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Invasive plants from the perspective of vegetation ecologists: Results of the IAVS Survey

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Nice and colorful plant community developed in the abandoned place in Graz, Austria. It consists nearly completely of the neophytes: *Catalpa bignioides*, *Solidago canadensis*, *Buddleja davidii*, *Erigeron annuus*, *Populus canadensis*, …

Plant invasions and their consequences represent a major problem in the present world, a strong threat to the biodiversity of our planet, and at the same time, one of the most frequently researched natural phenomena. That's why I selected this topic for a short survey among the IAVS members. The aim of the survey was to find out how vegetation scientists, based on their expert knowledge and rich field experience, perceive the issue. The summary of their response should help answer the following questions: i) What is the recent situation with plant invasions in different continents? ii) What are the most dangerous invasive species in individual countries and regions? iii) How do vegetation scientists perceive the problem and which species and threats do they consider as most problematic?

The survey on plant invasions took place in autumn 2019 and received responses from 210 IAVS members from 46 countries (Fig. 1). Each respondent could suggest up to three dangerous invasive plants in her/his region, and identify its effects upon the local environment.

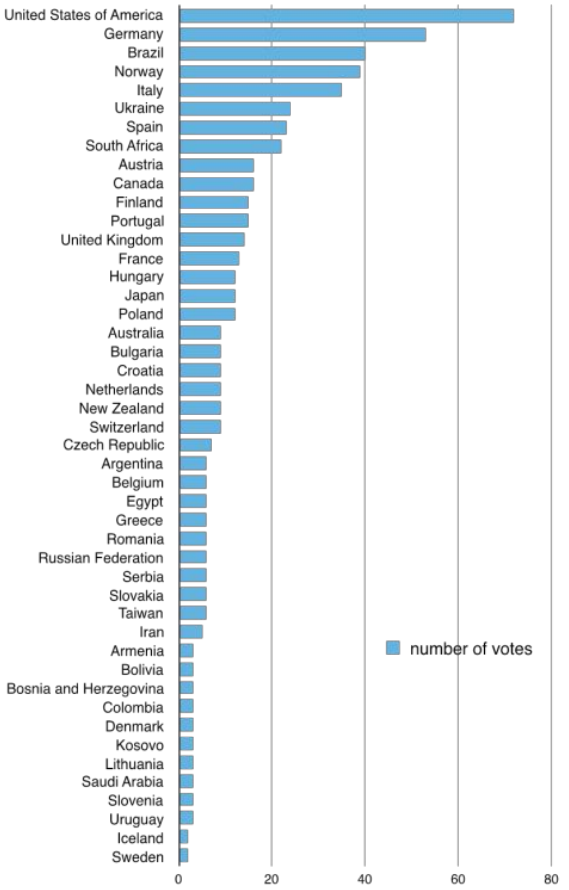

Fig. 1 Countries of the survey participants in decreasing order of the participant numbers.

In total, 182 plant species of 59 families were mentioned in the survey. Among the plant families, *Poaceae* was most frequent (33 species), followed by *Compositae* (24 species), *Leguminosae* (19 species), *Rosaceae* (11 species) and *Pinaceae* (6 species). See Table 1 and Fig. 2 for details.

Among the species and species groups (aggregates) the most frequently mentioned species were *Fallopia japonica* agg. (56 votes), *Robinia pseudoacacia* (29), *Ailanthus altissima* (28), *Solidago canadensis* agg. (26) and *Ambrosia artemisiifolia* (23) (Table 1).

Negative effects of invasive plants mentioned by the respondents include mainly uncontrollable spread, outcompeting native plants, modification of habitat properties and changes of ecosystem processes and functions (Table 2).

Thank you for your participation, sharing your experience, and the nice photos of invasive plants!

