
Refine
Close
Include datasheets that do not contain pathway data. Indicated by ? in the results
Transport - Stowaway
Container or bulk
Containers and packaging -non-wood
Containers and packaging -wood
Debris and waste associated with human activities
Floating vegetation and debris
Hitchhikers in or on plane
Hitchhikers on land vehicles
Hitchhikers on ship or boat
Machinery and equipment
Mail
Mulch, straw, baskets and sod
People and their luggages/equipment
Ship bilge water
Ship ballast water and sediment
Transport - Contaminant
Contaminated aquaculture stock
Contaminated bait
Food contaminant
Germplasm
Hides, trophies and feathers
Host and vector organisms
Livestock
Pets and aquarium species
Plants or parts of plants
Unaided
Water
Wind
Refine

Horizon Scanning Tool – Refine Search

Other filters:

Plant hosts: one or more plant hosts may be selected using the scientific or common name (plants rated as primary or secondary hosts of a plant pest are included).

Plant parts in trade: the plant parts liable to carry a pest in trade or transport.

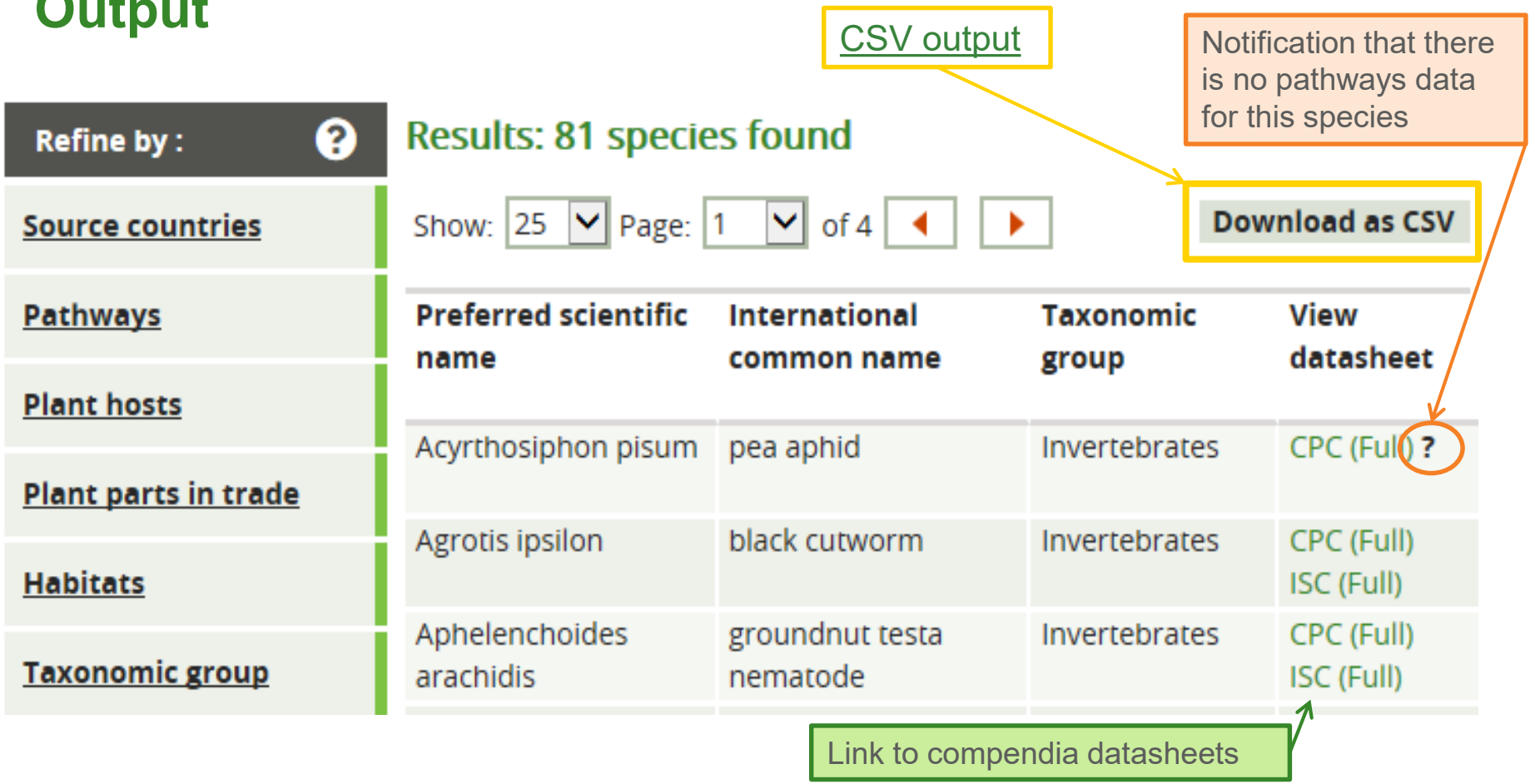
Habitats: the habitat(s) where the species has been recorded ('terrestrial – managed', 'terrestrial - natural/semi-natural', 'littoral', 'marine', 'freshwater', 'brackish', 'other').

Taxonomy: uses broad taxonomic groups ('bacteria', 'fungi/Chromista', 'invertebrates', 'plants', 'protozoa', 'vertebrates' and 'viruses'). Further taxonomic levels (to family) are in the CSV output.

