Invasive Species: Knowing their origin and pathways of introduction

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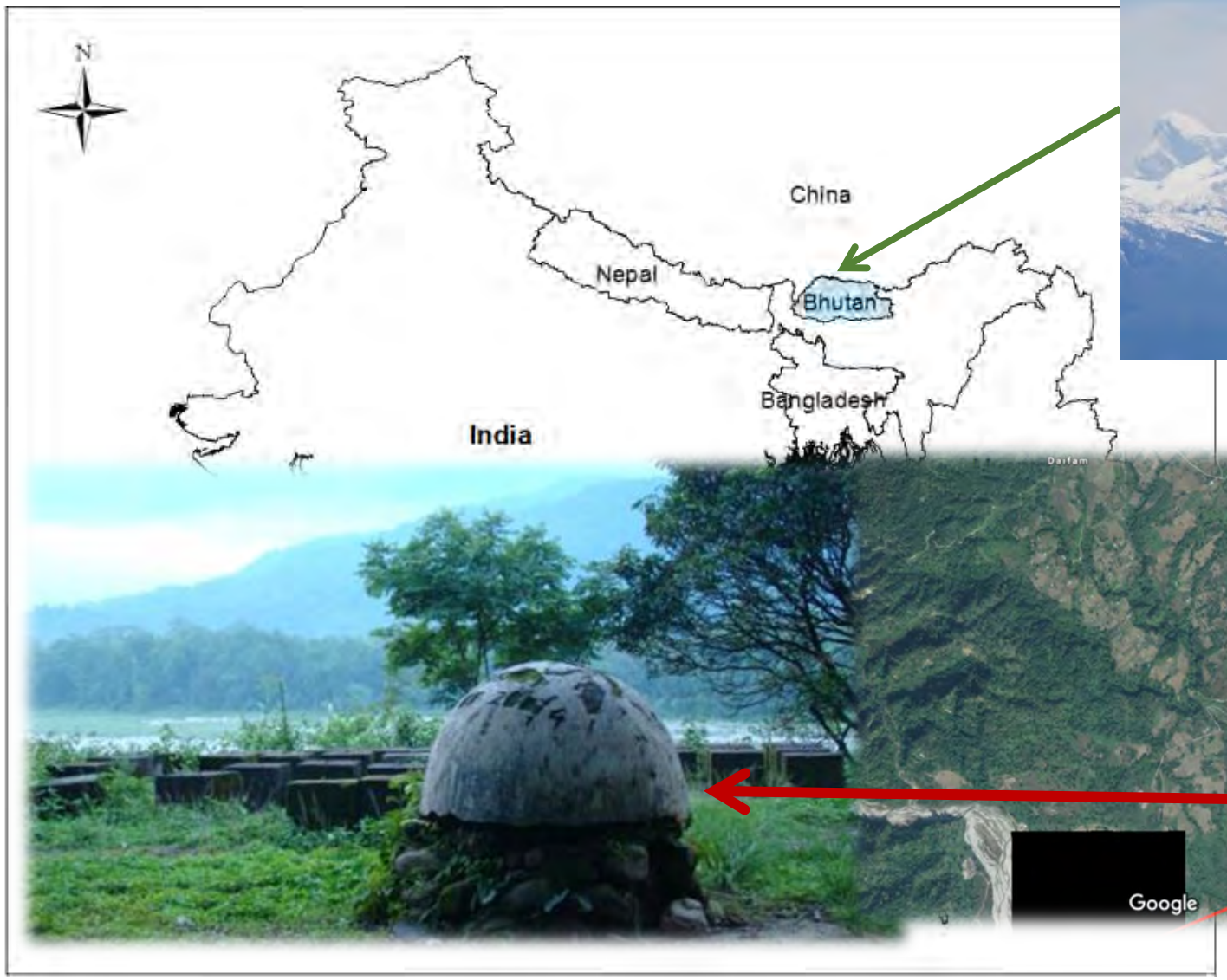
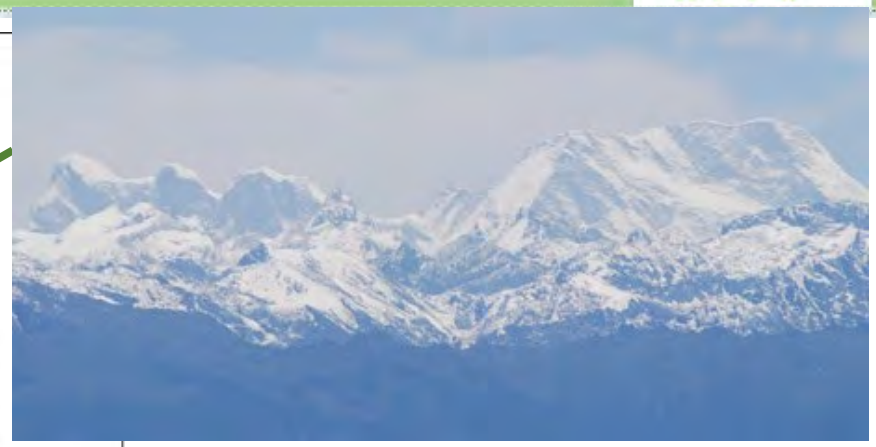
- Focussed on alien (non-native, non-indigenous, exotic, introduced) species
  - Term applies to a species living outside its native distributional range
  - Threat to food security and biodiversity
- Origin of alien plant species
  - Baseline inventory
- Pathways of introduction
- Impacts
- Gaps/constraints
- Way forward

Knowing the origin of species

- Baseline inventory
- Know your species and their origins before it is too late
  - outcompete native species
  - part of the ecosystem/unaware of threat lurking within
  - climate change –Parthenium weed at 2300 msal
- Policies/strategies-management

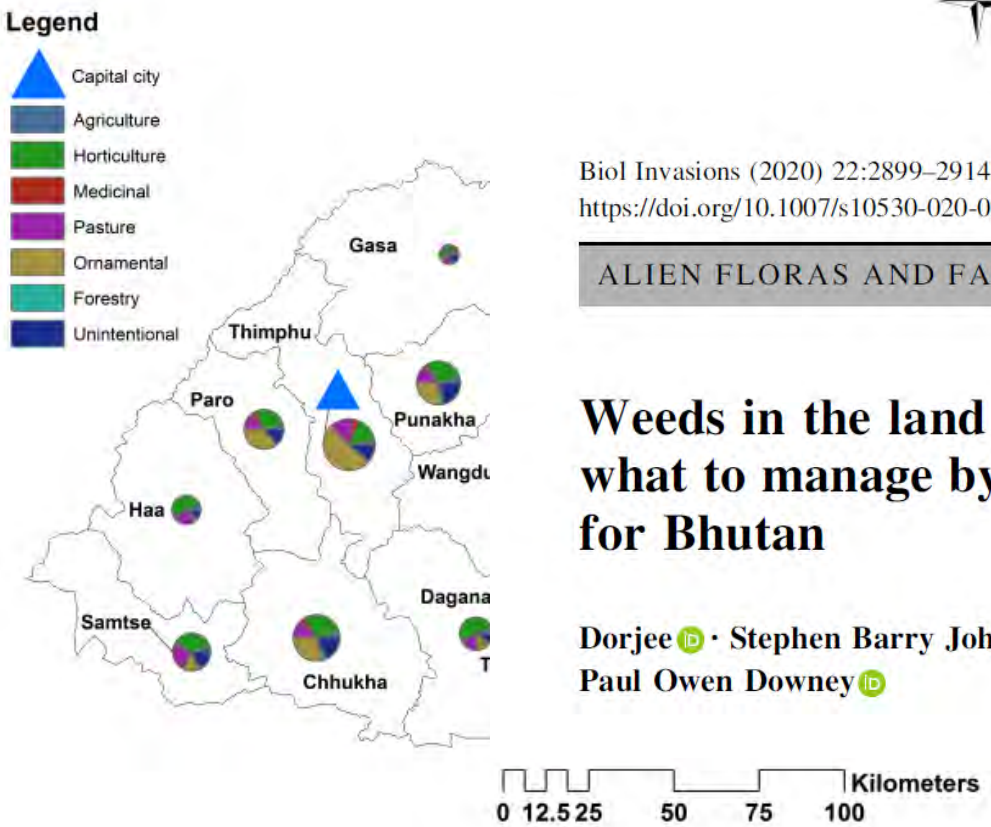
Bhutan





Alien plant species inventory of Bhutan (Dorjee et al. 2020)