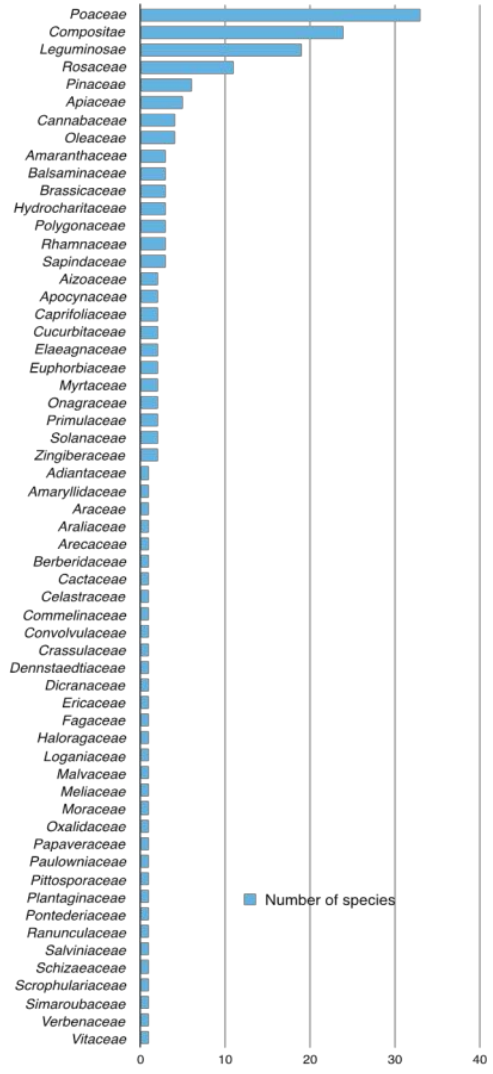

Fig. 2 Plant families most represented in the IAVS survey votes for the most dangerous invasive species.

Fallopia japonica

Countries where *Fallopia japonica* agg. was indicated as one of the most dangerous invasive plants by the IAVS members. *Fallopia japonica* agg. is native in East Asia.

Robinia pseudoacacia

Countries where *Robinia pseudoacacia* was indicated as one of the most dangerous invasive plants by the IAVS members. *Robinia pseudoacacia* is native in North America.

Ailanthus altissima

Countries where *Ailanthus altissimus* was indicated as one of the most dangerous invasive plants by the IAVS members. *Ailanthus altissimus* is native in East Asia.

Ambrosia artemisiifolia

Countries where *Ambrosia artemisiifolia* was indicated as one of the most dangerous invasive plants by the IAVS members. *Ambrosia artemisiifolia* is native in North, Central and South America.

Solidago canadensis agg.

Countries where *Solidago canadensis* agg. was indicated as one of the most dangerous invasive plants by the IAVS members. *Solidago canadensis* agg. is native in North America.

Solidago canadensis agg. (Asteraceae) invades mainly abandoned fields but frequently invades natural grasslands as well where it forms monocultures and is a serious threat for local biodiversity.

Table 1 Top dangerous plant invasive species from the perspective of IAVS survey participans ordered separately for each continent

AFRICA (29 votes, South Africa and Egypt)	
Acacia spp. (incl. *A. mearnsii* and *A. saligna*)	7
Lantana camara	4
Campuloclinium macrocephalum	3
Eichhornia crassipes	2
Eucalyptus spp. (incl. *Eucalyptus camaldulensis*)	2
ASIA (24 votes, Japan, Taiwan, Iran and Saudi Arabia)	
Ailanthus altissima	2
Azolla filiculoides	2
Leucaena leucocephala	2
Mikania micrantha	2
Prosopis juliflora	2
Sicyos angulata	2
AUSTRALIA (incl. New Zealand, 18 votes)	
Hyparrhenia hirta	2
Pinus spp. (incl. *Pinus contorta*)	2
EUROPA (374 votes, most European countries)	
Fallopia japonica agg.	51
Robinia pseudoacacia	29
Solidago canadensis agg.	26
Ailanthus altissima	24
Ambrosia artemisiifolia	23
Heracleum mantegazianum & *H. sosnowskii*	21
Impatiens glandulifera	19
Amorpha fruticosa	12
Picea sitchensis	10
Rosa × rugosa	10
Acacia spp.	9
Cortaderia selloana	9
Lupinus spp.	9
Prunus serotina	9
Carpobrotus spp.	8
Crassula helmsii	6