Horizon Scanning Tool

Prioritizing invasive species threats

Output



Semi-automatic prioritization of species for pest risk analysis

- Currently the HST outputs are large particularly if no filters are selected. (>1000 species). How can we facilitate scoring and ranking of species?

- Solution: develop a semi-automatic system that will allow us to filter/prioritize the species using a combination of indicators created from available databases

- How? Validate the results with the horizon scanning list developed by expert consensus (CEH / GBNNS)

Expert based Horizon Scanning

- Establishing a list of key species that could arrive on St Helena over the next ten years and cause harm to St Helena's environment, economy, and the health of the community
- Organised by CEH and GB NNSS in St Helena (November 2018)
- By expert consensus developed a list of priority species

				Arrival	Establishn	Biodiversi	Human he	Economic	impact
2	species	common_	organism_	A	B	C	D	E	(A*B*C*D
3	Aedes aegypti	Yellow fev	Diptera	4	4	1	5	4	320
4	Afrogecko porphyreus	Marbled le	reptiles	5	4	5	1	1	100
5	Ageratum houstonianum		plant	2	4	3	1	3	72
6	Amphibalanus amphitrite	Striped Ba	Marine	5	5	3	1	1	75
7	Anolis sagrei	Brown anc	reptiles	5	4	5	1	1	100
8	Anopheles gambiae	-	Diptera	3	4	1	5	4	240
9	Anoplolepis gracilipes	yellow cra	Hymenopt	5	5	5	2	2	500
10	Anser anser f. domestica	feral goose	Birds	3	2	3	2	3	108
11	Antithamnionella spirographidis	Red alga	Marine	5	5	3	1	1	75
12	Ascidia sydneiensis	Ascidian	Marine	5	5	3	1	1	75
13	Aulacomya atra	Bivalve	Marine	5	5	3	1	2	150
14	Bactrocera cucurbitae	melon fly	Diptera	5	5	1	1	4	100
15	Balanus glandula	Barnacle	Marine	5	5	3	1	2	150
16	Bassia scoparia		plant	2	4	5	1	3	120

How good is the CABI HST to pick up the species selected by the experts?

Can we predict the species that should be pre-selected with data available?

Outcome: a filtered list

Within the pre-selected list can we rank the species based on indicators?

Outcome: a list of indicators to rank species

How good is the CABI HST to pick up the species selected by the experts?
Effects of Source country

Initially

- Namibia, South Africa and the Ascension Islands, were chosen as source countries
- Results = 63 of the 256 expert species appeared on the output from the HST.
- Of the top 20 only 50% also appeared on the HST output

Additional Source Countries

- Guatemala, UK and USA/Florida.
- Results = 111 of the 256 expert species appeared on the output from the HST.
- Of top 20, 13 now also appeared on the HST output
- Still only getting 64%, but source countries do make a difference!

Why are certain species on the expert list but not on the HST list?
Breakdown of top 100

- Of the top 100 ranking species identified by the experts' 46 were not on the HST output
- 26/46 were not found on the ISC at all: human disease vectors aren't included. Marine species are underrepresented. We could have synonyms problems. In contrast it covers well pathogens (excluded from the expert exercise)
- 8/46 only had basic data sheets on the ISC.
- 2/46 have spelling discrepancies.
- 4/46 were already present in Saint Helena according to ISC and therefore won't appear on the CABI HST output.
- 6/46 the reason for not appearing on the CABI Horizon output is unknown.