- 138 families→545 genera →964 species



Biol Invasions (2020) 22:2899–2914
https://doi.org/10.1007/s10530-020-02306-5

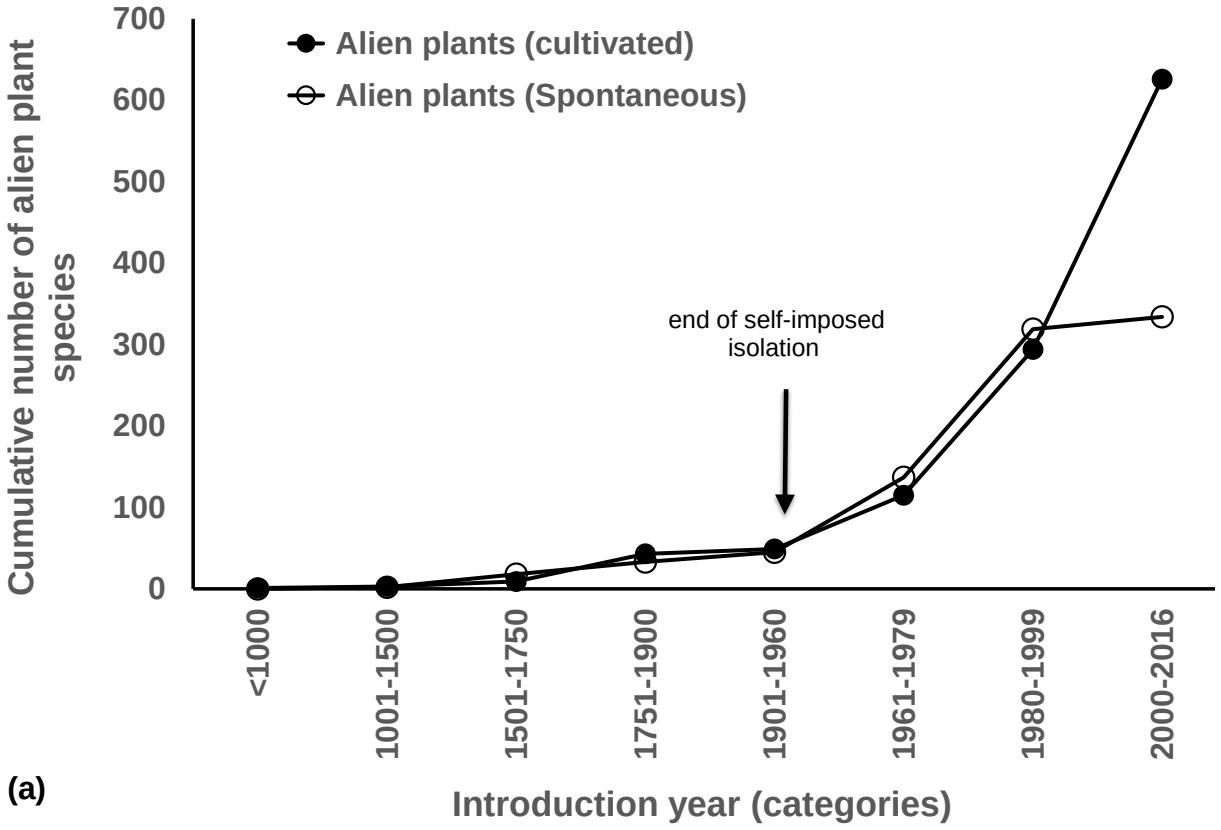
Check for updates

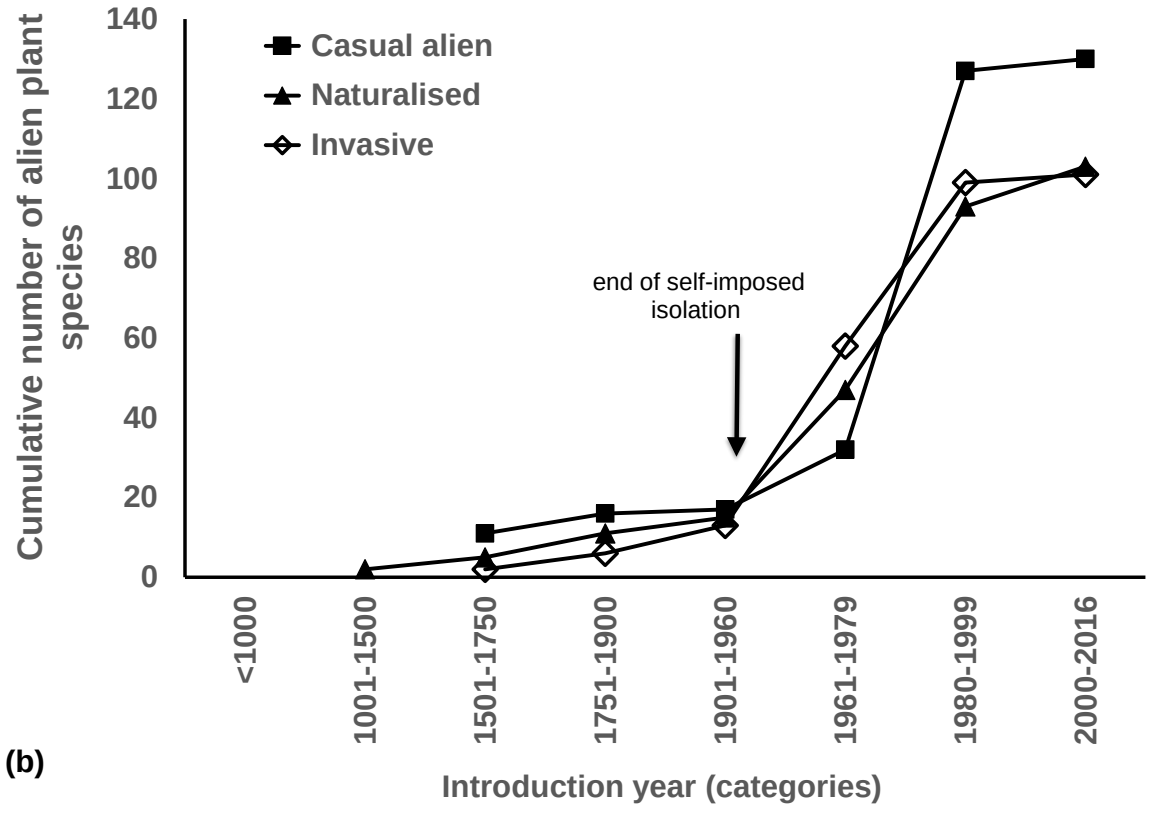
ALIEN FLORAS AND FAUNAS 6

Weeds in the land of Gross National Happiness: Knowing what to manage by creating a baseline alien plant inventory for Bhutan