NORTH AMERICA (88 votes, U.S and Canada)	
Microstegium vimineum	7
Bromus inermis	4
Bromus tectorum	4
Fallopia japonica agg.	4
Lonicera maackii	4
Phragmites australis	4
Alliaria petiolata	3
Ligustrum sinense	3
Ailanthus altissima	2
Berberis thunbergii	2
Cenchrus ciliaris	2
Centaurea solstitialis	2
Cytisus scoparius	2
Ligustrum japonicum	2
SOUTH AMERICA (55 votes, mainly Brazil and Argentina)	
Pinus spp. (incl. *Pinus elliottii, P. taeda*)	11
Brachiaria decumbens & Bracharia spp.	9
Eragrostis plana	6
Melinis minutiflora	4
Ulex europaeus	4
Cynodon dactylon	2
Hovenia dulcis	2
Ligustrum lucidum	2
Panicum maximum	2
Pinus taeda	2

Table 2 Top dangerous plant invasive species indicated by the IAVS survey participans, invasion details, invaded habitats, region of origin and list of countries affected by the invasion.

Species (aggregate)	Family	Number of votes	Uncontrolled spreading, space occupation, forming monocultures	Displacement of native plant species	Negative effect of other organisms than plants	Habitat modification or destruction	Change in natural processes and	Mechanical damage of constructions	Dangerous for human health	Habitat type endangered	Region of origin	Countries where the species is considered as a dangerous invader
Fallopia japonica agg.	*Polygonaceae*	56	x	x	x	x	x	x		riparian and coastal habitats	East Asia	Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Canada (British Columbia), Croatia, Czech Republic, Denmark, Finland, France, Germany, Italy, Kosovo, Netherlands, Norway, Poland, Romania, Serbia, Slovakia, Slovenia, Spain, Switzerland, United Kingdom, United States of America (New York)
Robinia pseudacacia L.	*Leguminosae*	29	x	x	x	x	x			termophilous forests and grasslands	North America	Austria, Bulgaria, Croatia, Czech Republic, France, Germany, Greece, Hungary, Italy, Kosovo, Serbia, Slovakia, Spain, Switzerland, Ukraine
Ailanthus altissima (Mill.) Swingle	*Simaroubaceae*	28	x	x	x	x	x	x		sand dunes, coastal habitats	East Asia	Armenia, Austria, Bulgaria, Croatia, Czech Republic, Greece, Iran, Italy, Japan, Serbia, Spain, Ukraine, United States of America (Tennessee)
Solidago canadensis agg.	*Compositae*	26	x	x		x	x			abandoned grasslands	North America	Austria, Croatia, Czech Republic, Germany, Hungary, Netherlands, Norway, Poland, Russian Federation (Central Russian plain), Slovakia, Slovenia, Sweden, Switzerland, Ukraine
Ambrosia artemisiifolia L.	*Compositae*	23	x	x		x	x		x	agricultural and ruderal habitats	North, Central and South America	Armenia, Austria, Bosnia and Herzegovina, Croatia, France, Germany, Hungary, Italy, Romania, Serbia, Slovenia, Switzerland, Ukraine
Heracleum mantegazzianum Sommier & Levier & *H. sosnowskyi* Manden.	*Apiaceae*	22	x	x					x	riparian and coastal habitats	Caucasus	Czech Republic, Denmark, Finland, Germany, Lithuania, Norway, Russian Federation (Leningrad region, Moscow region, Central Russian plain), Switzerland, United States of America (New York),
Impatiens glandulifera Royle	*Balsaminaceae*	19	x	x			x			riparian habitats	Himalayas	Czech Republic, Finland, Germany, Norway, Slovakia, Switzerland, United Kingdom
Acacia spp. *	*Leguminosae*	19	x	x	x	x	x			grasslands	Australia	Australia, Italy, Portugal, South
Pinus spp. **	*Pinaceae*	14	x	x			x			sand dunes, coastal habi-	North America	Brazil, New Zealand, South Africa
Amorpha fruticosa L.	*Leguminosae*	12	x	x		x	x			riparian and grassland habitats	North America	Bosnia and Herzegovina, Bulgaria, Croatia, Hungary, Italy, Romania, Ukraine

* incl. *A. saligna* (Labill.) Wendl., *A. mearnsii* De Wild., *A. dealbata* Link, *A. cyclops* G.Don, *A. longifolia* (Andrews) Willd., *A. melanoxylon* R.Br.