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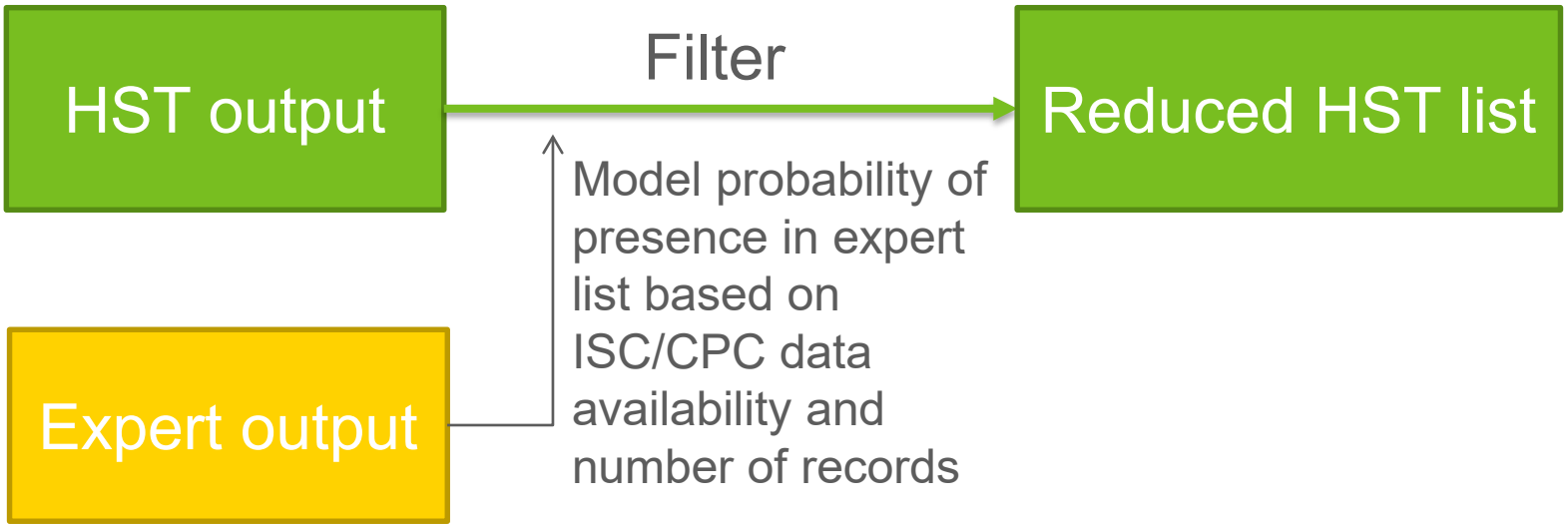
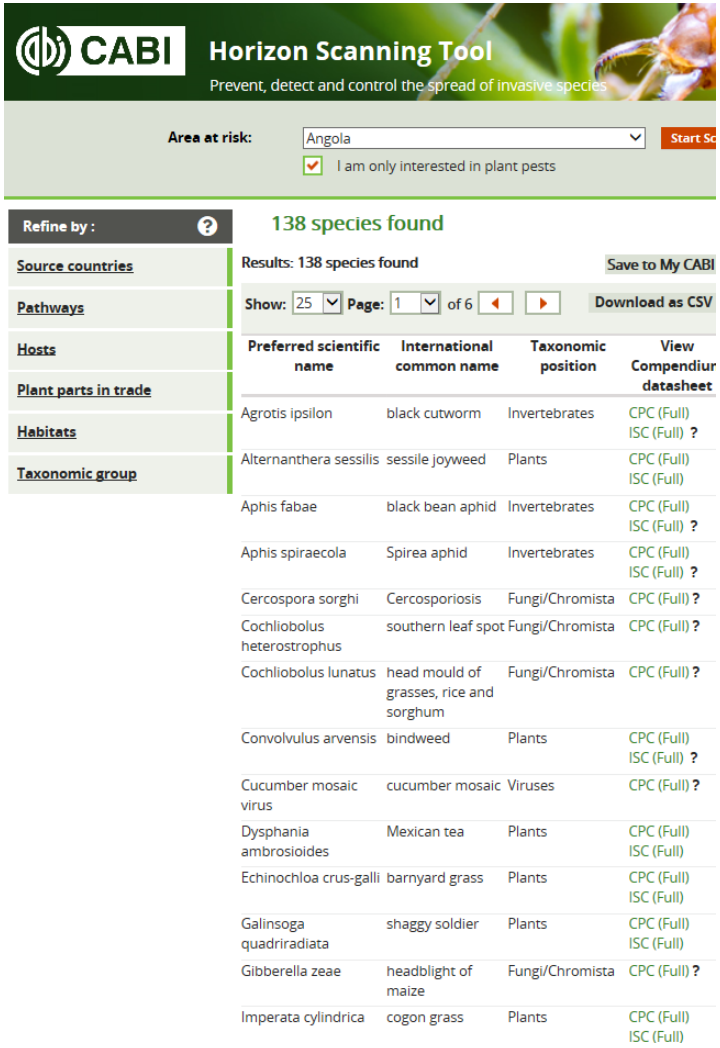
Prioritisation system conceptual approach



Assumptions:

1. The source countries filter is the main limit for arrival
2. Species with higher data availability and larger distribution are more likely to be problematic
3. The model calibrated with the expert list is very generic and don't consider context-dependent factors such as climate matching

CABI's Horizon Scanning Tool (HST)



Variables already available:

- The number of distribution records of presence
- The number of distribution records of presence in countries with matching climates
- The number of distribution records of presence in neighbouring countries to the country selected as the area at risk
- The number of hosts that have been recorded for that species
- Availability of data on habitat, pathways and datasheet