Dorjee · Stephen Barry Johnson · Anthony John Buckmaster · Paul Owen Downey

The cumulative number of alien plant species and in Bhutan relative to their introduction date (in date categories) -Dorjee et al. 2020





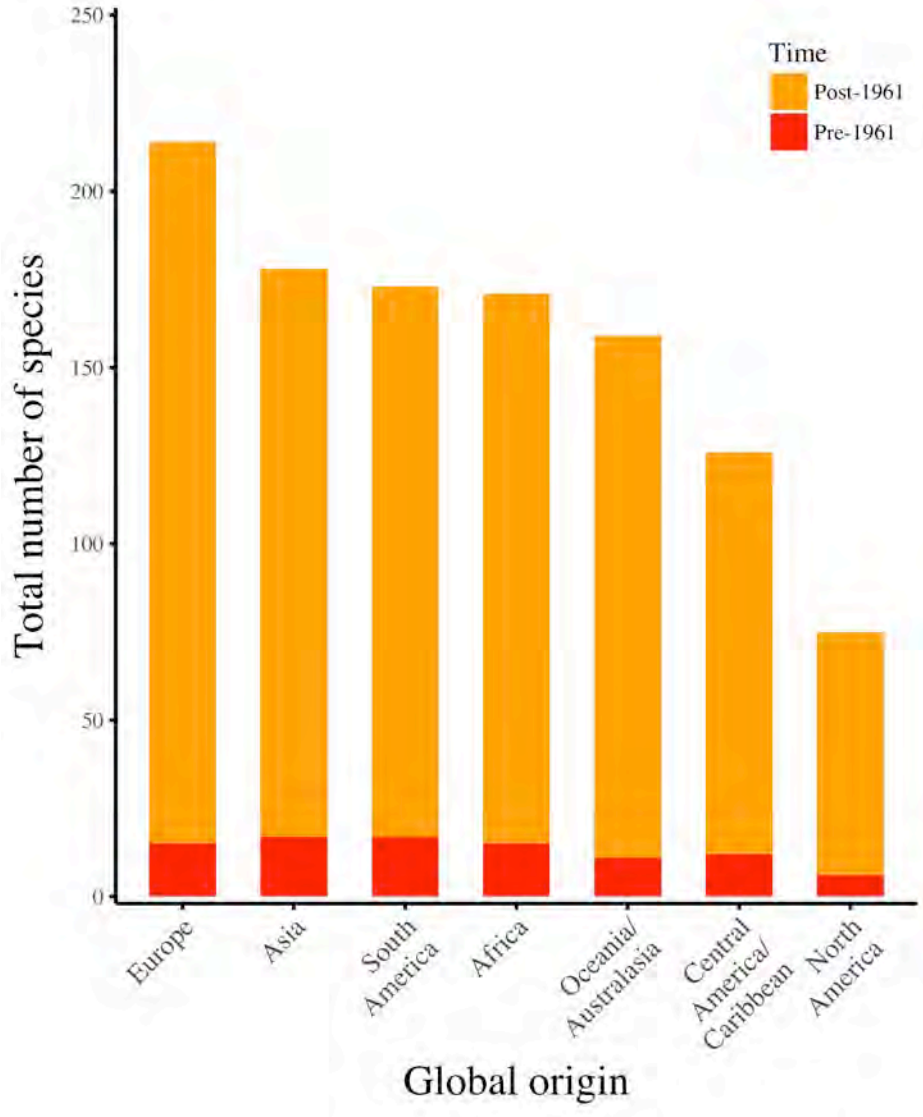
(a) Cultivated and all spontaneous species

(b) Casual, naturalised and invasive

Region	Before 1961		After 1961		Total	
	n	%	n	%	n	%
Asia (excluding Bhutan)	62	66	398	46	460	48
Africa	22	23	248	29	270	28
Europe	28	30	219	25	247	26
South America	18	19	226	26	244	25
Central America/Caribbean	16	17	163	19	179	19
North America	8	9	121	14	129	13
Oceania/Australasia	5	5	60	7	65	7
Total species	**(94)**	**-**	**(870)**	**-**	**(964)**	**-**

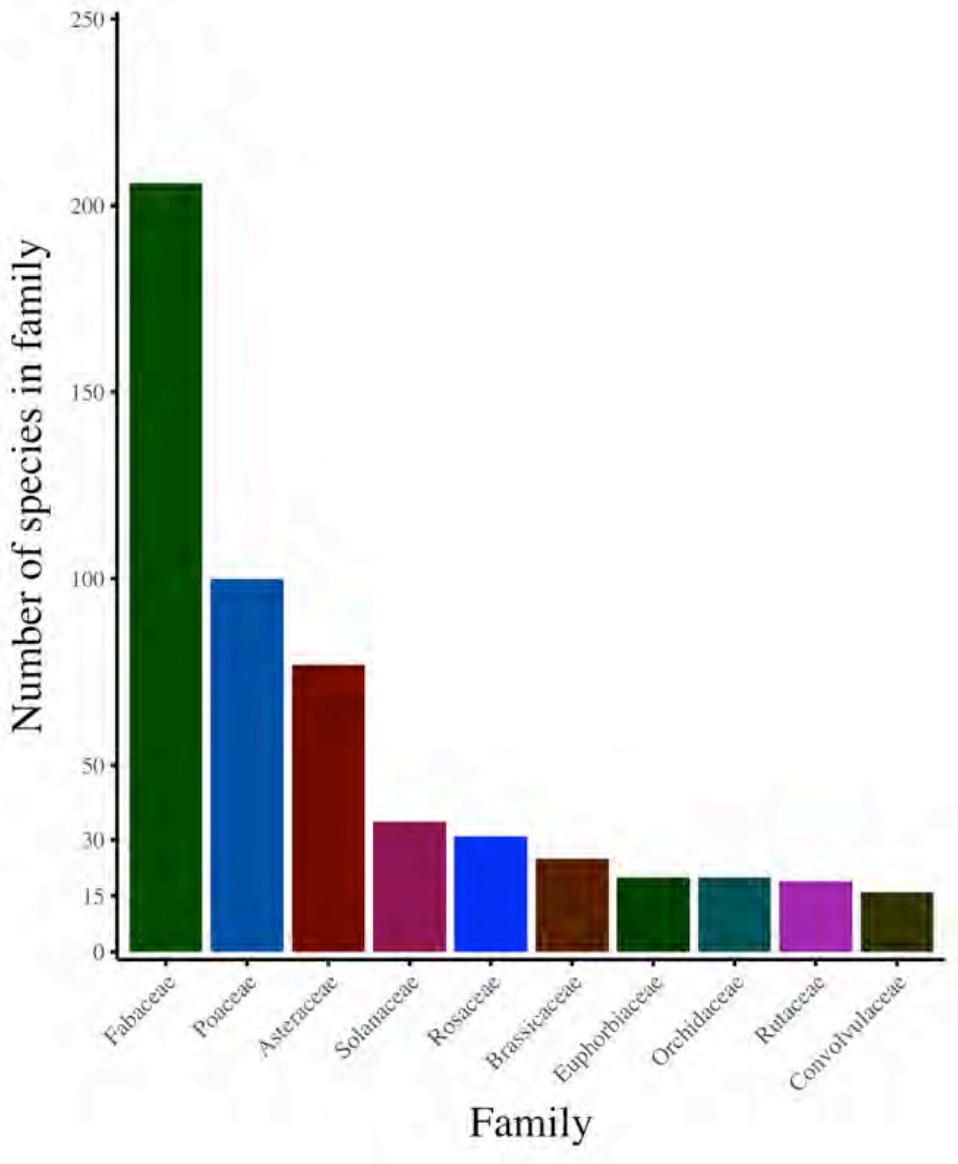
Alien plant species introduced by origin