** incl. *P. elliottii* Engelm., *P. taeda* L., *P. contorta* Douglas ex Loudon.

Table 2 Continuation

Species (aggregate)	Family	Number of votes	Uncontrolled spreading, space occupation, forming monocultures	Displacement of native plant species	Negative effect of other organisms than plants	Habitat modification or destruction	Change in natural processes and ecosystem functions	Mechanical damage of constructions	Dangerous for human health	Habitat type endangered	Region of origin	Countries where the species is considered as a dangerous invader
Picea sitchensis (Bong.) Carrière	*Pinaceae*	10	x	x			x			sand dunes, coastal habitats	North America	Norway
Rosa × rugosa Thunb.	*Rosaceae*	10	x	x			x			sand dunes, coastal habitats	East Asia	Denmark, Finland, Norway
Brachiaria decumbens Stapf *	*Poaceae*	9	x	x			x			savanna, natural forest	South Africa	Bolivia, Brazil
Cortaderia selloana (Schult.) Asch. & Graebn.	*Poaceae*	9	x	x			x			urban and grass-land habitats	South America	France, Portugal, Spain
Prunus serotina Ehrh.	*Rosaceae*	9	x	x		x	x			heathland, grass-land, forest	North and South America	Hungary, Germany, Netherlands, Poland
Lupinus spp. **	*Leguminosae*	9	x	x		x				semi-natural grasslands	North America	Finland, Norway, Sweden, Iceland
Carpobrotus edulis (L.) N.E.Br. ***	*Aizoaceae*	9	x	x		x				coastal habitats	South Africa	Italy, Portugal, Spain
Microstegium vimineum (Trin.) A.Camus	*Poaceae*	7	x	x	x					forest	South and East Asia	United States of America (Connecticut, Illinois, Maryland, Tennessee, North Caroli-na, Southern Illinois, West Virginia)
Crassula helmsii (Kirk) Cockayne	*Crassulaceae*	6	x	x						aquatic habitats	Australia and New Zealand	Belgium, Germany, Netherlands, United Kingdom
Eichhornia crassipes (Mart.) Solms	*Pontederia-ceae*	6	x	x	x		x			aquatic habitats	South America	Egypt, Iran, Italy, Portugal, United States of America (Puerto Rico)
Eragrostis plana Nees	*Poaceae*	6	x	x		x	x			grassland	South Africa	Brazil, Uruguay
Lantana camara L.	*Verbenaceae*	6	x	x	x	x	x			grassland, forest edge, suburban countryside	Central and South America	Argentina, Japan, South Africa
Buddleia davidii Franch.	*Loganiaceae*	5	x	x		x				open and urban habitats	East Europe	France, Italy, Spain, Switzerland, New Zea-land

*incl. *Brachiaria* spp.

** incl. *L. polyphyllus* Lindl., *L. nootkatensis* Sims

*** incl. *C. acinaciformis* (L.) L.Bolus

Table 3 Alphabetical list of invasive plants considered as dangerous (continuation of previous table including plants with less than 5 votes)