*All according to CABI data
https://www.cabi.org/horizonscanningtool

Model with current HST indicators

Aim to predict: probability of being in the expert list

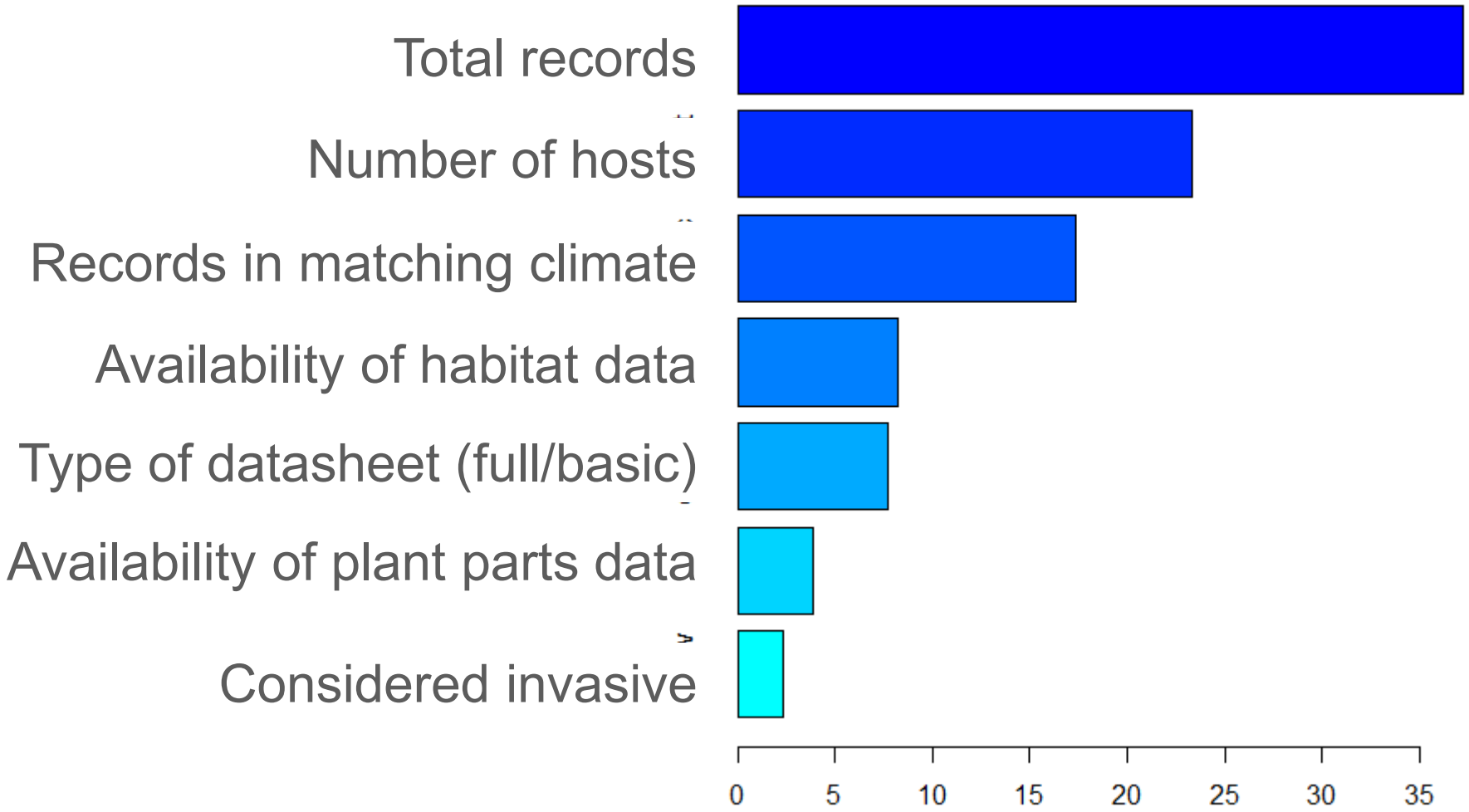
Data:
expert list (254 spp)
CABI HST output with additional countries (3700 spp)
Overlap between lists (114 spp)

Model: Boosted Regression Tree

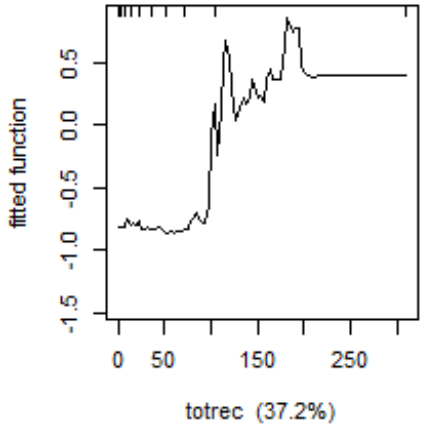
Variability explained: 24%

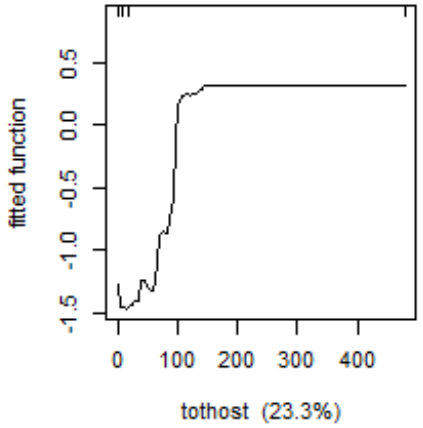
Threshold: prediction values from 0-1, using a cut-off of 0.05, gives a total of 903 species and 88% of species selected in expert list in the prediction.

