Exploring the Flora on Inert Landfill Sites in Southern Ticino (Switzerland)

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Results of a floristic survey conducted in eight deposits of inert materials and landfill sites in the south of the Canton Ticino are presented. 512 taxa belonging to 297 genera and 85 families were recorded during 2009. Species richness and composition demonstrate the value of inert landfill sites as substitution habitats for threatened and rare native plants, as privileged sites of early arrival for adventive taxa new to the Swiss flora and as sites of proliferation and starting points for further spread of invasive alien plants. Underlying mechanisms and conditions explaining species composition and the distribution of some noteworthy taxa are discussed. Results are compared with floristic surveys of railway areas in the same region. Particularly interesting are the observations of: *Avena sterilis* ssp. *ludoviciana, Bromus catharticus, Carduus pycnocephalus, Cyperus glomeratus, Cyperus longus, Eragrostis pectinacea, Eragrostis virescens, Kickxia elatine, Lactuca saligna, Paspalum dilatatum, Ranunculus sardous, Sporobolus vaginiflorus.*

Keywords: floristics, biodiversity, adventive, neophytes, invasive

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Forgotten by the scientific community for a long time, floristic and ecological research on urban and disturbed habitats have experienced a revival in the last two decades in Switzerland and elsewhere. Numerous publications have examined urban floras in e.g. Milano (Banfi & Galasso 1998), Basel (Brodtbeck et al. 1997), Lausanne (Droz et al. 2006) and Zürich (Landolt 2001), the flora of roadsides (Jeanmonod 2002, Ciardo & Delarze 2005), railway land (e.g. Tinner & Schumacher 2004) or harbours (Martini & Pericin 2003). Compared to the above mentioned systems, the flora and vegetation of landfill sites were much less studied. Research related to natural and directed succession, restoration or protection at inactivated landfill sites has been undertaken in Germany (Rebele & Lehmann 2002) and the USA (Barnswell & Dwyer 2007). Urban and industrial habitats are mainly characterised by a spatial and temporal pattern of different substrates and successional stages, human-mediated propagule dispersal (Rebele 1992), and can be surprisingly species-rich (Gilbert 1989).

Canton Ticino is Switzerland's southernmost region, contains its lowest altitudes, and has a considerably warmer climate than the rest of the country (Cotti et al. 1990). It may be considered a main entry point for new plant species migrating north into Switzerland from nearby Italy, particularly from the region Lombardy, due to extensive traffic of goods and people and to global climate change. Models predict that lowland southern Ticino counts among the Swiss areas with the highest neophyte species richness, which is primarily driven by temperature conditions (Nobis et al. 2009). This phenomenon is particularly visible in urban habitats in the Sottoceneri area, where a large number of thermophilic neophytes and adventive species can be

Table 1: Name, location, surface and altitude of the sampled sites

Site No.	Name	Political commune	Swiss metric coordinates X	Swiss metric coordinates Y	Area (m²)	Altitude (m)
1	Campagna	Comano	716959	98916	11 227	430
2	Gaggiolo	Stabio	714586	77057	37 253	390
3	Pizza Lunga	Stabio	717257	79590	12 054	350
4	Colombera	Stabio	717380	78784	10 752	335
5	S. Antonio	Balerna	721241	78628	16 630	275
6	Pobbia	Novazzano	721375	77632	3 825	257
7	Passeggiata	Balerna	721639	77199	17 675	245
8	Valle della Motta	Novazzano	718813	78853	1 806	330

observed on railway land (Schoenenberger et al. 2002, Schoenenberger & Giorgetti Franscini 2004). In 2003, 70% of all inert building material used in the Sottoceneri area, corresponding to more than 700 000 metric tons, was imported from quarries in nearby Italy (Repubblica e Cantone Ticino 2007). With a population size of over nine million inhabitants, Lombardy is one of Italy's and Europe's most urbanised areas, and urban areas, industrial sites and communication routes harbour by far the highest number of introduced species (Celesti-Grapow et al. 2010). With over 500 alien species, Lombardy has the highest absolute and relative number and the highest density (species/log area) of alien species of all Italian administrative regions (Celesti-Grapow et al. 2010).

The aim of the present work was to assess the importance southern Swiss inert landfill sites have as: (i) substitution habitats for threatened and rare native plants, (ii) sites of early arrival for adventive species new to the Swiss flora, (iii) sites of proliferation and starting points for further spread of invasive alien plant species. To our knowledge this is the first study addressing these questions in Switzerland.

Fig. 1: Location of investigated sites. CH: Switzerland; I: Italy; grey surface: lake Lugano.

1: Campagna
2: Gaggiolo
3: Pizza Lunga
4: Colombera
5: S. Antonio
6: Pobbia
7: Passeggiata
8: Valle della Motta

Materials and Methods

The studied area is located roughly at 46° North latitude on the southern fringe of the Swiss Alps adjacent to the Po Plain. The Insubrian climate is characterised by dry and sunny winters, and warm and humid summers (mean annual temperature approximately 12° C); most precipitation occurs in spring and autumn, with frequent and violent thunderstorms in summer (annual mean precipitations >1800 mm) and by high insolation levels. Many exotic plant species (like *Camellia japonica* or *Trachycarpus fortunei)* thrive particularly well in the insubrian region and are considered a symbol for it (Cotti et al. 1990).

A floristic survey was conducted between the beginning of April and the end of September 2009 in eight selected inert landfill sites in southern Ticino, Switzerland (Fig. 1, Tab. 1). Depen-

Photo 1: View of the deposit of inert materials in Comano (No. 1).

ding on its size, each site was visited between 5 and 9 times over the whole 2009 vegetation season (data not shown). Seven sites are located in the Mendrisio area and one in the Lugano area, all sites were within the Sottoceneri geographical area. Table 1 provides information on the political communes, Swiss metric coordinates of central points, surfaces and mean altitudes of the sites. Perimeters of all sites were recorded using a Garmin GPS™ device and maps produced with the Geographic Information Systems software ArcMap 9.3 (licensed to Canton Ticino), only surface data are presented here.

In each site, all detected, not deliberately introduced, vascular plant species, subspecies and/or aggregates were recorded (hereafter referred to as taxa). In the case of rare taxa or taxa of particular interest population size was assessed (data not shown). Nomenclature follows the Synonym Index of the Swiss Flora (Aeschimann & Heitz 2005), in case of taxa absent from the Index, the Flora of Italy (Pignatti 1982) or other sources were used and names eventually verified on the International Plant Names Index (www.ipni.org) or on the database of the Missouri Botanical Garden (www.tropicos.org). Collected herbarium specimens were deposited at the herbarium of the Cantonal Museum of Natural History in Lugano, Switzerland (herbarium code: LUG). All collected floristic data were transmitted to the Data Centre of the Swiss Flora (CRSF/ZDSF).

All statistical analyses and graphs were produced on Microsoft Excel (licensed to Cantone Ticino). Two-dimensional scatterplots were produced based on the Sørensen dissimilarity coefficient (Sørensen 1948). Data regarding chorotypes and Raunkiær's life forms were taken from the Flora of Italy (Pignatti 1982), so as to be comparable with the Italian Lombardy region (Pignatti 1994), which belongs to the same biogeographical area as southern Ticino. Ecological groups were retrieved from the Red List of threatened Ferns and Flowering Plants in Switzerland (Moser et al. 2002). Ecological indicator values follow Flora Indicativa (Landolt et al. 2010). For the analysis of chorotypes, life forms, ecological groups and indicator values, floristic data from all sites were pooled into one set; taxa lacking the respective information in the literature consulted were not considered for statistical analyses (as a result, between 0 and 12% of the taxa were excluded, data not shown).