Acer negundo L.	*Aceraceae*	3
Acer platanoides L.	*Aceraceae*	1
Acer pseudoplatanus L.	*Aceraceae*	3
Achyranthes bidentata Blume (syn. *Achyranthes japonica*)	*Amaranthaceae*	1
Adiantum capillus-veneris L.	*Adiantaceae*	1
Aegopodium podagraria L.	*Apiaceae*	1
Agropyron cristatum (L.) Gaertn.	*Poaceae*	1
Alliaria petiolata (M.Bieb) Cavara & Grande	*Brassicaceae*	3
Allium paradoxum (M.Brieb.) G. Don	*Amaryllidaceae*	1
Alternanthera philoxeroides (Mart.) Griseb.	*Amaranthaceae*	1
Ampelopsis glandulosa var. *brevipedunculata* (Maxim.)Momiy.	*Vitaceae*	1
Andropogon gayanus Kunth	*Poaceae*	1
Anthoxanthum odoratum L.	*Poaceae*	1
Anthriscus sylvestris (L.) Hoffm.	*Apiaceae*	1
Archontophoenix cunninghamiana (H.Wendl.) H.Wendl. & Drude	*Arecaceae*	1
Ardisia crenata Sims	*Primulaceae*	1
Argemone ochroleuca Sweet	*Papaveraceae*	1
Artemisia vulgaris L.	*Compositae*	1
Arundo donax L.	*Poaceae*	3
Asclepias syriaca L.	*Apocynaceae*	3
Avena barbata Pott ex Link	*Poaceae*	1
Azolla filiculoides Lam.	*Salviniaceae*	2
Baccharis halimifolia L.	*Compositae*	4
Bassia indica (Wight) A.J.Scott	*Amaranthaceae*	1
Berberis thunbergii DC.	*Berberidaceae*	2
Bidens pilosa L.	*Compositae*	1
Bothriochloa ischaemum (L.) Keng	*Poaceae*	1
Brassica tournefortii Gouan	*Brassicaceae*	1
Bromus inermis Leyss.	*Poaceae*	4
Bromus tectorum L.	*Poaceae*	4
Bunias orientalis L.	*Brassicaceae*	4
Calamagrostis epigeios (L.) Roth	*Poaceae*	1
Campuloclinium macrocephalum (Less.) DC.	*Compositae*	3
Campylopus introflexus (Hedw.) Brid.	*Dicranaceae*	3
Celtis australis L. L.	*Cannabaceae*	1
Celtis occidentalis L.	*Cannabaceae*	2
Celtis sinensis Pers.	*Cannabaceae*	1
Cenchrus ciliaris L.	*Poaceae*	3
Centaurea solstitialis L. (incl. *Centaurea* spp.)	*Compositae*	3
Cirsium vulgare (Savi) Ten.	*Compositae*	2
Clematis vitalba L.	*Ranunculaceae*	1
Convolvulus arvensis L.	*Convolvulaceae*	1
Conyza canadensis (L.) Cronquist	*Compositae*	2
Coreopsis lanceolata L.	*Compositae*	1
Corynephorus canescens (L.) P.Beauv.	*Poaceae*	1
Cotoneaster bullatus Bois (incl. *Cotoneaster* spp.)	*Rosaceae*	2
Cynodon dactylon (L.) Pers.	*Poaceae*	2
Cytisus scoparius (L.) Link	*Leguminosae*	4
Echinocystis lobata (Michx.) Torr. & A.Gray	*Cucurbitaceae*	1
Egeria densa Planch.	*Hydrocharitaceae*	1
Ehrharta calycina Sm.	*Poaceae*	1
Elaeagnus angustifolia L.	*Elaeagnaceae*	4
Elaeagnus umbellata Thunb.	*Elaeagnaceae*	1
Elodea canadensis Michx. (incl. *Elodea* spp.)	*Hydrocharitaceae*	3
Eragrostis curvula (Schrad.) Nees	*Poaceae*	1
Eragrostis lehmanniana Nees	*Poaceae*	1
Erigeron annuus (L.) Pers.	*Compositae*	2
Eucalyptus camaldulensis Dehnh. (incl Eucalyptus spp.)	*Myrtaceae*	2
Euonymus alatus (Thunb.) Siebold	*Celastraceae*	1
Euphorbia esula L.	*Euphorbiaceae*	1
Foeniculum vulgare Mill.	*Apiaceae*	1
Frangula alnus Mill.	*Rhamnaceae*	1
Genista monspessulana (L.) L.A.S.Johnson	*Leguminosae*	1
Gleditsia triacanthos L.	*Leguminosae*	2
Grindelia squarrosa (Pursh) Dunal	*Compositae*	4
Gymnocoronis spilanthoides (D.Don ex Hook. & Arn.) DC.	*Compositae*	1
Hedychium coronarium J.König	*Zingiberaceae*	1
Hedychium gardnerianum Sheppard ex Ker Gawl.	*Zingiberaceae*	1
Hieracium aurantiacum L.	*Compositae*	1
Hieracium pilosella L.	*Compositae*	1
Hovenia dulcis Thunb.	*Rhamnaceae*	2
Humulus scandens (Lour.) Merr. (syn. *Humulus japonicus*)	*Cannabaceae*	1
Hydrocotyle ranunculoides L.f.	*Araliaceae*	3
Hyparrhenia hirta (L.) Stapf	*Poaceae*	2

