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ControlInRoad
Controlling the spread of invasive species with innovative methods in road construction and maintenance

List of invasive alien plants along roadsides

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Executive summary

Invasive alien plants represent one of the main threats to biodiversity and related ecosystem and they may also have adverse impacts on human health and the economy. In this respect, roadsides play an important role in facilitating the spread of invasive alien plants by providing habitat for establishment as well as serving as corridors for spread. As a result, decision-makers that consider whether to build, improve, and maintain roads should take into account the establishment and spread of invasive alien plants along roadsides. Further, they are facing the need to implement preventive measures and to adapt or develop control strategies.

We present a brief synthesis on the role of roadsides as habitat and corridor for invasive alien plants and lists of invasive alien plants along roadsides that merit monitoring and management in Austria, Germany, the Netherlands, Ireland, Norway, Slovenia, and Sweden.

The List of Invasive Alien Species of Union concern (EU Regulation 1143/2014) and national lists of invasive alien plants from each study country formed the basis of the country lists. We checked the species for their occurrence and spread along roadsides (i.e. they grow in the vegetated strips laterally from the pavement to the adjoining land-use type). All information needed was gathered from the original source (i.e. the national lists), by an extensive literature search, floristic databases and expert consultation.

In total, 89 invasive alien plants related to roadsides have been compiled. The following numbers of species have been identified for each country: Austria (19), Germany (14), Ireland (12), the Netherlands (21), Norway (45), Slovenia (29), and Sweden (24). The majority of the species occurs only in one or two countries, while thirteen species (14%) are currently known to occur along roadsides in more than four of the seven countries.

The most frequently mentioned invasive alien plants along roadsides in the selected countries were the *Fallopia*-species (*F. japonica*, *F. x bohemica*, *F. sachalinensis*), the *Solidago*-species (*S. canadensis, S. gigantea*) and the *Heracleum*-species (*H. mantegazzianum*, *H. persicum*) as well as *Impatiens glandulifera*. Notable invasive tree and shrub species along roadsides were *Ailanthus altissima* and *Robinia pseudoacacia* and *Rosa rugosa*. Moreover, the dwarf shrub *Senecio inaequidens* is mentioned in all selected countries except in Ireland while the annual herbaceous *Ambrosia artemisiifolia* and the perennial herbaceous *Lupinus polyphyllus* in four out of seven countries.

Five of the assembled species are on the List of Invasive Alien Species of Union concern and these are the following: *Asclepias syriaca*, *Gunnera tinctoria*, *Heracleum mantegazzianum*, *Heracleum persicum* and *Impatiens glandulifera*.

1 Introduction

This report summarizes the results of task 1 (Extensive literature search on IAS [= Invasive Alien Species] related to transport infrastructure habitats in Europe) and task 2 (Identification of IAS related to transport infrastructure habitats with adverse social, economic and biodiversity impact) of work package 2 (List invasive plants related to transport infrastructure habitat).

Invasive alien species are defined as species that have a significant adverse impact to biodiversity and related ecosystem they may also have adverse impacts on human health and the economy (according to EU Regulation 1143/2014).

In this report we (1) give a brief overview about roadsides as habitat and corridor for invasive alien plants and (2) provide lists of invasive alien plants along roadsides in each of the study countries (Austria, Germany, the Netherlands, Ireland, Norway, Slovenia, and Sweden).

2 Roadsides as habitat and corridor for invasive alien plants

2.1.1 The roadside habitat

Road corridors can be defined as pavement plus roadside that consists of parallel vegetated strips that extend up to the beginning of the adjoining land-use type (i.e. natural areas, forest, or crop fields) (Ullmann & Heindl, 1989; Forman et al., 2003; Karim & Mallik, 2008; Annex A). The vegetated strips have specific biophysical characteristics (e.g. substrate type, soil compaction, environmental conditions like light regime, soil moisture, salt concentration) and thus, they have plant communities with different floristic composition. Indeed, roadsides can be colonized by a wide array of plant species as “distinct microhabitats” (Karim & Mallik, 2008, Annex A) exist.