The appendix published online at http://pages.unibas.ch/botges/bauhinia/22.htm provides a subsample of the recorded taxa. The list includes all taxa of the Swiss Red List in the geographical area SA1 (Canton Ticino and Moesa District of Canton Grisons) except the ones of the category LC which are not neophytes (Moser et al. 2002); it also includes taxa absent from the Red List (garden escapes and adventive taxa new for Switzerland) or considered absent in the sector SA1. Additional information on invasiveness status is given.

For the purposes of this study, we considered inert landfill sites, intended as temporary or final deposits, as homogeneous systems within their perimeters. In reality, several different types of activities and substrates can be observed; most of these are nevertheless common to all studied sites. Different disposed inert materials encompass demolition materials (e.g. concrete and bricks), excavation material (e.g. rubble, gravel, sand and clay), topsoil (humus) and all sorts of waste debris and rubbish. The repeated passage of heavy machinery on ramps and tracks create large areas with severely compacted soil and depressions where water accumulates over longer periods of time. Moreover, in many of the sites, some processing and recycling can be observed, sometimes most of the incoming materials leave the site again after sorting (as in sites No. 3 and 5). In site No. 2 no recycling was observed, and all the materials, including topsoil and gravel were dumped together. Site No. 8 has been closed down for about three years. Sites No. 5, 6, 7 were adjacent to railway tracks, a fact that might influence taxa composition (not analysed here). The sites' original soils previous to the initiation of the dumping sites may differ considerably, some landfills were placed on former wetlands (e.g. site No. 4), in forest (e.g. site No. 2), or in fields (e.g. site No. 3). All these elements make the inert landfill sites structurally very diverse habitats. For a general view of the investigated system see photo 1.

Results

Diversity

A total of 512 taxa belonging to 297 genera and 85 families were recorded in eight inert landfill sites in southern Ticino representing 20% of the vascular flora of the SA1 geographical region (Ticino and Moesa), respectively 16.3% of the Swiss vascular flora (MOSER et al. 2002). Plant richness strongly correlates (R2 = 0.99) with surface of the sites (Fig. 2), ranging from 69 taxa in the smallest site (No. 8) to 320 taxa in the biggest site (No. 2). Only 28 taxa were present in all sites. These include very frequent and widespread taxa such as *Plantago lanceolata* or *Trifolium repens,* typically ruderal plants like *Panicum capillare, Setaria pumila* or *Verbena officinalis,* fast spreading adventive taxa like *Eragrostis pectinacea* or *Panicum dichotomiflorum,* and invasive neophytes like *Ambrosia artemisiifolia, Artemisia verlotiorum, Bidens frondosa* or *Solidago canadensis*. A large number of taxa (176) were found in a single site only. These include many anecdotic garden escapes such as *Cichorium endivia, Datura innoxia, Mirabilis jalapa* or *Pachysandra terminalis,* taxa from other ecosystems gone astray in the landfill sites like *Aruncus dioicus, Campanula trachelium, Lycopus europaeus* s.str. or *Turritis glabra,* plants from further successional stages like *Carpinus betulus, Ligustrum vulgare* or *Quercus robur,* most of the rare and endangered taxa, and adventive plants new for Switzerland or Ticino (for further details see http://pages.unibas.ch/botges/bauhinia/22.htm). A relatively constant number of taxa was common to 3–7 sites, representing the characteristic ruderal flora of those systems (Fig. 3). The most frequent families, both in terms of taxa and genera richness are Poaceae and Asteraceae, contributing to about one quarter of the floral biodiversity of southern Swiss inert landfill sites (Table 2). The most diverse genera recorded in these families are *Bromus* (6 taxa), and *Crepis* (5 taxa), whereas the overall most diverse genera are *Carex* (10 taxa), *Euphorbia* (9 taxa), *Veronica* (9 taxa) and *Trifolium* (8 taxa). The typically weedy families Amaranthaceae and Chenopodiaceae are represented with 7 taxa (all *Amaranthus* sp.) and 6 taxa respectively (data not shown).

With respect to floristic composition, the studied sites are quite homogenous. The only site which seems to differ is Valle della Motta (No. 8), which is the only site that has closed and that has the most hydromorphic character amongst all (Fig. 4). There is no evidence for a longitudinal gradient: the northernmost site (No.1), located 20 km north from the other sites being one of the least dissimilar to the other sites.

Chorological spectrum

Following the classification of chorotypes of the Flora of Italy (PIGNATTI 1982), eurasian and cosmopolitan elements are most representative for southern Swiss landfill sites, with 172 and 160 taxa respectively. They are followed by septentrional (71) and eury-mediterranean (56) taxa. The chorological spectrum

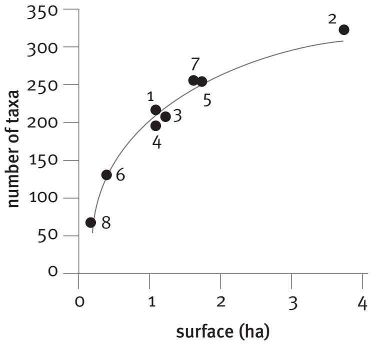

Fig. 2: Species-area curve showing typical log relationship between species richness and surface of the sites.

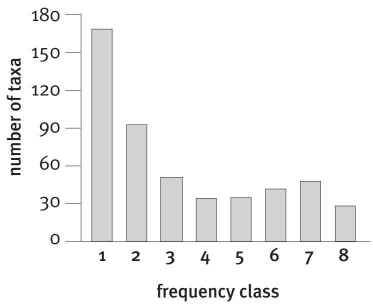

Fig. 3: Frequency distribution of taxa in the studied area.

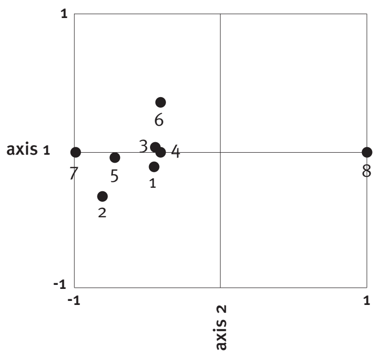

Fig. 4: Principal component analysis of taxa composition among the studied areas based on Sørensen's dissimilarity values.

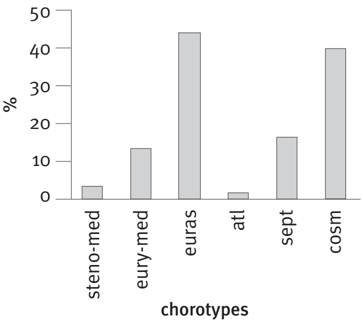

Fig. 5: Chorological spectrum of southern Ticino landfill sites. Only the six most frequent chorotypes are shown: steno-mediterranean, eury-mediterranean, eurasian, atlantic, septentrional and cosmopolitan.

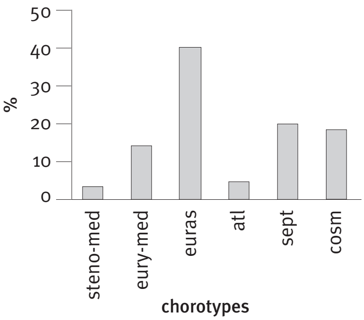

Fig. 6: Chorological spectrum of the Italian Lombardy region (Pignatti 1994). Southern European orophytes and less representative chorotypes are omitted.