Table 3 Continuation

Impatiens noli-tangere L.	*Balsaminaceae*	1
Impatiens parviflora DC.	*Balsaminaceae*	3
Imperata cylindrica (L.) Raeusch. (and other warm season non-native grasses)	*Poaceae*	1
Jacobaea maritima (L.) Pelser & Meijden subsp. *maritima*	*Compositae*	1
Lagarosiphon major (Ridl.) Moss	*Hydrocharitaceae*	1
Lespedeza juncea var. *sericea* (Thunb.) Lace & Hauech (syn. *Lespedeza cuneata*)	*Leguminosae*	1
Leucaena leucocephala (Lam.) de Wit	*Leguminosae*	3
Ligustrum japonicum Thunb.	*Oleaceae*	3
Ligustrum lucidum W.T.Aiton	*Oleaceae*	2
Ligustrum sinense Lour.	*Oleaceae*	3
Linaria genistifolia subsp. *dalmatica* (L.) Maire & Petitm	*Plantaginaceae*	1
Lonicera maackii (Rupr.) Maxim.	*Caprifoliaceae*	4
Lonicera morrowii A.Gray	*Caprifoliaceae*	1
Ludwigia peploides (Kunth) P.H.Raven	*Onagraceae*	1
Lygodium spp.	*Schizaeaceae*	1
Lysimachia punctata L.	*Primulaceae*	1
Melaleuca quinquenervia (Cav.) S.T.Blake	*Myrtaceae*	1
Melia azederach L.	*Meliaceae*	1
Melinis minutiflora P.Beauv.	*Poaceae*	4
Mikania micrantha Kunth	*Compositae*	2
Morus alba L.	*Moraceae*	1
Myriophyllum aquaticum (Vell.) Verdc.	*Haloragaceae*	2
Nassella spp.	*Poaceae*	1
Nicotiana glauca Graham	*Solanaceae*	1
Oenothera drummondii Hook.	*Onagraceae*	1
Olea europea L.	*Oleaceae*	1
Oplismenus undulatifolius (Ard.) Roem. & Schult.	*Poaceae*	1
Opuntia humifusa (Raf.) Raf.	*Cactaceae*	1
Oxalis pes-caprae L.	*Oxalidaceae*	2
Padus serotina (Ehrh.) Borkh.	*Rosaceae*	1
Panicum maximum Jacq. (syn. *Megathyrsus maximus*)	*Poaceae*	3
Panicum repens L.	*Poaceae*	1
Paulownia tomentosa Steud.	*Paulowniaceae*	1
Pennisetum clandestinum Hochst. ex Chiov.	*Poaceae*	1
Pennisetum setaceum (Forssk.) Chiov.	*Poaceae*	1
Phalaris arundinacea L.	*Poaceae*	1
Phragmites australis (Cav.) Trin. ex Steud.	*Poaceae*	4
Pistia stratiotes L.	*Araceae*	1
Pittosporum undulatum Vent.	*Pittosporaceae*	1
Poa angustifolia L.	*Poaceae*	1
Prosopis glandulosa Torr.	*Leguminosae*	1
Prosopis juliflora (Sw.) DC.	*Leguminosae*	3
Pseudotsuga menziesii (Mirb.) Franco	*Pinaceae*	2
Pteridium aquilinum (L.) Kuhn	*Dennstaedtiaceae*	2
Pyracantha coccinea M. Roem.	*Rosaceae*	1
Quercus rubra L.	*Fagaceae*	1
Rhamnus cathartica L.	*Rhamnaceae*	1
Rhododendron ponticum L.	*Ericaceae*	2
Rosa multiflora Thunb.	*Rosaceae*	1
Rubus fruticosus L.	*Rosaceae*	1
Rubus hedycarpus subsp. *armeniacus* (Focke) Focke	*Rosaceae*	3
Rubus ulmifolius Schott	*Rosaceae*	1
Rudbeckia laciniata L.	*Compositae*	1
Rumex acetosella L.	*Polygonaceae*	1
Saccharum spontaneum subsp. *aegyptiacum* (Willd.) Hack.	*Poaceae*	1
Senecio glastifolius L.f.	*Compositae*	1
Senecio inaequidens DC.	*Compositae*	1
Sicyos angulata L.	*Cucurbitaceae*	2
Silybum marianum (L.) Gaertn.	*Compositae*	1
Solanum elaeagnifolium Cav.	*Solanaceae*	2
Sorghum halepense (L.) Pers.	*Poaceae*	2
Spartium junceum L.	*Leguminosae*	1
Spiraea douglasii Hook.	*Rosaceae*	1
Spiraea tomentosa var. rosea (Raf.) Fernald	*Rosaceae*	1
Symphyotrichum lanceolatum (Willd.) G.L.Nesom (syn. *Aster lanceolatus*)	*Compositae*	1
Tradescantia fluminensis Vell.	*Commelinaceae*	2
Triadica sebifera (L.) Small	*Euphorbiaceae*	1
Tsuga heterophylla (Raf.) Sarg.	*Pinaceae*	1
Ulex europaeus L.	*Leguminosae*	4
Verbascum thapsus L.	*Scrophulariaceae*	1
Verbesina encelioides (Cav.) Benth. & Hook.f. ex A.Gray	*Compositae*	1
Vicia cracca L.	*Leguminosae*	1
Vincetoxicum nigrum Moench	*Apocynaceae*	1
Waltheria indica L.	*Malvaceae*	1