- Europe: Pasture, ornamental, horticulture, unintentional
- Asia: Ornamental, pasture, horticulture
- South America: Ornamental, unintentional, pasture
- Africa: Pasture, ornamental, unintentional
- Oceania: Ornamental, forestry, unintentional
- Central America: Ornamental, pasture, horticulture
- North America: Ornamental, pasture, unintentional

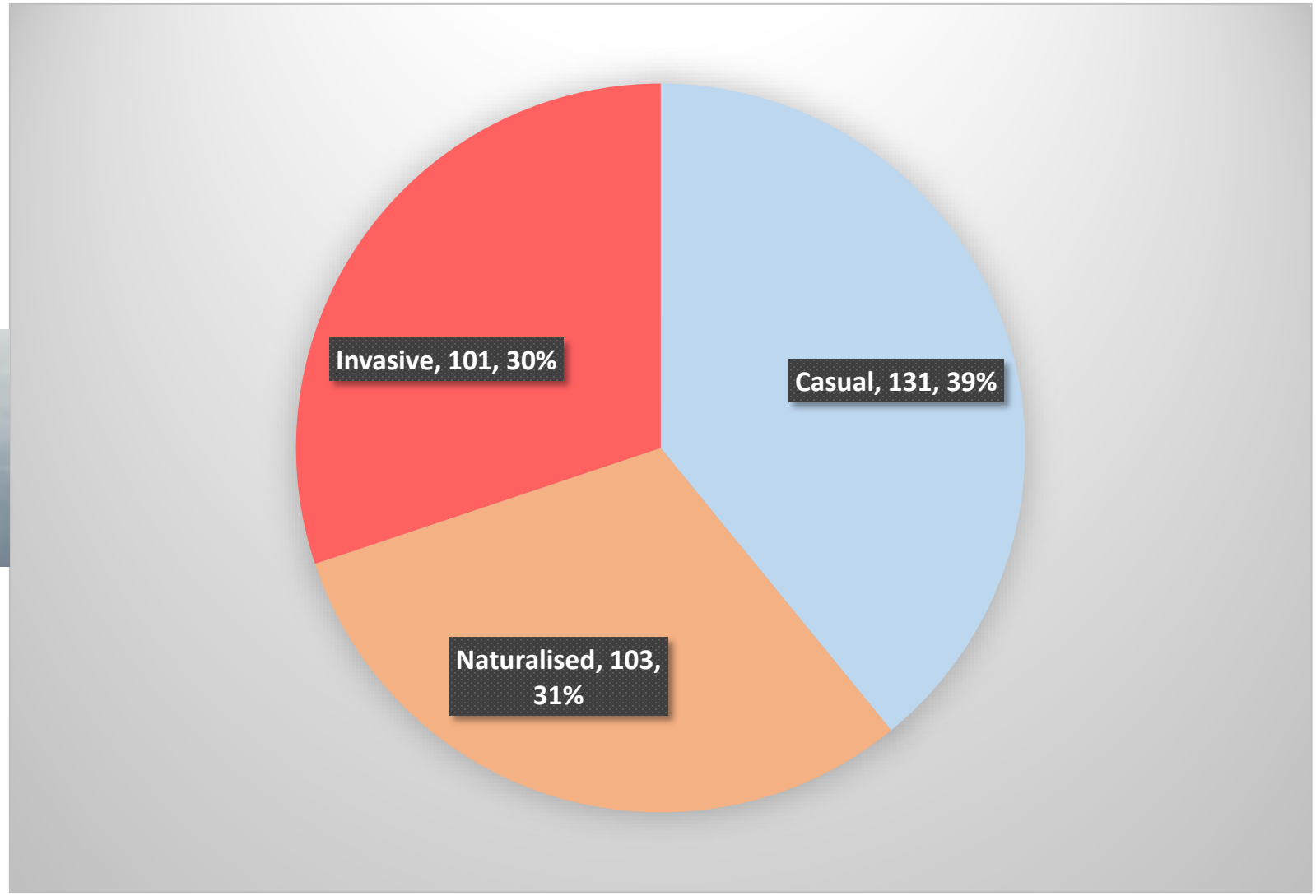


Dominant alien plant species introduced by families

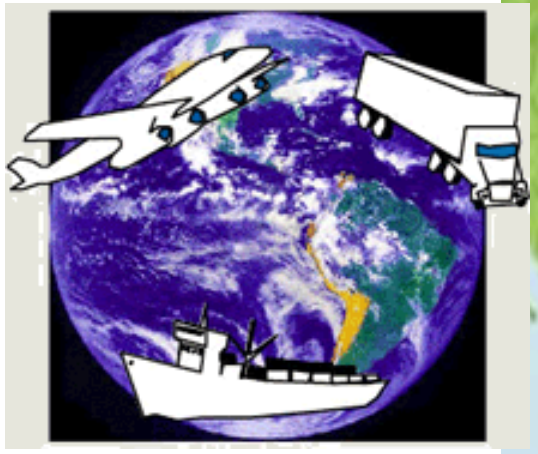
- Fabaceae (206 species): Equally represented by cultivated and casual aliens (~45%), 11% naturalised, 2% invasive
- Poaceae (101 species): 44% cultivated, 15% casual, 32% naturalised, 9% invasive
- Asteraceae (77 species): 51% cultivated, 9% naturalised, 35% invasive