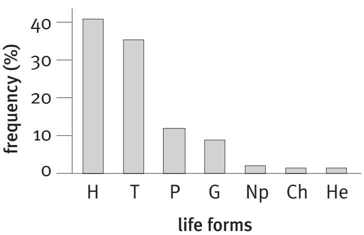

Fig. 7: Spectrum of Raunkiær's plant life forms in the study sites.
H: Hemicryptophytes
T: Therophytes
P: Phanerophytes
G: Geophytes
Np: Nanophanerophytes
Ch: Chamaephytes
He: Helophytes

Table 2: The most frequent plant families of inert landfill sites in southern Ticino. Percentages are given in relation to total amount of species, subspecies and/or aggregates (taxa) and genera.

	Families	No. taxa	% taxa	No. genera	% genera
1	Poaceae	64	12.5	39	13.1
2	Asteraceae	57	11.1	39	13.1
3	Fabaceae	35	6.8	16	5.4
4	Lamiaceae	27	5.3	16	5.4
5	Brassicaceae	22	4.3	17	5.7
6	Rosaceae	22	4.3	12	4.0
7	Scrophulariaceae	21	4.1	9	3.0
8	Caryophyllaceae	20	3.9	10	3.4
9	Cyperaceae	16	3.1	3	1.0
10	Polygonaceae	14	2.7	5	1.7
11	Apiaceae	11	2.1	11	3.7
12	Euphorbiaceae	11	2.1	3	1.0
13	Ranunculaceae	10	2.0	6	2.0
14	Solanaceae	9	1.8	4	1.3
15	Geraniaceae	8	1.6	2	0.7
16	Liliaceae	8	1.6	5	1.7
	others (69 families)	157	30.7	100	33.7
	Total (85 families)	512		297	

of the landfill sites, strongly resembles the general spectrum of Lombardy (with orophytes being omitted) (Pignatti 1994), the Italian region in vicinity to the south of the study area (Fig. 5, Fig. 6). Striking is the cosmopolitan component, which includes all naturalised alien taxa (archeophytes and neophytes), being about twice as important in landfill sites than in overall Lombardy region.

Life forms

Following Raunkiær's life forms classification (Raunkiær 1905), the studied sites are dominated by hemicryptophytes (211 taxa) and therophytes (181 taxa), as one would expect in ruderal habitats and early successional stages (Klötzli et al. 2010). Phanerophytes and geophytes represent another 100 taxa in southern Ticino's inert landfill sites (Fig. 7).

Ecological Groups

Unsurprisingly, the highest proportion (almost half) of the taxa found in the study sites were weeds and ruderal plants, including neophytes (Fig. 8). Other well represented ecological plant groups are forest (90 taxa) and grassland plants, both nutrient-rich (50 taxa) and nutrient-poor (43 taxa). Wetland and aquatic plants represent 41 taxa; their occurrence is due to the fact that some landfill sites were placed on former wetlands and to the regular presence of compacted soil where water stagnates over longer periods of time.

Ecological adaptations

Most taxa recorded are primarily distributed between the warm-colline and the upper-colline altitudinal zones (Fig. 9). However, 49 taxa are typical for the hot-colline zone. Interestingly, a large proportion of the relatively recent neophytes (invasive and non-invasive) and rare adventive taxa belong to this group, including *Abutilon theophrasti, Acacia dealbata, Acalypha virginica, Ambrosia artemisiifolia, Arundo donax, Carduus pycnocephalus, Commelina communis, Conyza sumatrensis, Cyperus esculentus, Diospyros lotus, Eleusine indica, Eragrostis virescens, Euphorbia prostrata, Muhlenbergia schreberi, Polygonum orientale, Setaria italica, Trachycarpus fortunei, Xanthium italicum*. The study sites harbour primarily taxa representative of moderately dry to moist soil conditions (Fig. 10). However, a large proportion of the taxa (253) were well adapted to moderate to strong soil moisture variation during the growth season (Fig. 11). Most plants recorded thrive on moderately-aerated and moderately nutrient-poor to nutrient-rich soils (Fig. 12, 13), with a intermediate humus content (Fig. 14). However, an important fraction (164 taxa) is typical for compacted or soaked soils. Twenty-seven percent (or 138 taxa) of the plants are heavy metal tolerant (data not shown).

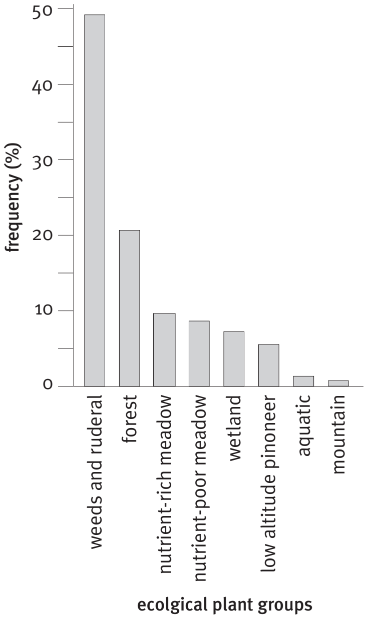

Fig. 8: Relative frequencies of ecological plant groups of the flora of inert landfill sites.

Red List

As many as 59 threatened taxa (11.5% of total) were recorded in the studied landfill areas, demonstrating the value of these habitats for conservation of rare plants (Table 3). Considering only native taxa and archeophytes, 23 (4.5% of total) threatened taxa were recorded. Taxa particularly noteworthy for their rarity include the native *Bromus japonicus, Chenopodium ficifolium, Crepis foetida, Cuscuta cesatiana, Cyperus glomeratus, Cyperus longus, Diplotaxis muralis, Draba muralis, Euphorbia stricta, Kickxia elatine, Lactuca saligna, Legousia speculum-veneris, Misopates orontium, Ranunculus sardous, Trifolium fragiferum, Verbascum phlomoides, Vicia villosa* s.str., the non-European neophytes *Geranium sibiricum* and *Euphorbia prostrata*, the European neophytes *Herniaria hirsuta* and *Xanthium italicum*, and the originally cultivated adventive *Galega officinalis*. Two taxa, *Avena sterilis* ssp. *ludoviciana* and *Carduus pycnocephalus*, both of Mediterranean origin, may be considered new for the Swiss flora, or not recorded for longer periods. The comparison of inert landfill flora with the spontaneous flora of railway infrastructure of Ticino, which is in many regards a similar system, shows a higher proportion of threatened red list taxa (RL, including rare neophytes and anciently cultivated taxa) on railway land, whereas the proportion of not evaluated (NE) taxa, mainly garden escapes, is higher on landfill sites.