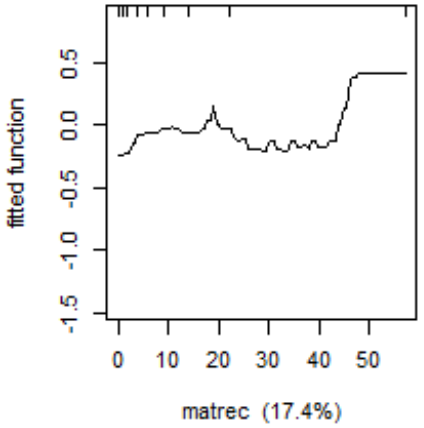
Relative importance of indicators

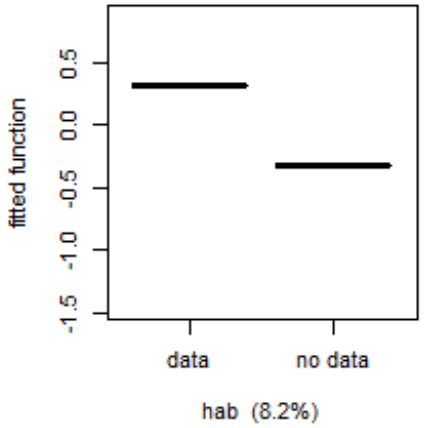


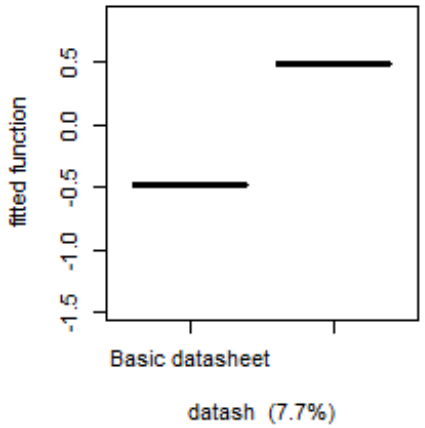
Relation with indicators

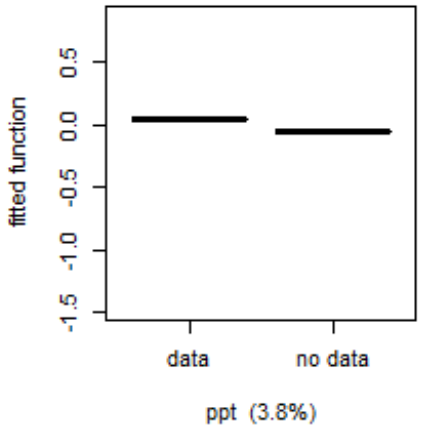