Many roadside vegetation studies have been published in European countries (overview in Forman et al., 2003). However, systematic studies of road networks are rare in Europe or elsewhere (e.g. Ullmann & Heindl, 1989; Šerá, 2008; Rentsch et al., 2013). In general, roadsides are rich in species depending among others on topography, climatic and geological conditions. For example, the numbers of plant species found along roadsides in the cities of Braunschweig (Germany) and Vantaa/Helsinki (southern Finland) were 512 (42% of Braunschweig’s total flora) and 474 (67% of Vantaa’s total flora), respectively (Ranta et al., 2015; Brandes, 2016). However, Jaźwa et al. (2016) recognized only 64 species along major roads leading throughout part of the Scandinavian Peninsula (Finland and Norway).

2.1.2 Occurrence of invasive alien plants along roadside

Roadsides are a favourable habitat for alien plants. Certainly, the flora includes a significant proportion of alien plants as shown by several authors. Approximately 30% of the species occurring along roadsides were alien in West Virginia, USA (Rentch et al., 2013). In central Europe, the percentage of alien plants in the floristic spectrum of roadsides ranges roughly between 10 and 20% as stated by Ullmann & Heindl (1989). Some recent European studies revealed proportions of alien plants of 32% (Braunschweig, Germany; Brandes, 2016) and 24% (south Bohemia, Czech Republic; Šerá 2010). Lembrechts et al. (2014) identified only 5.2% alien plants along roadsides in a subarctic mountain region (Narvik, Norway).

In Europe, most invasive alien plants originate from North America or Asia and have been planted for ornamental use or cultivation. They escaped from gardens and expanded their range and some of them proliferate very well along roadsides. Moreover, during construction,

roadsides are sometimes seeded with invasive alien legumes and trees e.g. to reduce soil erosion and/or to improve aesthetics as well as to provide wildlife habitat (e.g. *Lupinus polyphyllus*, *Trifolium pratense*).

However, information about the number of invasive alien plants in the roadside flora is limited to our knowledge. For example, Ranta et al. (2015) found 15 invasive alien plants present (3.1% of the total roadside flora) in the examined traffic corridors (incl. roads but also railroad area, forest/recreation roads) in Vantaa (southern Finland). Šerá (2010) pointed out that almost 6.3% of all recorded herbaceous roadsides species (235) were classified as invasive in south Bohemia.

2.1.3 Spread of invasive alien plants along roadsides

The highly connected nature of road networks in most parts of Europe potentially allows a roadside species to spread long distances without encountering barriers for dispersal or establishment. Passing vehicles and road maintenance machinery among others are known to facilitate seed dispersal along roads (Forman et al., 2003; von der Lippe et al., 2013).

In Europe, two intensively examined invasive alien plants are the herbaceous *Ambrosia artemisiifolia* and the woody plant *Ailanthus altissima*. von der Lippe et al. (2013) observed a median (secondary) dispersal distance of one metre and a 99% quantile of 10 m for *Ambrosia artemisiifolia* and eight metres and a 99% quantile of 40 m for *Ailanthus altissima* after 80 vehicle passes (at 48 km/h). Although at a low density, seeds of *Ambrosia artemisiifolia* were transported by individual vehicles up to 25 m, and more effectively by mowing machines as shown by Vitalos & Karrer (2009).

The expansion of invasive alien plants from the roadside into natural areas is of great concern. Meunier & Lavoie (2012) pointed out that the road network has probably acted as a dispersal corridor for the invasive *Galium mollugo* in a protected natural area in Quebec (Canada), while abandoned crop fields located close to the roads provided a suitable habitat that in turn facilitates populations of *Galium mollugo* to establish over larger areas. Passing vehicles favoured the spread of *Asclepias syriaca* over long distance along roadsides in southwestern USA. Apparently from there, *Asclepias syriaca* spread into open sites in the surrounding area (Wyatt 1993).

However, there are only a few studies available that give some insight into how far a species may spread from roadsides (e.g. *Ailanthus altissima*, Kowarik & Böcker, 1984; *Gunnera tinctoria*, Sheehy Skeffington & Hall, 2011). Indeed, the bulk of alien plants invaded adjacent habitats only up to a few meters from a roadside, and the farthest distance reported was about 120 m as reviewed by Forman et al. (2003).

3 Lists of invasive alien plants along roadsides

3.1 Material and methods

We used a step-wise process for the compilation of the country lists. National lists of invasive alien plants from each study country (Table 1) and the List of Invasive Alien Species of Union concern (EU Regulation 1143/2014) formed the basis of our country lists.