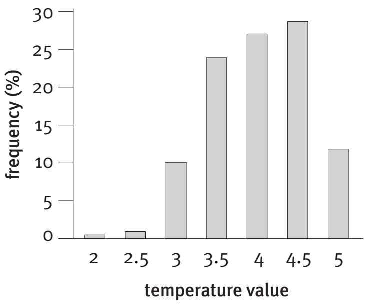

Fig. 9: Relative frequencies of different temperature value indicators (mean temperature during growth season) in the studied area (according to Landolt et al. 2010)
2: subalpine
3: montane
4: colline
5: hot colline

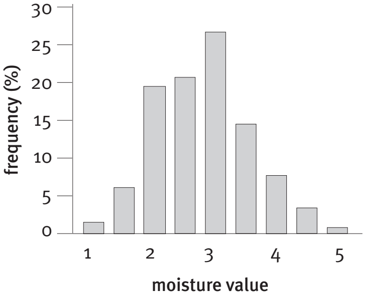

Fig. 10: Relative frequencies of different soil moisture value indicators in the studied area (according to Landolt et al. 2010).
1: very dry
2: moderately dry
3: moderately moist
4: very moist
5: inundated.
Intermediate values not indicated

Table 3: Relative frequencies of taxa from the Red List for the region SA1 (Moser et al. 2002), in inert landfill sites compared to the flora of railway land in Ticino (Schoenenberger & Giorgetti Franscini 2004, including unpublished data). The values in brackets refer to frequencies when European neophytes, non-European neophytes, and adventive cultivated taxa are omitted. RL: red list of threatened taxa; – considered absent from SA1.

Red List categories (IUCN 2001)	Landfill flora		Railway Flora	
	No. taxa	%	No. taxa	%
RE Extinct in CH	0	0.0	4	0.5
CR Critically Endangered	5 (4)	1.0 (0.8)	15	2.0
EN Endangered	21 (13)	4.1 (2.5)	40	5.2
VU Vulnerable	33 (23)	6.4 (4.5)	56	7.3
NT Near Threatened	43 (20)	8.4 (3.9)	59	7.7
LC Least Concern	355	69.4	506	66.3
DD Deta Deficient	22 (1)	4.3 (0.2)	33	4.3
NE not evaluated	32	6.3	35	4.6
–	1	0.2	15	2.0
RL (RE + CR + EN + VU)	59 (23)	11.5 (4.5)	115	15.1
Total	512		763	

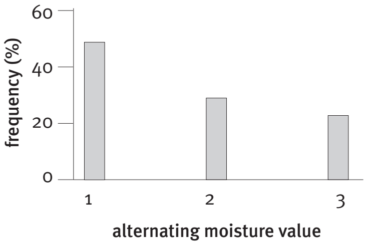

Fig. 11: Relative frequencies of different alternating soil moisture indicators in the studied area (according to Landolt et al. 2010).
1: small moisture variation
2: moderate moisture variation
3: strong moisture variation

Neophytes

An overall number of 83 (16.2% of total) neophyte taxa were recorded on the studied sites. Per site, proportion of neophytes ranged from 15.7 % to 23.2% (between 16 and 57 taxa). Several of the most invasive neophytes of Switzerland were recorded in the studied sites, including *Ailanthus altissima, Ambrosia artemisiifolia, Artemisia verlotiorum, Buddleja davidii, Impatiens glandulifera, Lonicera japonica, Prunus serotina, Reynoutria japonica, Rhus typhina, Robinia pseudoacacia, Senecio inaequidens, Solidago canadensis* and *Solidago gigantea*. Propagule spread for some of these taxa is visibly facilitated by human transport to the sites, whereas others are most probably dispersed by wind and animals and find suitable habitats in the inert landfill sites.

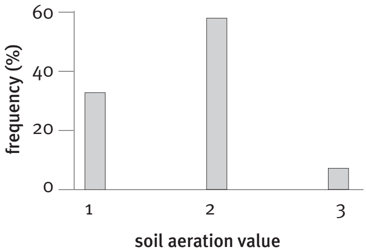

Fig. 12: Relative frequencies of different soil aeration status indicators in the studied area (according to Landolt et al. 2010).
1: compacted or soaked soil
2: medially aerated soil
3: well aerated soil

Discussion

Like most man-made habitats, inert landfill sites in southern Switzerland consist of a small-scale mosaic of different conditions. The habitats are mainly characterised by moderately moist conditions with fluctuating water availability, averagely aerated, rather nutrient rich soils with intermediate humus content. Piles of primarily mineral materials usually do not allow the development of dense vegetation except for some short lived and often invasive neophytes, due to lack of nutrients and water and the quick recycling for building purposes. Species-rich vegetation thrives best on dumping areas covered with excavation material ('ruderal soil') and on topsoil piles (Rebele 1992).

Inert landfill sites harbour a mostly thermophile flora dominated by hemicryptophytic and therophytic weed and ruderal plant communities, typically reflecting, in its taxa composition and chorological spectrum, the flora of the Italian Lombardy region (Pignatti 1994), one of Europe's most urbanised and industrialised areas. Typically ruderal taxa widespread on inert landfill sites include *Crepis foetida, Datura stramonium, Potentilla norvegica, Setaria italica, Solanum chenopodioides, Torilis arvensis,* and *Tragopogon dubius.*

Due to repeated disturbance and the presence of bare soils, alternating soil moisture conditions and the human-facilitated transport of propagules, several threatened native plant taxa find valuable substitution habitats on inert landfill sites. Rare segetal taxa like *Aristolochia clematitis, Bromus japonicus, Buglossoides arvensis, Crepis setosa, Dianthus armeria, Kickxia elatine, Misopates orontium, Legousia speculum-veneris* or *Vicia villosa* s.str., which can hardly be found in modern-agriculture fields in Ticino anymore, find suitable habitats on inert landfill sites, where they sometimes develop important populations. Rare pioneer plants *(Draba muralis, Galeopsis angustifolia)*, plants originating from wetlands and natural riverbeds *(Cyperus* spp., *Ranunculus sardous, Rumex conglomeratus)* or typical for compacted soils with alternating moisture *(Centaurium pulchellum, Trifolium fragiferum)* may be regularly found in these habitats. In a similar study from the United States, several threatened and endangered plant taxa were found on a closed-down landfill site and a protected nature reserve is being created on the site (Barnswell & Dwyer 2007). The conservation value of pioneer vegetation in disturbed, urban and industrial habitats, particularly ruderal annual vegetation and vegetation of trampled wet soils has been widely recognised (Rebele 1992, Delarze & Gonseth 2008).

Due to extensive vehicle traffic and inert material transport from nearby Italy, building sites and inert landfill sites in southern Ticino act as privileged sites for early arrival of new adventive plant taxa, such as *Carduus pycnocephalus* or *Geranium sibiricum* and starting points from which further areas may be colonised. The establishment of such elements is favoured by climatic warming (Nobis et al. 2009). In fact, most of these taxa, of Mediterranean origin or from overseas, are thermophiles, typical for the hot-colline zones.

Several invasive neophytes are common on inert landfill sites, one of the most typical example being the ruderal annual *Ambrosia artemisiifolia,* which was found in large populations on all the investigated sites. Despite extensive control efforts by the Canton Ticino (Mola 2009), mainly in urban areas and along the N2 motorway (which crosses Ticino in South-North direction), *A. artemisiifolia* continues to spread, it can notably be increasingly found on building sites in the Sottoceneri area, which are likely using seed-contaminated primary inert materials imported from heavily infested Lombardy or recycled materials from landfill sites. Railway lines seem to play a less important role

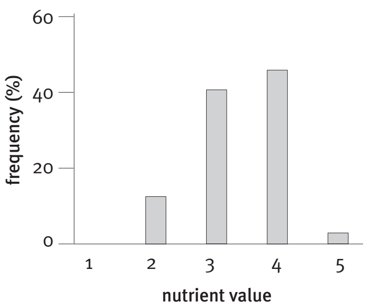

Fig. 13: Relative frequencies of different soil nutrient value indicators in the studied area (according to Landolt et al. 2010).
1: very nutrient-poor
2: nutrient-poor
3: moderately nutrient-poor to moderately nutrient-rich
4: nutrient-rich
5: very nutrient-rich to overfertilised