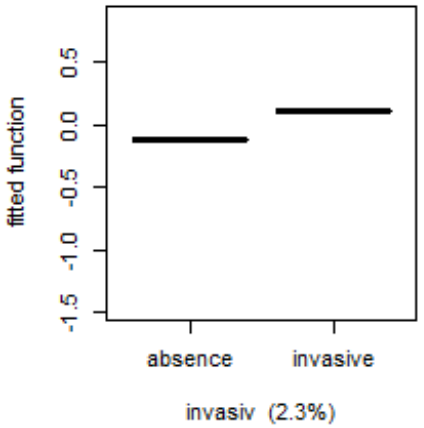












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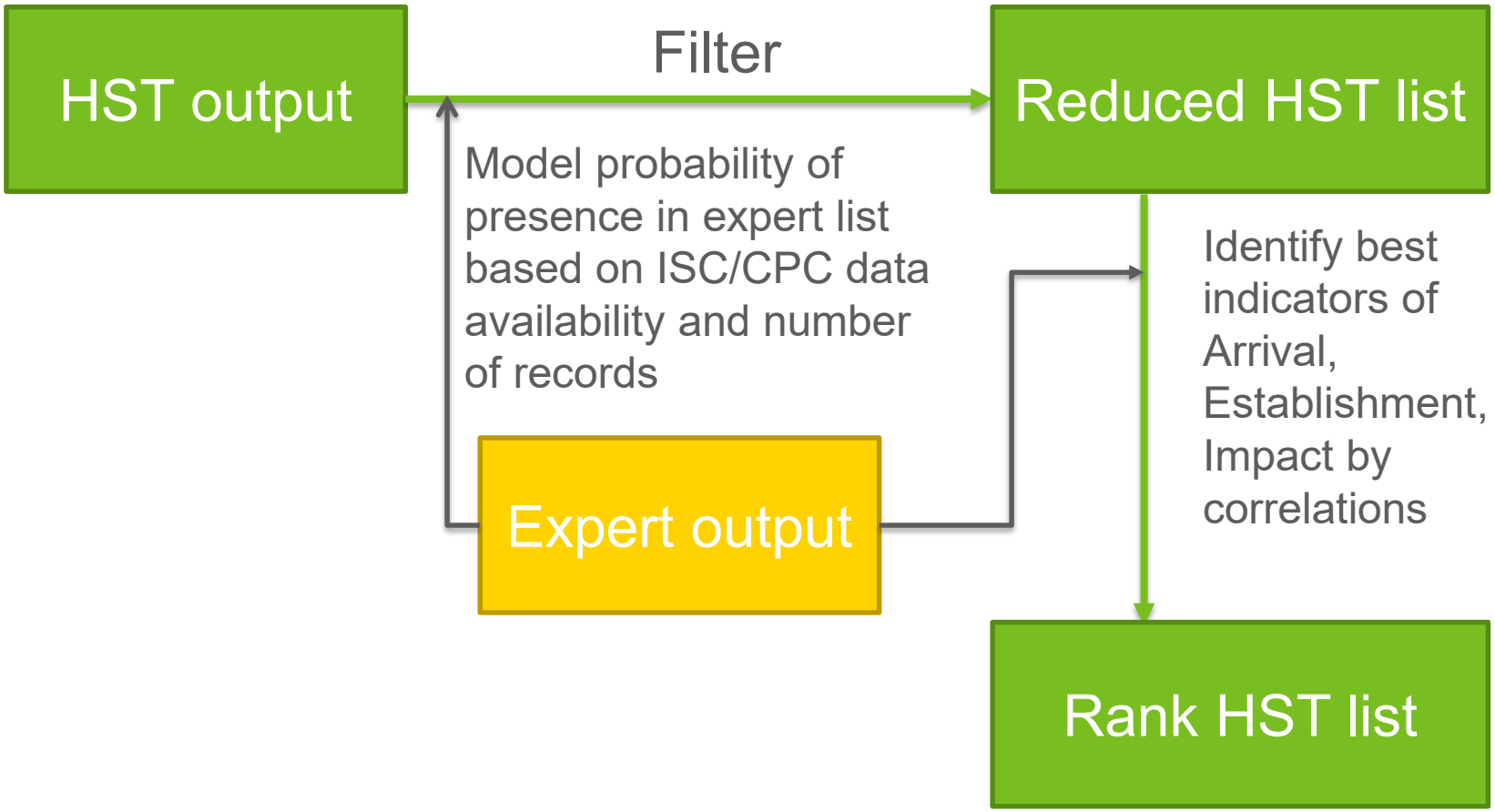
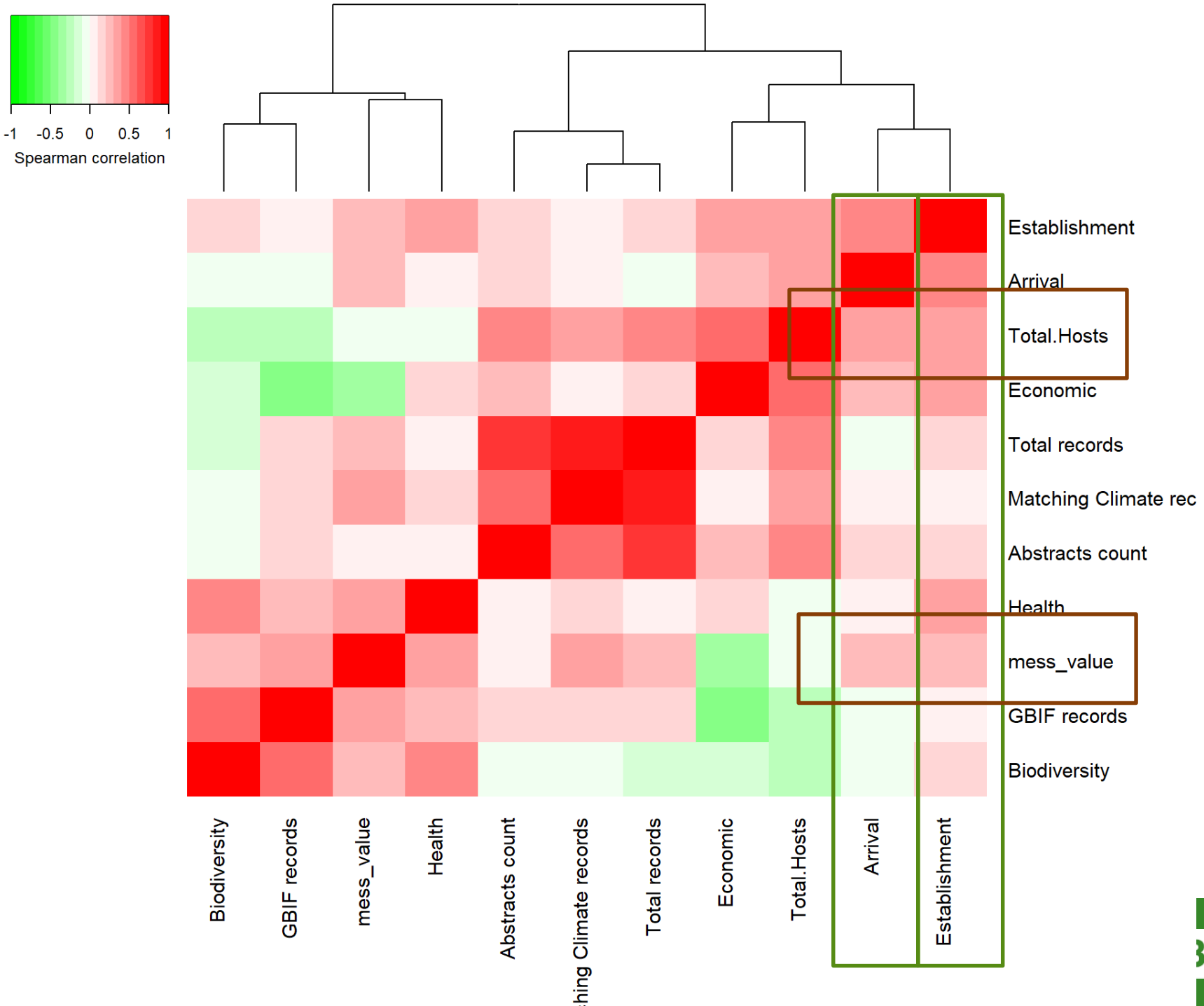