In summary

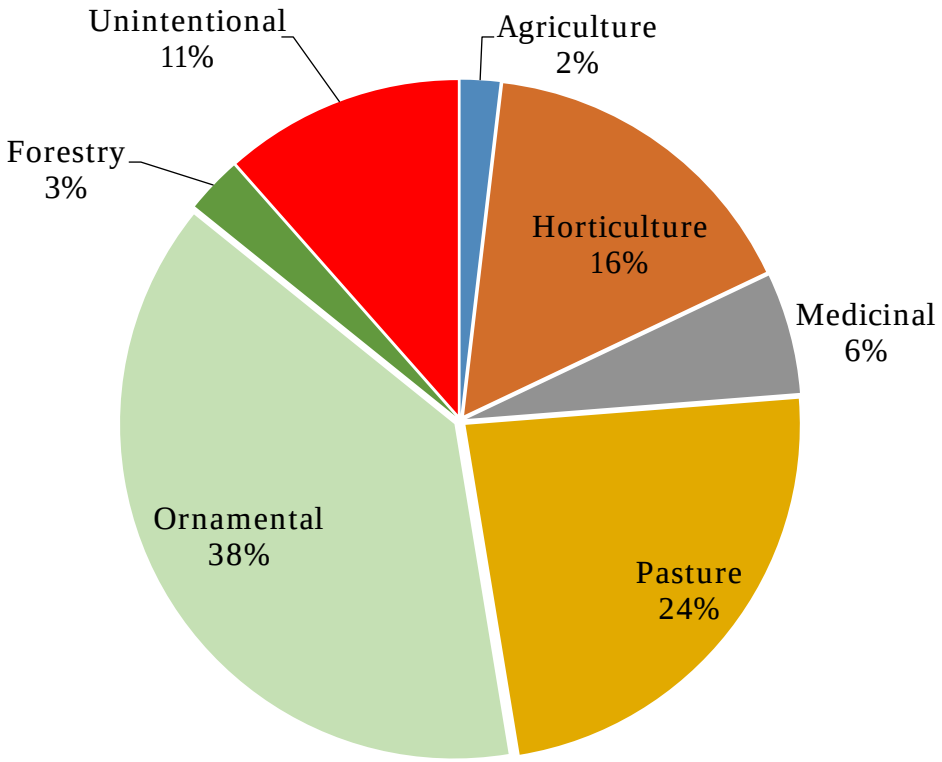


Pathways of introduction

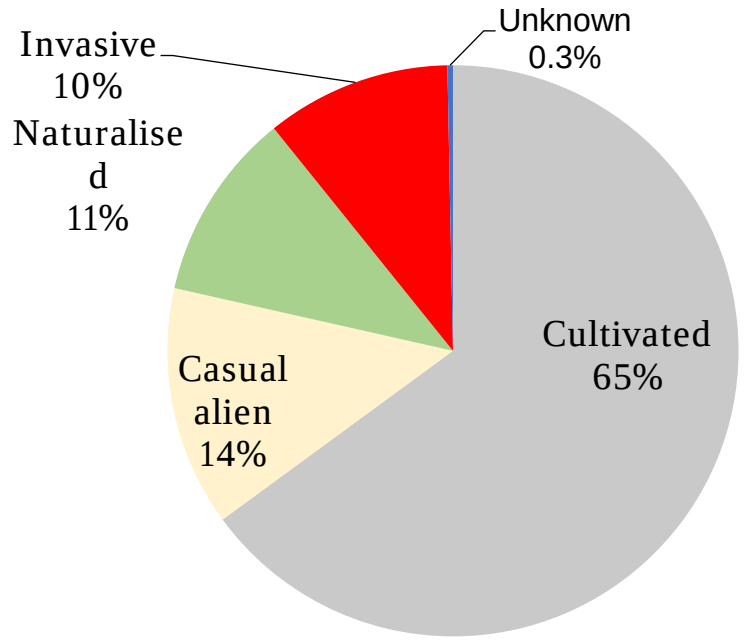


Source:Travelblog.org

Pathways	No. of species	%
Intentional	853	88.5
Unintentional	111	11.5
Total	**964**	**100**



Alien species by pathways (%)



Alien species by status (%)

Impacts:

No quantitative studies/assessments on the impact of invasive species in Bhutan

- 30 species recorded as invasive (NBC, 2014)
  - Current status:101 invasive species (Dorjee et al. 2020)

- Major invasive alien species recorded in India in Bhutan (Parker, 1992; NBC, 2011):

Ageratum conyzoides, *Eupatorium adenophorum*, *Eupatorium odoratum*, *Galinsoga parviflora*, *Lantana camera*, *Opuntia* spp., *Leucaena leucocephala*, *Mikania micaranta*, *Parthenium hysterophorus*…

-IAPs are difficult to eradicate once they gain entry & virtually impossible to eradicate in poor countries

Mikania micaranta

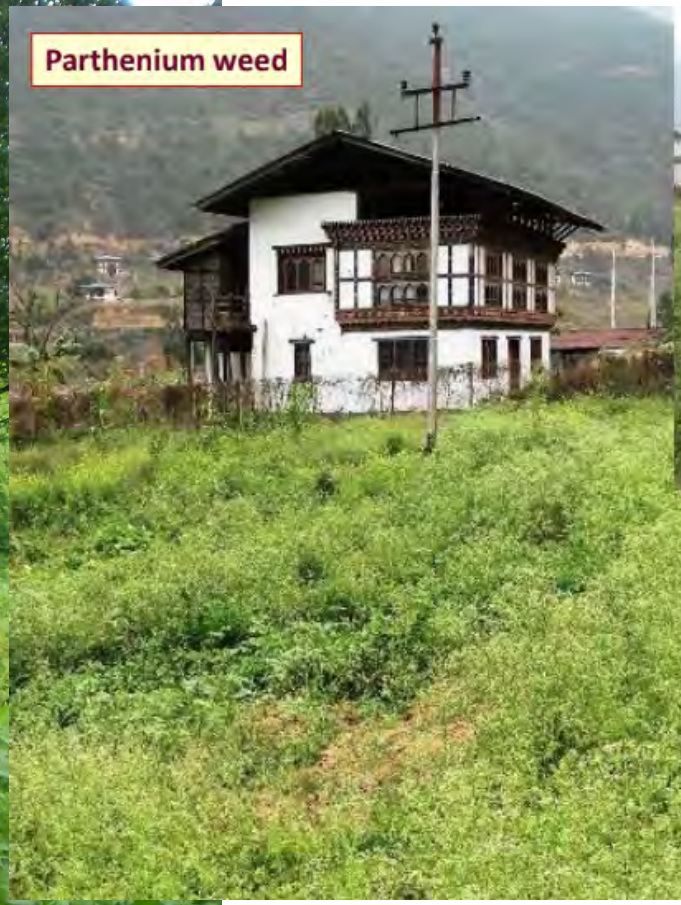
Parthenium hysterophorus

Lantana camara

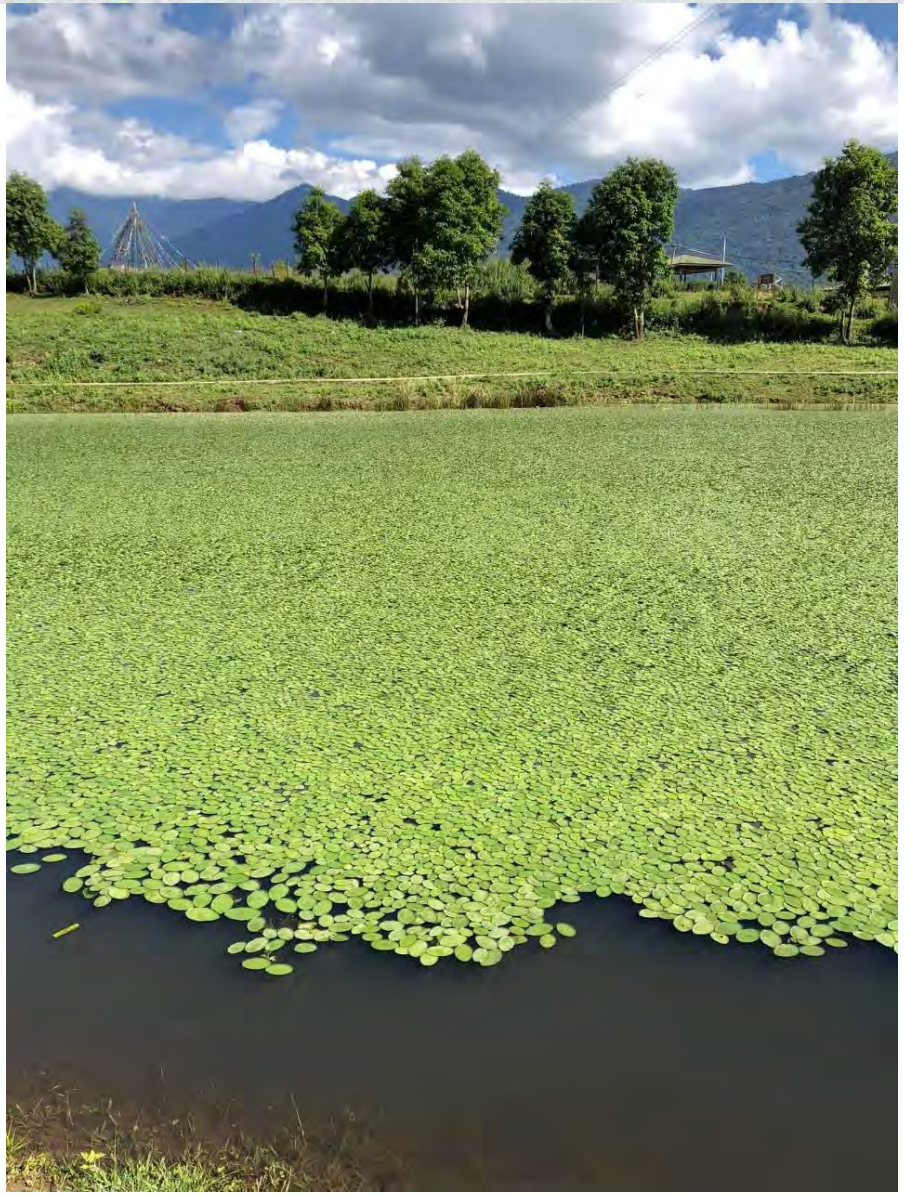
Invasive alien plant species/weeds in Bhutan