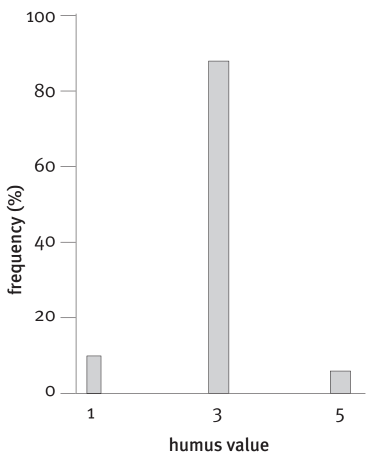

Fig. 14: Relative frequencies of different soil humus content indicators in the studied area.
1: little to no humus content
3: medium humus content
5: high humus content   mus content

for its spread, only a few small populations were recorded between 2001 and 2004; at that time the southernmost part of the N2 motorway was already heavily infested (Schoenenberger et al. 2002, Schoenenberger & Giorgetti Franscini 2004). *Ambrosia artemisiifolia* is listed as a forbidden plant in the recently introduced Swiss Release Ordinance (Swiss Federal Council 2008). Other taxa inscribed in the ordinance and profusely present on the sites are *Reynoutria japonica, Rhus typhina, Solidago canadensis* and *Solidago gigantea. Senecio inaequidens,* which is also in that list, was found only once (site No. 3). Motorways and railway lines are the privileged invasion routes of this species. In fact, gradual but rapid colonisation has been observed on Swiss motorways (Jeanmomod 2002), in Ticino it is known from along the N2 motorway as far North as Bellinzona (Mola 2009), whereas on railways it spreads all the way between Chiasso and Bodio (Schoenenberger et al. 2002). This species is particularly problematic because of its pyrrolizidine alkaloid content which induces hepatotoxicity in livestock with potentially lethal consequences (Dimande et al. 2007). In late 2007 we observed *S. inaequidens* in a pasture in Manno, at about 200 m from a railway station. Additional observations of this species in more natural ecosystems like meadows and rocky slopes have been made since, particularly in the Vedeggio Valley.

Garden or culture escapes represent a typical element of inert landfill sites. Most of these casual taxa (e.g. *Citrullus lanatus, Cosmos bipinnatus, Fragaria×ananassa* or *Tagetes patula)* are short lived and have little or no chance to establish. Some may establish self-sustaining (subspontaneous) populations and are sometimes considered partially naturalised, like *Commelina communis, Consolida ajacis, Lunaria annua* or *Nigella damascena*. Interestingly, several taxa considered subspontaneous in Switzerland (Aeschimann & Burdet 1989, Lauber & Wagner 2007), like *Alcea rosea, Antirrhinum majus, Brassica napus, Hibiscus trionum* or *Polygonum orientale,* are considered naturalised in Italy (Celesti-Grapow et al. 2009). In fact, at the beginning of the naturalisation process, all alien taxa are present in few and small populations, implying that among the several adventive or subspontaneous taxa there are some that will increase their range and effective numbers (Weber 1999), particularly as a consequence of global warming (Walther et al. 2002). Many of the worst invasive taxa today were originally introduced as ornamentals. We identified some garden escapes, like *Datura innoxia, Mirabilis jalapa, Ipomea* sp. or *Rubus phoenicolasius,* which are little or unknown in the Swiss floristic literature but considered invasive in Italy (Celesti-Grapow et al. 2009). However, one should note that Celesti-Grapow et al. (2009) define non-native invasive taxa only by the rate of establishment and spread, therefore on a strictly ecological basis following Pyšek et al. (2004) and not coupled to possible negative effects as does e.g. the Swiss Black List (CPS-SKEW 2008). Nevertheless, all alien invasive plants entailing negative impacts are characterised by rapid establishment and spread. Some of the casual garden escapes found on inert landfill sites are either considered damaging invasive neophytes (e.g. *Acer negundo, Arundo donax)* or considered among the worst invasive taxa in Europe, like *Acacia dealbata* (DAISIE 2009), particularly in the warm Mediterranean region. Several thermophilic ornamental plant taxa started years ago to colonise natural habitats in Ticino on a large scale; whereas, due to global warming, these taxa (as e.g. *Trachycarpus fortunei),* are now cultivated outdoors north of the Swiss Alps; in Ticino even more thermophile taxa can now establish (Landolt 2001). The 83 recorded neophyte taxa found in this study by far exceeds the predicted present-day model for neophyte species richness (max. 43 species) at the landscape level in southern and lowland Ticino under conditions of urban sprawl and climate warming (Nobis et al. 2009); it reflects much more the projected future scenarios under the conditions of strong environmental changes.

Notes on the distribution of noteworthy taxa

***Abutilon theophrasti* Medik.**

Although not mentioned in recent Swiss floras (Aeschimann & Burdet 1989, Lauber & Wagner 2007), this species appears sporadically as a potentially noxious weed all over the Swiss agricultural system, particularly in maize, soybeans and sugar beet crops (Bohren et al. 2008). In Ticino, it can be found in agricultural fields near Chiasso, Riva San Vitale and near Locarno. We found it in four of the studied landfill sites including No. 1, located near Lugano. A specimen was collected by Lucio Mari in 1865 in the surroundings of Chiasso (LUG 6651, under *Abutilon avicennae* Gaertner), almost 150 years later we collected it from the same area (LUG 19169, 19170).

***Acalypha virginica* L.**

In Switzerland, this North American species is mainly known from southern Ticino and considered naturalised. It was recorded in 1992 as an adventive in a port in Basel (Brodtbeck et al. 1997). This still very sporadic annual species was probably recorded for the first time by Ugolino Ugolini in 1924 (unpublished handwritten note at the Museum of Natural History Lugano), who found it in the Parco Ciani in Lugano, it was collected again in 1964 by Alfred Becherer in the same place (LUG 4538). We found a single plant in the same place in 2010, and more important populations in two landfill sites close to the Italian border (No. 2 and 7).

***Aphanes arvensis* L.**

Historically considered a rare species (Chevenard 1910) and still inscribed in the category VU of the Red List (SA1, Moser et al. 2002), this species is now widespread and frequent in urban areas, at least in the Sottoceneri area, where it is an almost constant element in grid paved parking places.

***Artemisia annua* L.**

Still considered a very rare species in recent Swiss floras (Aeschimann & Burdet 1989, Lauber & Wagner 2007), this species became now fairly common in urban disturbed habitats, particularly in the area around Locarno and Lugano where it can commonly be seen in building sites and waste land. Along the river Cassarate in Canobbio and in waste land around it, it has an almost invasive behaviour (Schoenenberger et al. 2002, Schoenenberger & Giorgetti Franscini 2004). We found it in the landfill site in Comano (No. 1) and close to site No. 8.

***Avena sterilis* ssp. *ludoviciana* L.**

Not mentioned in recent Swiss floras (Aeschimann & Burdet 1989, Lauber

& Wagner 2007), we found this species in three of the studied sites (No. 2, 5 and 6). German botanist Alban Voigt found *Avena sterilis* s.l. around 1920 in Melide, Lugano and Bironico (unpublished handwritten note at the Museum of Natural History Lugano). North of the Swiss Alps *Avena sterilis* s.l. was historically recorded as an adventive on railway land i.e. in Zürich (Landolt 2001). Interestingly, the very similar *Avena barbata* Potter can be found in several locations along the Gotthard railway line (Schoenenberger & Giorgetti Franscini 2004).