Expect based Ranking

				Arrival	Establishment	Biodiversity Impact	Human health impact	Economic impact	
	species	common_names	organism_type	A	B	C	D	E	(A*B*C*D*E)
1	Wasmannia auropunctata	little fire ant	Hymenoptera	5	5	5	3	5	1875
2	Solenopsis invicta	red imported fire ant	Hymenoptera	5	4	5	4	2	800
3	Chromolaena odorata	plant	plant	5	5	5	2	3	750
4	Parthenium hysterophorus	plant	plant	3	5	5	3	3	675
5	Corvus splendens	house crow	Birds	4	4	5	2	4	640
6	Cryptostegia grandiflora	plant	plant	4	4	5	2	4	640
7	Cryptostegia madagascariensis	plant	plant	4	4	5	2	4	640
8	Caesalpinia decapetala	plant	plant	2	5	5	3	4	600
9	Anoplolepis gracilipes	yellow crazy ant	Hymenoptera	5	5	5	2	2	500
10	Cortaderia selloana	plant	plant	5	5	5	2	2	500
11	Cuscuta campestris	plant	plant	5	5	5	1	4	500
12	Vespula germanica	german wasp	Hymenoptera	4	5	4	3	2	480
13	Ailanthus altissima	plant	plant	1	5	5	4	4	400
14	Galenia populosa	Namibian ice plant	plant	5	5	4	2	2	400
15	Tamarix ramosissima	plant	plant	5	4	5	2	2	400
16	Imperata cylindrica	plant	plant	5	5	5	1	3	375
17	Canis familiaris	feral dogs	Mammals	3	5	4	2	3	360
18	Campuloclinium macrocephalum	plant	plant	3	3	4	3	3	324
19	Aedes aegypti	Yellow fever mosquito	Diptera	4	4	1	5	4	320
20	Aedes albopictus	tigermosquito	Diptera	4	4	1	5	4	320
21	Anopheles quadrimaculatus	common malaria mosq	Diptera	4	4	1	5	4	320
22	Coptotermes formosanus	asian subterranean te	Blattodea	4	4	4	1	5	320

Stage	Variable	Explanation
Arrival	Taxonomic Group	The taxonomic group the species belongs to.
Arrival	Total # records	Total number of presence records.
Arrival	Neighbouring records	Total number of presence records in neighbouring countries.
Arrival Establishment	Matching Climate records	Total number of presence records for the species in countries with matching climates.
Arrival	Gbif records	Total number of records of the species in GBIF
Establishment	Mess Value	This is a climate matching.
Impact	Total # Hosts	The total number of hosts a species has.
Impact	CABI Abstract	Total number of abstracts that appear when searching the species name.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Spearman correlation