Unfortunately, national lists use different categories and/or designations for the invasiveness of alien plant species and are based on different methodologies. In general, our country lists include alien plants that were classified as 'invasive' (or 'severe impact', 'high impact', 'black list') on the national lists. These species exert an impact on natural and semi-natural ecosystems like changes in species composition, succession patterns, nutrient cycles and hybridization while some of them have also an economic impact or pose a threat to human health.

Although we focus on invasive alien plants, we also included alien plants from the lists that are not classified as aforementioned (e.g. as 'potentially invasive', 'medium impact', 'grey list'), but regularly occur and spread along roadsides. Evidence of impacts may not be well known or described but such alien species may eventually become invasive after a lag period and management may be justified. This is specified in the respective text for each country. Throughout the report the term 'invasive alien plants' for all species included is used.

In a next step, we discarded invasive alien plants that have been classified as 'casual' (i.e. they do not form self-replacing populations) as well as aquatic plants (*sensu* floating, submerged, and emergent plants) and bryophytes.

Then we checked the remaining species for their occurrence and spread along roadside, i.e. they grow in the vegetated strips (e.g. shoulder [verge], side slope, ditch, backslope; so called "roadside microhabitats" according to Karim & Mallik, 2008) laterally from the road surface to the adjoining land-use type (Annex A).

If possible, information about the species' frequency of occurrence along roadsides has been added. However, these ratings indicated in the country lists are only indicative. Most notable species in terms of frequency and impact were shaded in green based on the first author's judgement (Tables 2 to 8).

All information needed was gathered from the original source (i.e. the national lists), by literature search (e.g. CAB Abstracts, Google Scholar), floristic databases, and expert consultation (Table 1). For each species listed, we also noted their life form (Annex B), origin, and principal mode of introduction (Klotz et al., 2002; WCSP, 2017).

It is noted that despite best efforts species may have been overlooked that merit inclusion on the list and others already included are worthy of discussion. Nonetheless, the authors are confident that the presented list here contains most notable and problematic invasive alien plant species along roadsides in each country.

We plan to update the lists as new information becomes available during the project (see also chapter 4a and the project website http//:www.controlinroad.org) and correspondence on the lists is welcomed.

Table 1: National lists of invasive alien plants used, main sources and experts contacted for the compilation of the country lists.

Country	List of invasive alien plants	(Main) Source	Expert
Austria (AT)	Neobiota in Österreich	Essl & Rabitsch (2002)	Franz Essl (University of Vienna & Environment Agency Austria)
Germany (DE)	Naturschutzfachliche Invasivitätsbewertung gebietsfremder Gefäßpflanzen	Nehring et al. (2013a)	Detlev Metzing (Federal Agency for Nature Conservation)
Ireland (IR)	Invasive species in Ireland	http://www.biodiversityireland.ie/projects/invasive-species/	-
Netherlands (NL)	Nederlands Soortenregister	http://www.nederlandsesoorten.nl/content/lijsten	Johan van Valkenburg (National Plant Protection Organization)
Norway (NO)	Alien species in Norway – with the Norwegian Black List 2012	Gederaas et al. (2012)	-
Slovenia (SI)	Invasive alien plant taxa in the flora of Slovenia	Jogan et al. (2012)	Nejc Jogan (University of Ljubljana)
Sweden (SE)	Invasive plant species in the Swedish flora	Tyler et al. (2015), https://www.naturvardsverket.se/Amnen/Invasiva-frammande-arter/	Melanie Josefsson (Swedish Environmental Protection Agency)

3.2 Country lists

3.2.1 Austria

In Austria, the first national inventory of invasive alien plants was already published in 2002 (Essl & Rabitsch, 2002, see also http://www.umweltbundesamt.at/). 17 alien plants were considered to be invasive (= posing a threat to biodiversity at the genetic, species or ecosystem level). The evaluation of the habitat preferences of these species based on literature sources and expert consultation showed that 10 species occur and spread along roadsides.