Micania

Source: P. Wangdi



Source: S. Adkins



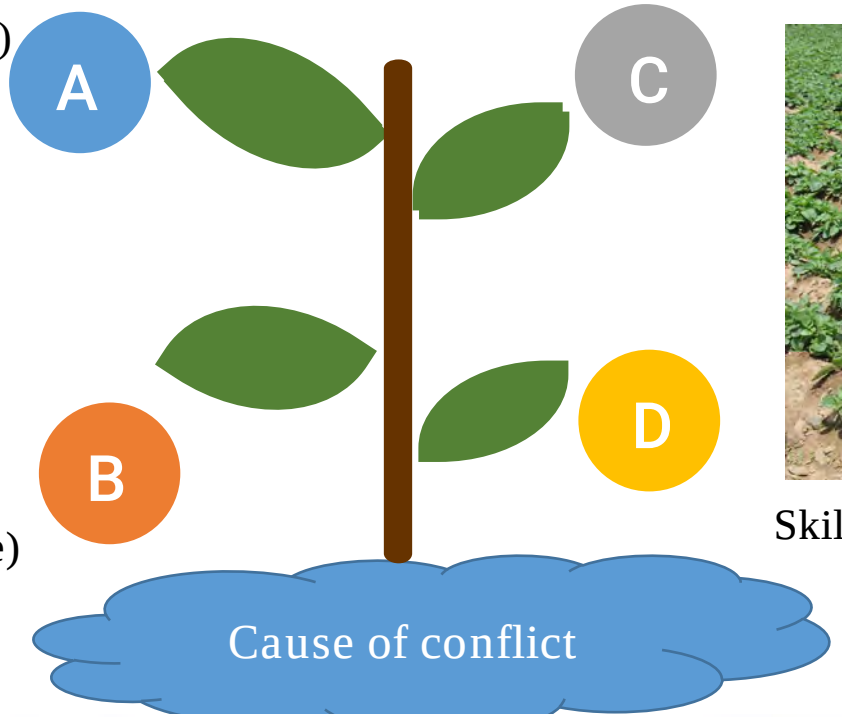
Water lilies (Need to confirm the species?)

Eichhornia crassipes
(water hyacinth)

Beyond the costs of the impacts themselves, other costs of control:

Economic costs (e.g. herbicides; labour)

Environmental costs (off-target damage)



Social costs (incl. time spent)

Skills and equipment

REVIEWS REVIEWS REVIEWS

Conflict in invasive species management

Sarah L Crowley[1], Steve Hinchliffe[2], and Robbie A McDonald[1*]

How do we manage the growing threats from IAPS?

Biosecurity continuum

Pre-border

- WRA

Border

- Quarantine
- Surveillance
- Detection

Post-border

- WRM

DoA (e.g. weeds/ornamental plants

BAFRA/ Relevant Sectors

Farmers/Nurserymen

Land owners/Municipality/ Community

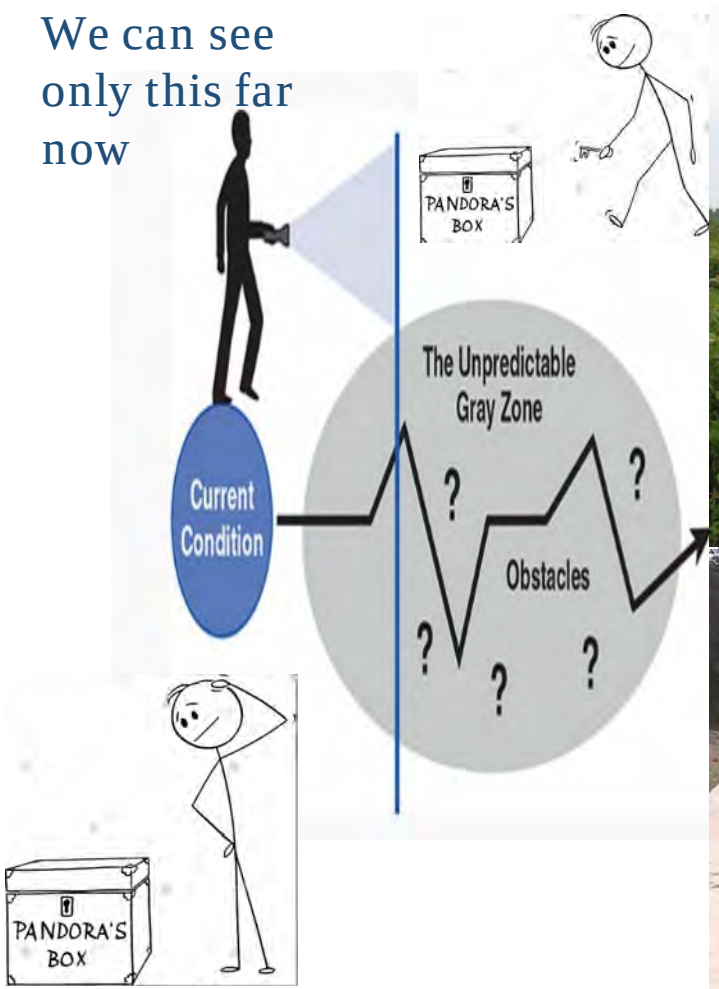
Collective responsibility

Weed Risk Assessment


Lantana

Source:Bob Saunders


Water hyacinth



WRA-Decision tool

Modified Australian Weed Risk Assessment (AWRA) System for Bhutan

Why AWRA for Bhutan?

- Effective in characterising alien plants (invasive or non-invasive)
- Can quickly and accurately assess the potential threats of alien plants
- Economic returns of prevention (1:100) is more than other measures like containment (1.5:10)
- List generated can be categorised (permitted/prohibited) and used for post-border management