Allium paradoxum (*Amaryllidaceae*), native to Asia may be regarded as “local invasive” around Berlin, now increasing dominance in other parts of Germany.

Grindelia squarossa (*Asteraceae*), native to western and central North America is invasive in the Lugansk region, Kreminna, Ukraine. This individual was recorded on sand near the railway station, 7 August 2015.

Cirsium vulgare (native in Europe, W Asia and NW Africa) and *Rudbeckia laciniata* (native to N America; both *Asteraceae*) are invading the natural communities in Hokkaido, northern Japan.

Elaeagnus angustifolia (*Eleagnaceae*), native to western and central Asia, is invasive in the Lugansk region, Svatovo, Ukraine. Chalk outcrops on the right bank of the Krasna river, 12 August 2015.

Carpobrotus edulis (*Aizoaceae*), native to South Africa has escaped from cultivation and has naturalized in many other regions throughout the world. On the Mediterranean coast, *Carpobrotus* has spread out rapidly and now parts of the coastline are completely covered by this invasive species. The pictures show populations in the Pontine Archipelago, Italy, where conservationists removed it by manual eradication, and subsequently recorded several rare species in the region such as *Matthiola tricuspidata* (rare in Lazio region) and *Mesembryanthemum nodiflorum* (native *Aizoaceae*).

Erigeron annuus (*Asteraceae*), *Solidago canadensis* (*Asteraceae*) and *Heracleum sosnowskyi* (*Apiaceae*) are widespread invaders in the Moscow region, Russia.

Cerrado ecosystem invaded by *Urochloa brizantha* (*Poaceae*) native in tropical South Africa. The picture was taken in a natural reserve Reserva De Itirapina, Brazil.

Asclepias syriaca (*Asclepiadaceae*) one of the most aggressive invader in Central Ukraine. Dry grasslands of the Dnieper River valley, Kyiv region.