***Bromus catharticus* Vahl**

Native to South America, this forage plant seems to be naturalising in Ticino. We found it on two inert landfill sites in the Mendrisio District (No. 2, 3) and it was previously found on the Magadino Plain in railway stations and in agricultural land (Schoenenberger & Giorgetti Franscini 2004).

***Coronopus didymus* (L.) Sm.**

Still considered a rare species, we observed a rapid spread in the last decade in Ticino. Nowadays it can be easily found in pavements, at the base of alley trees or on building sites in Lugano and Locarno. It is present in some urban areas North of the Alps, as in Basel (Brodtbeck et al. 1997), Lausanne (Droz et al. 2006) or Zürich (Landolt 2001). We found it in five of the studied inert landfill sites.

***Crepis pulchra* L.**

This Mediterranean adventive species is fairly unknown in Switzerland. Previously known in a few vineyards, railway areas or along motorways North of the Alps, it was reported for the first time in Ticino in 2003 in the railway station in Biasca (Schoenenberger & Giorgetti Franscini 2004). We found it in two inert landfill sites (No. 2 and 5).

***Eleusine indica* (L.) Gaertn.**

Favoured by global warming and human transport, this tropical species has undergone a spectacular spread in the last years in Ticino. It can be now found very frequently in trampled and disturbed habitats all over southern and central Ticino. We found it in seven of the studied sites. North of the Swiss Alps it is known from Basel (Lauber & Wagner 2007), Lausanne (Droz et al. 2006) and Zürich (Landolt 2001).

***Eragrostis pectinacea* (Michx.) Nees**

Anecdotally recorded several times over the last thirty years in Switzerland as an adventive, i.e. in Valais and Basel (Röthlisberger 2002), on railway stations in southern Ticino (Schoenenberger & Giorgetti Franscini 2004) and in Lausanne (Droz et al. 2006), we found it abundantly in all the studied landfill sites. It seems to be spreading quickly in Ticino, where it can now be found on natural riverbanks too, i.e. on the delta of the river Ticino (Bolle di Magadino Nature Reserve).

***Eragrostis virescens* J. Presl**

Observed in Europe since 1927, this South American species has been observed in the last thirty years several times all over North Italy (Martini & Scholz 1998). In Switzerland, the species has been recorded around Basel since the 1970's, in Lausanne and in several locations in Ticino and Mesolcina valley (reviewed in Röthlisberger 2005, Schoenenberger & Giorgetti Franscini 2004). Quite disseminated nowadays in the city of Lugano and surroundings, we found this morphologically quite variable species in 3 inert landfill sites (No. 1, 5 and 7). In Ticino, the quite similar species *Eragrostis neomexicana* Vasey is naturalising particularly in the lower part of the Ticino valley.

***Euphorbia prostrata* Aiton**

Systematically present and persistent in railway stations between Melide and Chiasso (Schoenenberger et al. 2002, Schoenenberger & Giorgetti Franscini 2004), we found this species in three landfill sites (No. 5, 6 and 7). In Ticino, it seems to be distributed mainly on railway land and urban areas in the Sottoceneri area. Further localities in Switzerland are reviewed in Röthlisberger (2007).

***Paspalum dilatatum* Poir.**

Considered an invasive species in Italy as defined on a strictly ecological basis (CELESTI-GRAPOW et al. 2009) and frequent on roadsides along the coasts, this plant is still little known in Switzerland. To our knowledge it has been growing and persisting for several years near Sonvico and in Ponte-Tresa. We found it in one landfill site in the Mendrisio area (No. 3).

***Sporobolus vaginiflorus* (Torr.) Wood.**

An invasive species following CELESTI-GRAPOW et al. (2009), it is mainly known from the Swiss motorway N1 and N9 between Geneva and Aigle (CIARDO & DELARZE 2005). We found it in one landfill site close to railway land (No. 7), but it may be much more widely distributed in Ticino.

***Xanthium italicum* Moretti**

Common in the outskirts of Milano (BANFI & GALASSO 1998), and on the sandbanks of the river Ticino (MACCHI 2005), we found this species in two of the study sites (No. 2 and 5), and very close to site No 8. Other recent observations have been made in the Sottoceneri area where the species seems to be establishing itself. Old records under *Xanthium strumarium* L. (CHEVENARD 1910) probably refer at least partially to *X. italicum.*

Outlook

This study is a first attempt to describe the spontaneous flora of inert landfill sites in Ticino and the underlying mechanisms explaining the current composition. Individual inspections of inert landfill sites in Lombardy revealed a number of thermophilic and invasive species not recorded in the Swiss sites. More systematic inventories might highlight possible future scenarios for the composition of the ruderal flora of southern Switzerland. Other issues worthy to be investigated include the evolution of the vegetation once the inert landfill sites have reached capacity and have been closed, through the monitoring of successional stages, the assessment of best management practices to avoid the takeover and spread of damaging invasive neophytes, and to maintain a certain conservation value as secondary habitats for threatened taxa.

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Exploring the Flora on Inert Landfill Sites in Southern Ticino (Switzerland)

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List of taxa recorded on inert landfill sites in southern Ticino; species inscribed in the Red List of threatened plants in the sector SA1 (Ticino and Moesa), neophytes, garden escapes, or species new for Switzerland or the Canton Ticino.

EG: Ecological Plant Groups. 1: forest; 2: mountain; 3: low altitude pioneer; 4: aquatic;
5: wetland; 6: nutrient-poor meadow; 7: weeds and ruderal; 8: nutrient-rich meadow (MOSER et al. 2002)

RL: Red List category SA1. CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concern; DD: Data Deficient; NE: Not Evaluated; –: taxon treated by the Red List but considered absent from SA1 (MOSER et al. 2002)

AI: additional information from the Red List. N: extra-European neophyte; E: European neophyte; C: cultivated; i: invasive (MOSER et al. 2002)

BL: Black List (BL) and Watch List (WL) (CPS-SKEW 2008)

RO: Release Ordinance, forbidden plants (SWISS FEDERAL COUNCIL 2008)

D: DAISIE 100 of the most invasive alien species in Europe (DAISIE 2009)

I: Invasive species of Italy (CELESTI-GRAPOW et al. 2009)

1–8: Investigated sites (see Fig. 1)

LUG: Collection number of the Herbarium Lugano

Taxon	EG	RL	AI	BL	RO	D	I	1	2	3	4	5	6	7	8	LUG
Abutilon theophrasti Medik.	7	NT	N				x	x		x		x		x		
Acacia dealbata Link	7	DD	N			x	x	x								
Acalypha virginica L.	7	NT	N				x		x					x		15443
Acer negundo L.	1	DD	Ni				x							x		
Acer saccharinum L.	-	NE								x				x		13052
Agrostis gigantea Roth	3	NT						x				x			x	15421, 15422
Ailanthus altissima (Mill.) Swingle	3	LC	Ni	BL		x	x		x		x	x	x	x		
Alcea rosea L.	7	DD	N						x							
Allium sativum L.	7	LC	C											x		
Amaranthus albus L.	7	LC	N				x				x			x		