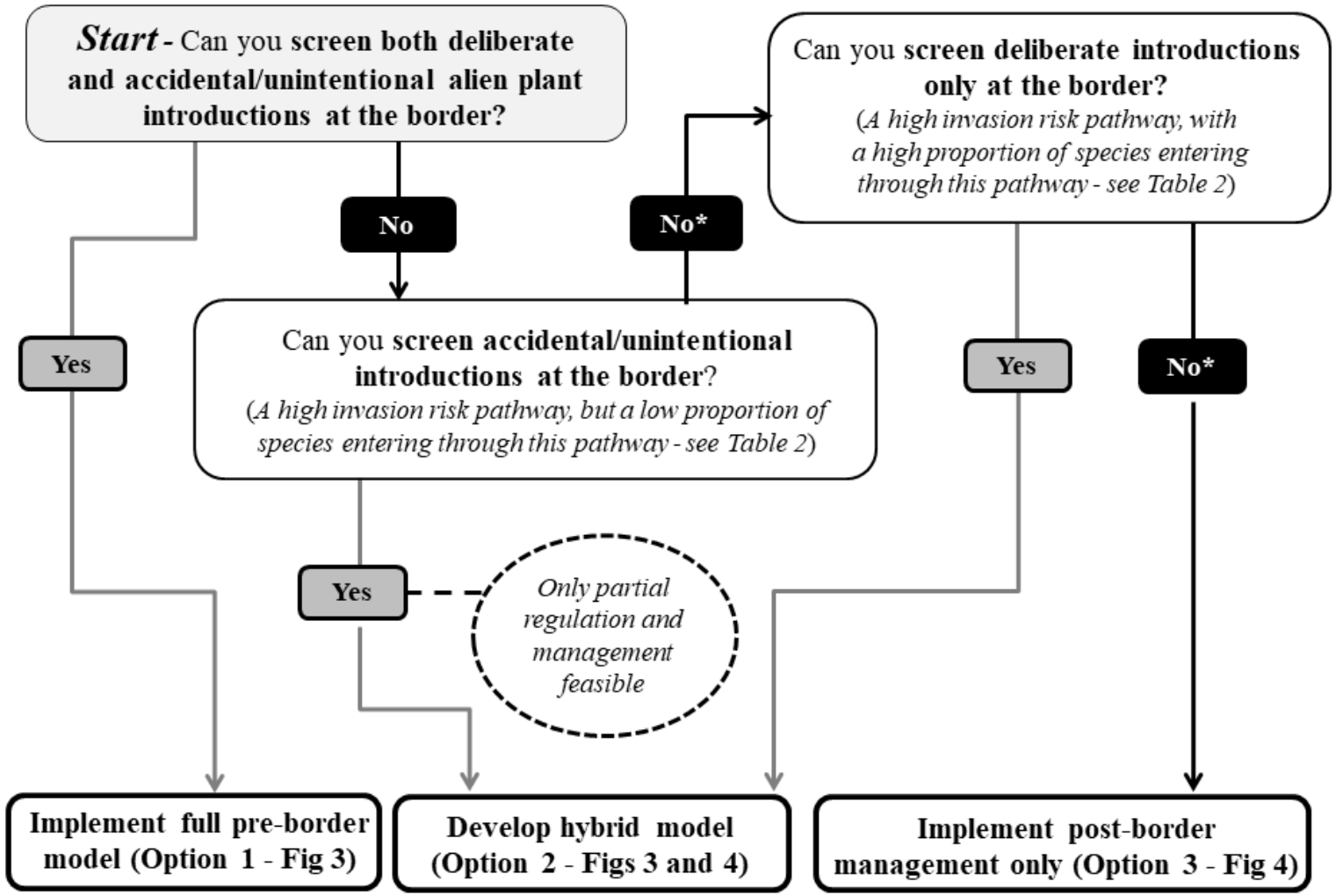
Hybrid weed risk assessment framework-post border management

Original Paper | Published: 29 April 2021

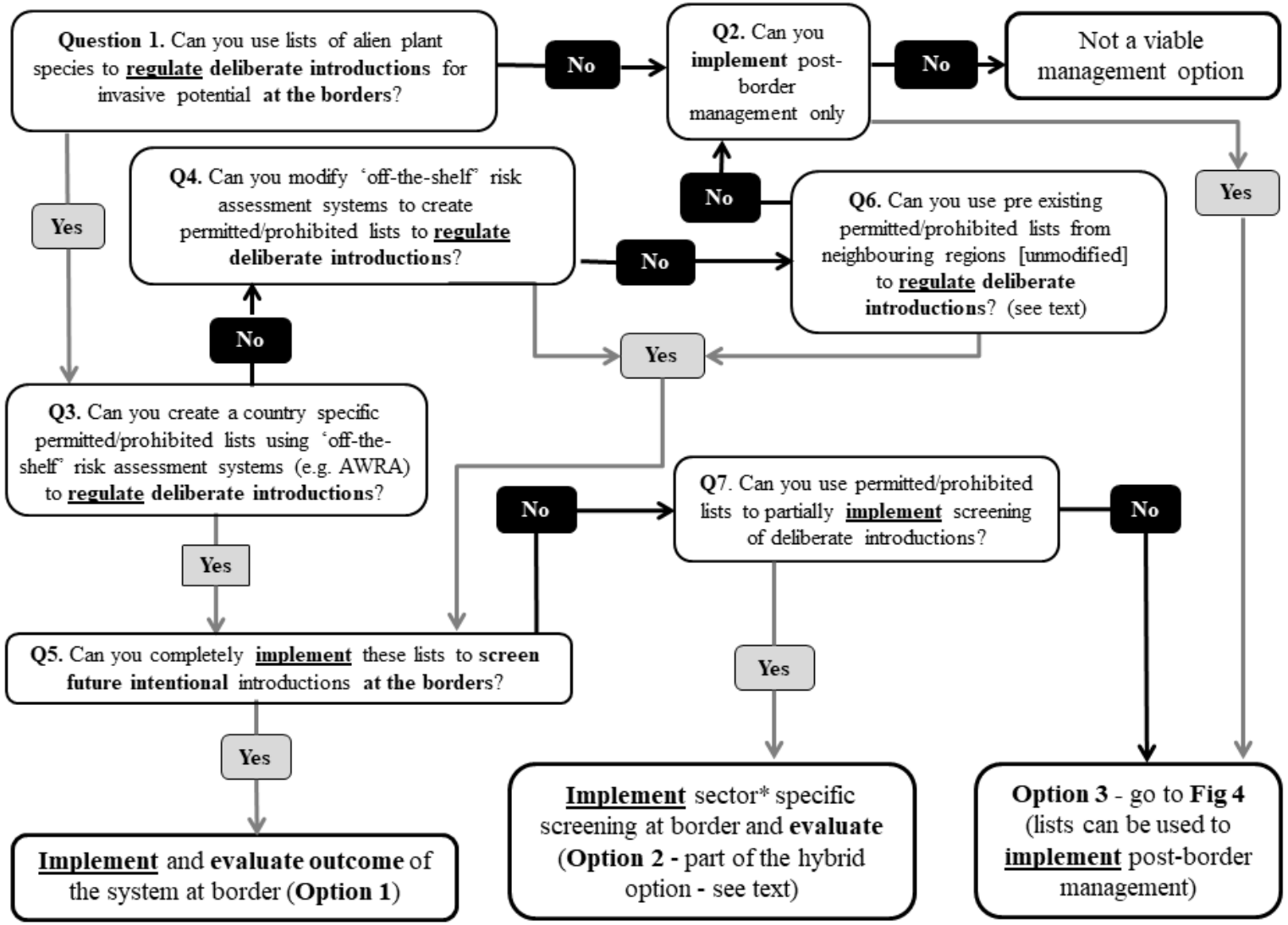
Developing a hybrid weed risk assessment system for countries with open and porous borders: insights from Bhutan