Establishment
Arrival
Total.Hosts
Economic
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Matching Climate rec
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mess_value
GBIF records
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Biodiversity
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Health
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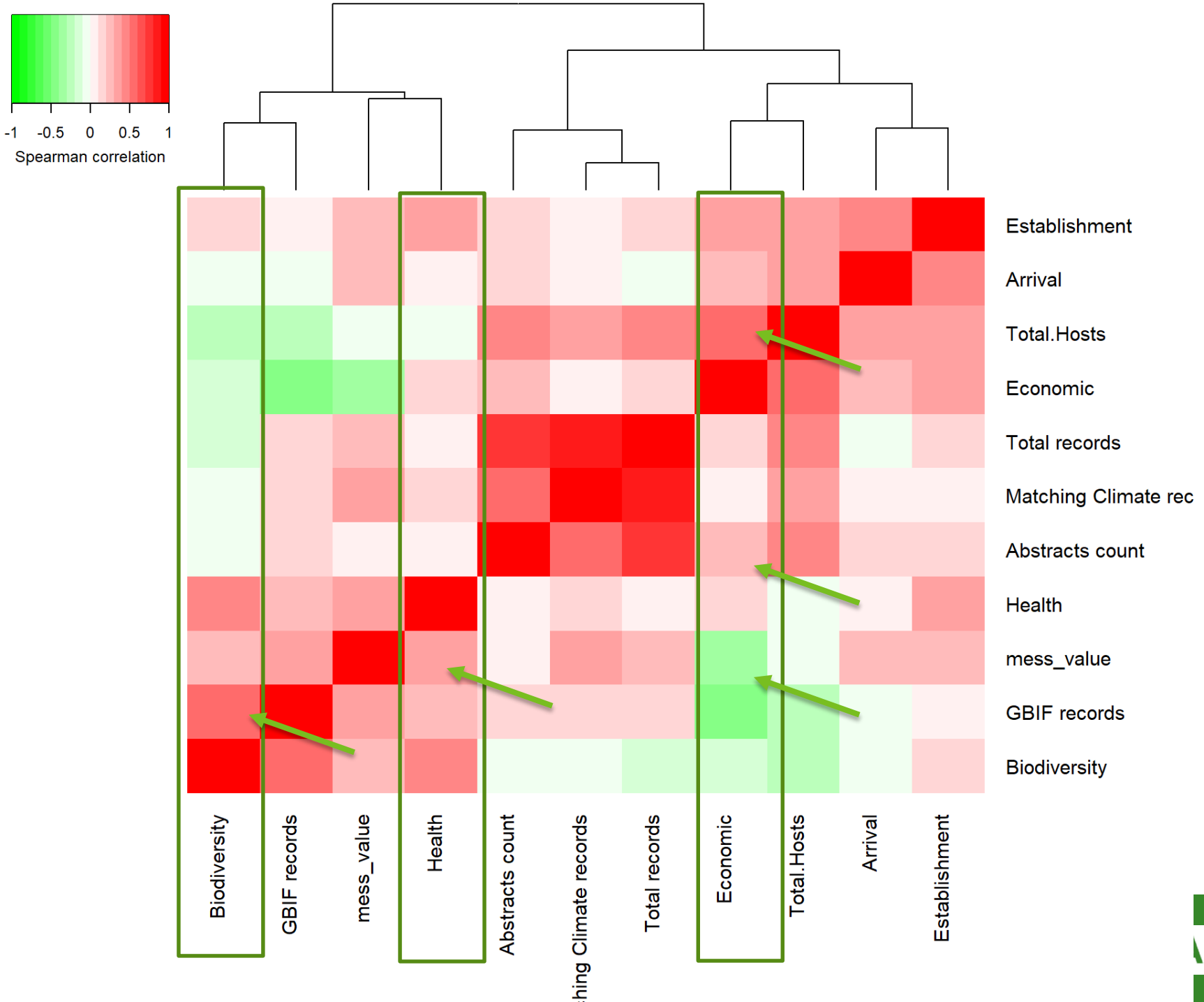
Establishment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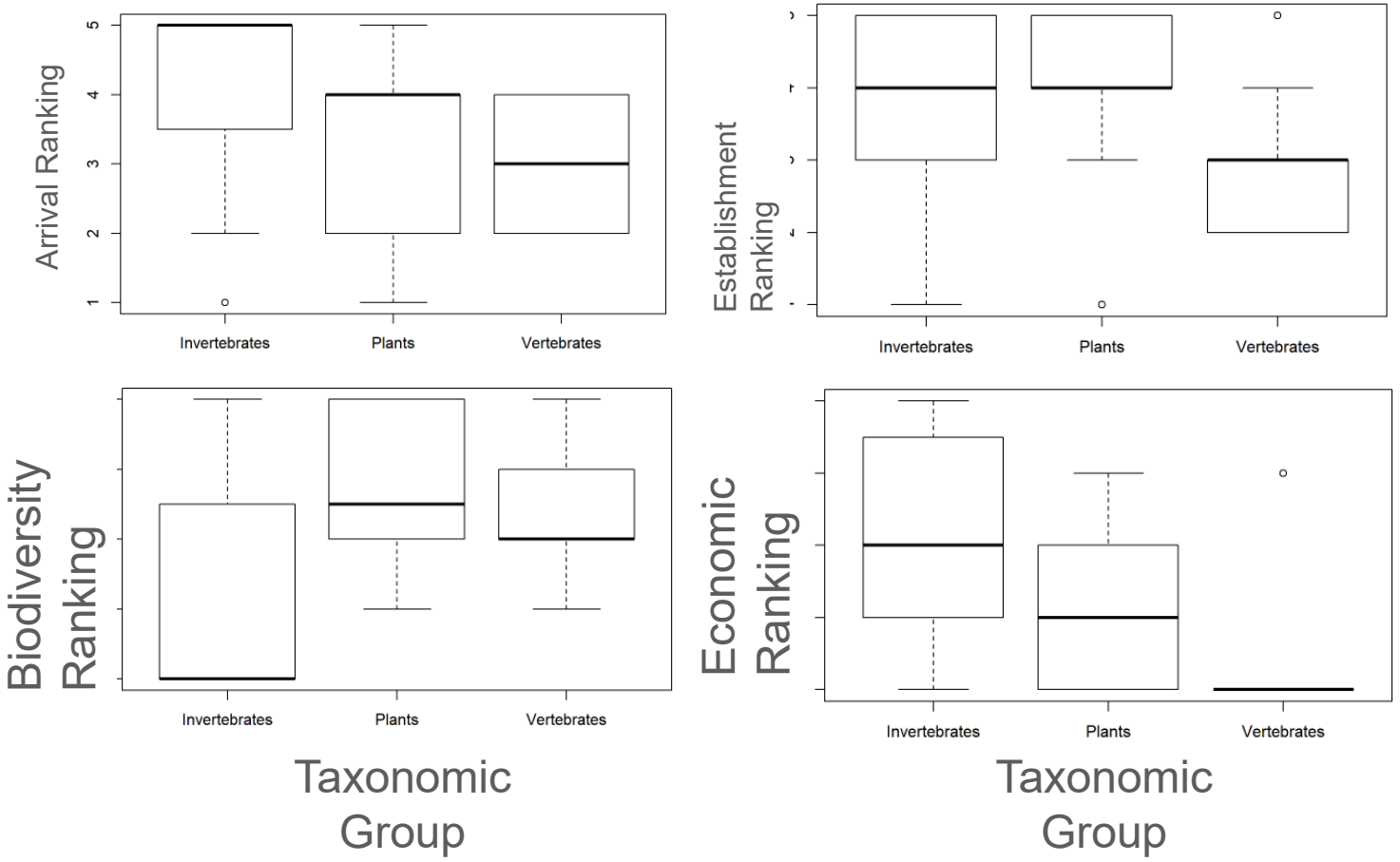
Interestingly: Taxonomic group



Summary indicators

- There is high correlation among all indicators but also between the expert scoring

- Arrival and establishment risk are very correlated. None of the indicators of number of records is relevant for them.

-> Combine arrival and establishment

- **Total hosts** and **mess value** (climate matching) are the best for all risk and impact scoring.
- **Number of abstracts and GBIF records are** also relevant for impact.

- There are differences in risk and impact across taxa

-> Better make separate analyses for each taxa

To do list

1. Run separate analysis for each taxonomic group
2. Determine which variables correlate most strongly with risk and impact scores for each taxa.
3. Generate taxa specific models.
4. Test robustness of models using Ghana expert list and HST output.
5. Create downloadable script which can be run on any HST output

Summary

The aim is to create a tool which can be used to priorities invasive species, based on:

- The level of risk they pose to the target country.
- Impact they may have on human health, biodiversity and the economy.

Discussion

Any suggestion for other variables that could be used as a proxy for risk or impact variables?

What format would be most useful for users?

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Australian Centre for International Agricultural Research

Agriculture and Agri-Food Canada

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Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Agency for Development and Cooperation SDC