Taxon	EG	RL	AI	BL	RO	D	I	1	2	3	4	5	6	7	8	LUG
Amaranthus bouchonii Thell.	7	VU	N				x	x	x				x	x		15449, 19052, 19053
Amaranthus cruentus L.	7	LC	N				x	x	x							
Amaranthus deflexus L.	7	LC	N				x		x							
Amaranthus hypochondriacus L.	7	LC	N					x	x	x	x	x	x	x		15454, 19054
Ambrosia artemisiifolia L.	7	EN	Ni	BL	x	x	x	x	x	x	x	x	x	x	x	
Anagallis arvensis L.	7	NT							x	x	x	x		x		19024
Anethum graveolens L.	7	DD	C									x				
Anthemis arvensis L.	7	VU						x								19003
Antirrhinum majus L.	3	NT	C									x		x		
Aphanes arvensis L.	7	VU							x							15162
Aquilegia vulgaris L.	1	VU							x							
Aristolochia clematitis L.	7	VU								x						
Artemisia annua L.	7	VU	E				x	x								
Artemisia verlotiorum Lamotte	7	LC	Ni	BL			x	x	x	x	x	x	x	x	x	
Arundo donax L.	5	NT	Ni				x		x							
Aster novi-belgii aggr.	5	NT	Ni												x	19060
Astilbe sp. Buch. Ham ex D.Don	-	NE										x				
Avena sativa L.	7	LC	C											x		
Avena sterilis subsp. *ludoviciana* (Durieu) Nyman	-	NE							x			x	x			15476
Beta vulgaris L.	7	DD	C							x						
Bidens frondosa L.	5	LC	Ni				x	x	x	x	x	x	x	x	x	15455
Brassica napus L.	7	LC	C										x	x		
Bromus catharticus Vahl	-	NE							x	x						19005
Bromus japonicus Thunb.	7	EN										x	x			13026, 13031, 13032
Bromus tectorum L.	7	VU									x			x		
Bryonia dioica Jacq.	1	VU												x		
Buddleja davidii Franch.	3	LC	Ni	BL			x	x	x	x	x	x		x	x	
Buglossoides arvensis (L.) I. M. Johnst.	7	VU											x			19013
Calamintha glandulosa (Req.) Benth.	6	NT							x		x	x		x		
Calendula officinalis L.	7	DD	C						x	x		x				
Callistephus chinensis (L.) Nees	7	DD	N							x				x		19055

Taxon	EG	RL	AI	BL	RO	D	I	1	2	3	4	5	6	7	8	LUG
Calystegia sylvatica (Kit.) Griseb.	1	DD						x	x	x			x	x		
Campanula patula subsp. costae (Willk.) Nyman	6	NT							x	x		x				
Capsella rubella Reut.	7	LC	E					x	x	x		x		x		
Carduus pycnocephalus L.	-	NE												x		13053, 13054
Carex distans L.	5	NT										x				15173, 15174
Carex guestphalica O. Lang	6	NT							x	x				x	x	15175, 15176 15177, 15466
Carex pendula Huds.	1	NT							x							
Catapodium rigidum (L.) C. E. Hubb.	7	NT										x				19036, 19037
Centaurium pulchellum (Sw.) Druce	5	VU										x			x	15469, 19045
Cerastium semidecandrum L.	6	NT										x		x		
Chaerophyllum temulum L.	1	NT							x							
Chenopodium ficifolium Sm.	7	EN								x						19066, 19067
Chenopodium glaucum L.	7	VU						x								
Cichorium endivia L.	7	DD	C							x						
Citrullus lanatus (Thunb.) Mansfeld	-	NE								x		x				
Commelina communis L.	7	NT	N				x	x				x				
Consolida ajacis (L.) Schur	7	EN	C									x				19027
Conyza canadensis (L.) Cronquist	7	LC	N				x	x	x	x	x	x	x	x	x	15451, 15468
Conyza sumatrensis (Retz.) E. Walker	-	NE					x	x	x	x	x	x	x	x		15444, 15452
Coronopus didymus (L.) Sm.	7	CR	N						x	x	x	x		x		19035
Cosmos bipinnatus Cav.	-	NE						x						x		
Crepis foetida L.	7	EN							x			x	x	x		19028, 19029
Crepis pulchra L.	7	-	E						x			x				13028–13030,1306, 19000, 19001
Crepis setosa Haller f.	7	VU	E							x		x	x			13024, 13025, 13027
Cucubalus baccifer L.	1	VU							x							15439, 15440
Cucurbita maxima Duchesne	7	DD	C					x		x						

Taxon	EG	RL	AI	BL	RO	D	I	1	2	3	4	5	6	7	8	LUG
Cucurbita pepo L.	7	DD	C						x			x				
Cuscuta cesatiana Bertol.	7	EN						x						x		15441, 19043
Cyperus esculentus L.	5	LC	Ni	WL					x							
Cyperus fuscus L.	5	VU						x		x	x	x		x		
Cyperus glomeratus L.	5	CR					x				x				x	15462
Cyperus longus L.	5	EN								x						13044
Cyperus microiria Steud.	-	NE					x							x		
Datura innoxia Mill.	-	NE					x	x								
Datura stramonium L.	7	VU	N				x		x	x		x	x	x		19061, 19062
Dianthus armeria L.	7	VU						x	x		x			x		19017
Diospyros lotus L.	1	DD	C									x		x		
Diplotaxis muralis (L.) DC.	7	EN								x						
Diplotaxis tenuifolia (L.) DC.	7	NT							x			x				
Dipsacus fullonum L.	7	VU							x							
Draba muralis L.	3	EN												x		
Duchesnea indica (Andrews) Focke	1	LC	N				x	x	x	x						
Eleusine indica (L.) Gaertn.	7	NT	N				x	x	x	x	x	x	x	x		15429
Epilobium tetragonum L. s.str.	5	NT										x				
Eragrostis pectinacea (Michx.) Nees	-	NE					x	x	x	x	x	x	x	x	x	15475, 19080–19095
Eragrostis virescens J. Presl	-	NE						x				x		x		19056, 19068–19079
Erigeron annuus (L.) Desf. s.str.	7	LC	Ni	WL			x	x	x	x	x	x	x	x	x	
Erigeron annuus subsp. strigosus (Willd.) Wagenitz	7	LC	Ni	WL					x							15445
Euphorbia lathyris L.	7	NT	C						x		x			x		
Euphorbia maculata L.	7	LC	N				x	x	x	x	x	x	x	x	x	
Euphorbia nutans Lag.	7	NT	N								x	x		x		
Euphorbia prostrata Aiton	7	EN	N				x					x	x	x		15427, 15453 19040, 19041
Euphorbia stricta L.	1	EN										x				
Fagopyrum esculentum Moench	7	EN	C					x								
Foeniculum vulgare Mill.	7	LC	C									x				
Forsythia x *intermedia* Zabel	-	NE												x		