Dorjee ✉, Stephen B. Johnson, Anthony J. Buckmaster & Paul O. Downey

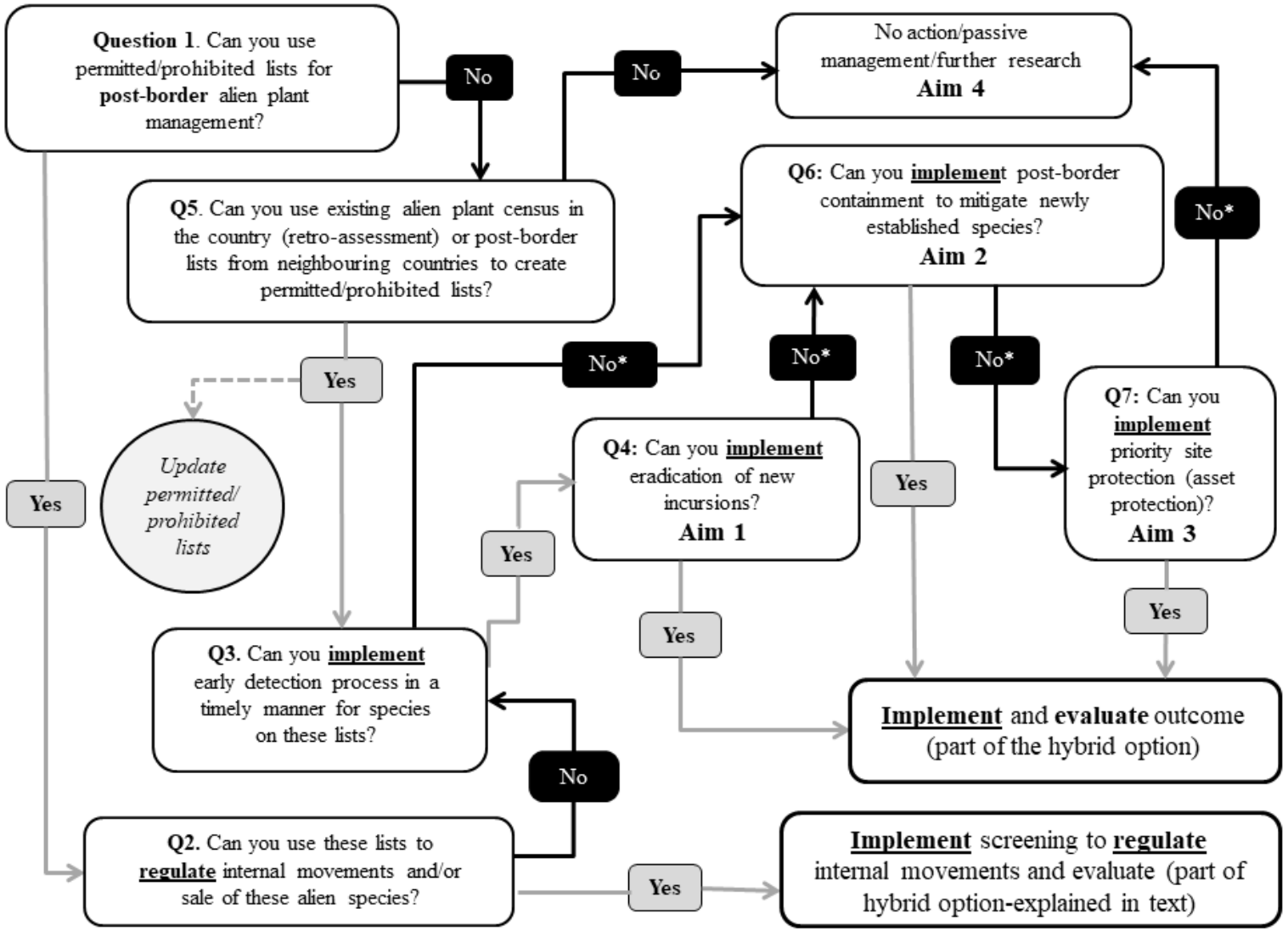
Biological Invasions **23**, 2945–2959 (2021) | Cite this article



*Not a feasible option given limitations of porous borders (see text)



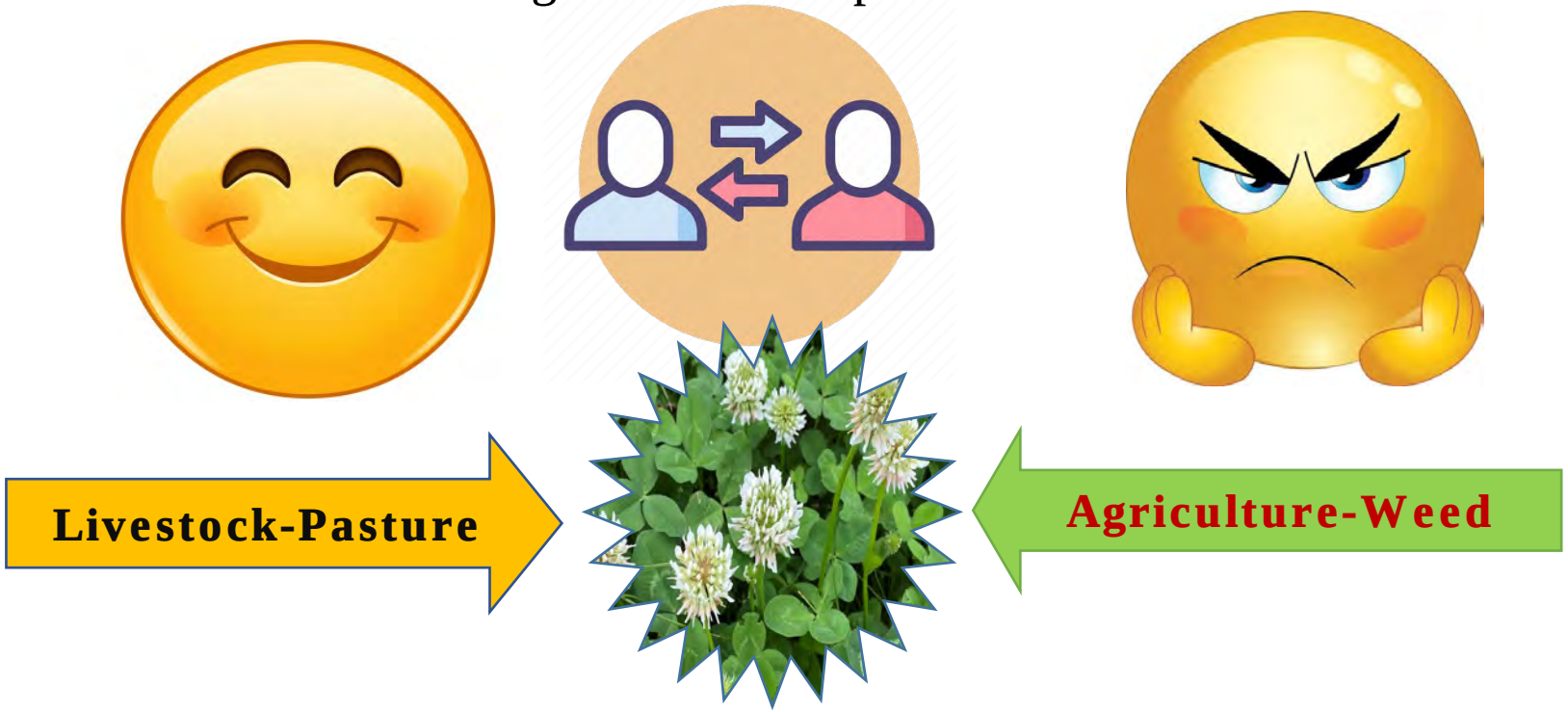
*Sector here refers to agriculture, horticulture, forestry and livestock



*Address/identify issues with capacity and capability as outlined in the text

Take home message+

- Implement WRA and Hybrid Weed Risk Assessment
  - Many high-risk invasive alien species can be prevented from introduction and those inside country can be eradicated or contained
  - Informed decision making for conflict species



Constraints

- Lack of resources: Physical, financial and human capacity and capability
- Inadequate policy and legislative support (risk screening and management framework)
- Lack of coordination among various sectors and agencies- duplication of mandates and roles
- Weak institutional linkage within and outside the country for the National Plant Protection Centre, Department of Agriculture

New Journey: Weed/IAS Management

- Policy & institutional support
- Leadership & coordination
- Research
- Information management
- Education & public awareness
- Training & capacity building
- International cooperation

- Prevention
- Early detection
- Eradication
- Control
- Restoration.


JIGME DORJI NATIONAL PARK
Take nothing but memories
Leave nothing but footprints