Taxon	EG	RL	AI	BL	RO	D	I	1	2	3	4	5	6	7	8	LUG
Fragaria x *ananassa* Duchesne	-	NE								x						
Galega officinalis L.	1	EN	C												x	
Galeopsis angustifolia Hoffm.	3	VU							x					x		
Galinsoga ciliata (Raf.) S. F. Blake	7	LC	N				x	x		x	x	x	x	x		
Galinsoga parviflora Cav.	7	LC	N				x	x	x	x						
Geranium dissectum L.	7	VU						x					x			
Geranium sibiricum L.	1	EN	N						x							15437, 15438
Gladiolus (cultivar) L.	-	NE								x						
Helianthus annuus L.	7	LC	C					x	x					x		
Helianthus tuberosus L.	7	LC	Ci	WL			x	x	x	x						
Hemerocallis fulva (L.) L.	7	LC	N						x							
Herniaria hirsuta L.	3	EN	E											x		
Hibiscus trionum L.	-	NE							x			x				13043
Hosta (cultivar) Tratt.	-	NE							x							
Hydrangea (cultivar) L.	-	NE										x				
Impatiens glandulifera Royle	7	LC	Ni	BL	x	x	x			x						
Impatiens parviflora DC.	1	LC	N				x	x	x	x		x				
Ipomoea sp. L.	-	NE						x						x		
Iris x *germanica* L.	6	VU	C						x							
Jasminum officinale L.	7	DD	N									x				
Juncus tenuis Willd.	7	LC	N				x	x	x		x			x		15165
Kickxia elatine (L.) Dumort.	7	CR										x				19044
Lactuca saligna L.	7	CR										x				15456
Lathyrus latifolius L.	3	NT	C						x							
Legousia speculum-veneris (L.) Chaix	7	EN							x			x				19038
Lepidium campestre (L.) R. Br.	7	VU							x		x					19010
Lepidium virginicum L.	7	LC	N				x	x	x	x	x	x	x	x		
Lonicera japonica Thunb.	1	LC	Ni	BL			x		x							
Lotus tenuis Willd.	6	NT							x						x	15425, 15463
Lunaria annua L.	7	LC	C					x			x					
Lycopersicon esculentum Mill.	7	DD	C					x	x	x		x		x		
Melilotus altissimus Thuill.	7	NT										x				
Melissa officinalis L.	7	DD	C						x					x		

Taxon	EG	RL	AI	BL	RO	D	I	1	2	3	4	5	6	7	8	LUG
Mentha suaveolens Ehrh.	5	VU	E									x				15430, 13051
Mentha x *piperita* L.	7	DD	C					x	x			x	x	x		
Mirabilis jalapa L.	-	NE					x							x		
Misopates orontium (L.) Raf.	7	EN										x				19026
Muhlenbergia schreberi J. F. Gmel.	7	NT	N				x	x	x		x	x		x		15433
Myosotis ramosissima Rochel	7	VU						x	x	x		x		x		13019
Nigella damascena L.	7	DD	C											x		
Oenothera glazioviana Micheli	7	DD	Ni				x	x		x		x		x	x	19105–19019
Oenothera sp. L.	7		Ni					x	x	x		x		x	x	
Oxalis fontana Bunge	7	LC	N				x	x	x	x	x	x	x	x		
Oxalis violacea L. non Thunb.	-	NE							x			x				
Pachysandra terminalis Sieb. et Zucc.	-	NE										x				13021
Panicum capillare L.	7	LC	N				x	x	x	x	x	x	x	x	x	
Panicum dichotomiflorum Michx.	7	LC	N				x	x	x	x	x	x	x	x	x	15423, 15424, 15434, 19057
Panicum miliaceum L.	7	NT	C											x		15178, 19046
Papaver dubium subsp. lecoqii (Lamotte) Syme	7	VU									x			x		
Papaver somniferum L.	7	NT	N							x						
Parthenocissus inserta (A. Kern.) Fritsch	1	DD	Ni	WL			x	x				x				
Paspalum dilatatum Poir.	-	NE					x			x						15461
Paulownia tomentosa (Thunb.) Steud.	1	LC	Ni	WL				x	x							
Petunia (cultivar) Juss.	-	NE						x	x							
Phalaris canariensis L.	7	NT	E											x		15471
Phlox paniculata L.	-	NE						x								
Phyllostachys viridis (R.A.Young) Mc Clure	-	NE							x							
Phytolacca americana L.	7	LC	Ni	WL			x	x	x	x	x	x		x		
Platanus x *hispanica* Münchh.	1	DD	N											x		
Polygonum orientale L.	7	NT	N						x							15442
Potentilla norvegica L.	7	VU	E					x	x		x					19031, 19032
Prunus serotina Ehrh.	1	NT	Ni	BL		x	x	x	x	x						
Pyracantha coccinea	3	NT	N						x	x						13039

Taxon	EG	RL	AI	BL	RO	D	I	1	2	3	4	5	6	7	8	LUG
Roem.																
Quercus rubra L.	1	NT	Ni				x	x						x		
Ranunculus sardous Crantz	7	CR									x					19012
Reynoutria japonica Houtt.	7	LC	Ni	BL	x	x	x	x	x	x	x			x		
Rhus typhina L.	3	NT	Ni	BL	x			x	x		x			x		
Robinia pseudoacacia L.	1	LC	Ni	BL		x	x	x	x	x	x	x		x	x	
Rubus phoenicolasius Maxim.	1	DD	N				x	x	x							
Rudbeckia hirta L.	7	LC	Ni					x	x			x				
Rumex conglomeratus Murray	5	VU									x					13048, 19018
Salix fragilis L.	1	NT	E								x			x		
Satureja hortensis L.	7	DD	C									x		x		13042
Saxifraga tridactylites L.	3	NT												x		
Scirpus sylvaticus L.	5	NT						x								
Senecio inaequidens DC.	7	LC	Ni	BL	x		x			x						
Setaria italica (L.) P. Beauv.	7	VU	E				x	x		x		x		x		15179, 15168, 19042
Solanum chenopodioides Lam.	7	VU	N					x	x	x	x	x		x		15446, 15447
Solanum tuberosum L.	7	LC	C							x				x		
Solanum villosum Mill. s.l.	7	VU												x		
Solidago canadensis L.	7	LC	Ni	BL	x		x	x	x	x	x	x	x	x	x	
Solidago gigantea Aiton	5	LC	Ni	BL	x		x		x	x	x	x	x	x	x	
Sorghum halepense (L.) Pers.	7	LC	N				x		x	x	x	x	x	x		
Sporobolus vaginiflorus (Torr.) Wood.	-	NE					x							x		13045, 13046
Symphytum bulbosum K. F. Schimp.	1	VU						x								
Symphytum officinale L.	5	NT						x	x							
Tagetes patula L.	-	NE						x								
Tamarix gallica L.	-	NE										x				
Tanacetum parthenium (L.) Sch. Bip.	7	NT	C						x			x				
Torilis arvensis (Huds.) Link	7	VU							x		x	x	x	x		
Trachycarpus fortunei (Hook.) H. Wendl.	1	LC	Ni	WL			x	x	x							

Taxon	EG	RL	AI	BL	RO	D	I	1	2	3	4	5	6	7	8	LUG
Tragopogon dubius Scop.	7	VU							x			x	x	x		
Trifolium fragiferum L.	6	EN							x							13055, 13056
Trifolium resupinatum L.	7	NT	C					x								
Triticum aestivum L.	7	LC	C									x		x		
Ulmus minor Mill.	1	NT							x			x				
Verbascum phlomoides L.	7	EN										x		x		19030
Veronica anagallis-aquatica L.	4	NT								x						
Veronica filiformis Sm.	8	NT	N						x							
Veronica peregrina L.	7	VU	N					x	x	x	x	x	x	x		13020, 19006, 19007
Veronica persica Poir.	7	LC	N				x	x	x	x	x	x	x	x	x	
Vicia villosa Roth s.str.	7	EN							x		x					19011
Vulpia myuros (L.) C. C. Gmel.	7	NT						x	x		x	x	x			
Xanthium italicum Moretti	8	EN	Ei				x		x			x				15457–15459, 15464, 15465
Yucca filamentosa L.	-	NE							x			x				
Yucca gloriosa L.	-	NE												x		13023
Zea mays L.	7	LC	C					x	x	x				x		