We also checked another 18 alien plants that have been classified as potentially invasive (= expected to become invasive if current spread continues) in Austria. We added from these species to our country list *Heracleum mantegazzianum* and *Asclepias syriaca* as they are listed in the EU Regulation 1143/2014 as well as *Ambrosia artemisiifolia*, *Fallopia* x *bohemica*, *Fallopia sachalinensis*, *Buddleja davidii* and *Senecio inaequidens* (potentially invasive) and *Dittrichia graevelons* (not invasive) because recent developments showed a continuous spread along roadsides (Table 2).

Table 2: Invasive alien plants that occur and spread along roadsides in Austria. Their life form, origin, classification, key references used and annotations are shown. Species with a green shaded box are the most notable ones. For the definitions regarding the column "life form" see Annex B.

ID	Genus	Species	Family	Life-form	Origin	Classification[1]	key references	Annotations
1	*Acer*	*negundo*	Aceraceae	M	North America	i	Essl & Rabitsch (2002), Essl (pers. com.)	Rare along roadsides
2	*Ailanthus*	*altissima*	Simaroubaceae	M	Asia	i	Essl & Rabitsch (2002), Walter et al. (2005), Kowarik & Säumel (2007)	Frequent along roadsides (E-Austria)
3	*Ambrosia*	*artemisiifolia*	Asteraceae	T	North America	pi	Essl & Rabitsch (2002), Walter et al. (2005), Essl et al. (2009)	Frequent along roadsides (main highways, E-Austria), health impact
4	*Asclepias*	*syriaca*	Apocynaceae	H	North America	pi	Essl & Rabitsch (2002), Walter et al. (2005), Follak (pers. obs.)	Rare along roadsides; listed in the EU Regulation 1143/2014 on invasive alien species
5	*Buddleja*	*davidii*	Scrophulariaceae	N	Asia	pi	Essl & Rabitsch (2002), Walter et al. (2005), Essl (2004)	Frequent along roadsides (E-Austria)
6	*Dittrichia*	*graveolens*	Asteraceae	T	Mediterranean	n	Stöhr et al. (2012)	Frequent along roadsides (all major highways)
7	*Fallopia*	*japonica*	Polygonaceae	G	Asia	i	Essl & Rabitsch (2002), Mandák et al. (2004), Essl & Walter (2005), Follak (pers. obs.)	Frequently along roadsides
8	*Fallopia*	*x bohemica*	Polygonaceae	G	Hybrid	pi	Essl & Rabitsch (2002), Walter et al. (2005), Stöhr et al. (2006)	Frequent along roadsides
9	*Fallopia*	*sachalinensis*	Polygonaceae	G	Asia	pi	Essl & Rabitsch (2002), Walter et al. (2005)	Frequent along roadsides
10	*Helianthus*	*tuberosus*	Asteraceae	G	North America	i	Essl & Rabitsch (2002), Walter et al. (2005), Follak (pers. obs.)	Rare along roadsides (ditches, moist roadsides)
11	*Heracleum*	*mantegazzianum*	Apiaceae	H	Caucasus	pi	Essl & Rabitsch (2002), Essl (2003, 2006)	Rare (ditches, moist roadsides); listed in the EU Regulation 1143/2014 on invasive alien species

12	*Impatiens*	*glandulifera*	Balsaminaceae	T	India	i	Drescher & Prots (2000), Essl & Rabitsch (2002)	Rare (ditches, moist roadsides), rather logging roads, hiking trails; listed in the EU Regulation 1143/2014 on invasive alien species
13	*Populus*	*x canadensis*	Salicaceae	M	Hybrid	i	Essl & Rabitsch (2002), Essl (pers. com.)	Rare planted along roadsides, escaped/gone wild
14	*Robinia*	*pseudoacacia*	Fabaceae	M	North America	i	Essl & Rabitsch (2002), Follak (pers. obs.), Vítková et al. (2017), Kleinbauer et al. (2010)	Frequent along roadsides, planted along roadsides for soil stabilization, escaped/gone wild
15	*Rudbeckia*	*laciniata*	Asteraceae	H	North America	i	Essl & Rabitsch (2002), Essl (pers. com.)	Rare along roadsides
16	*Senecio*	*inaequidens*	Asteraceae	S	South Africa	pi	Essl & Rabitsch (2002), Walter et al. (2005), Hohla (2011), Merkblatt Südafrikanisches Greiskraut	Frequent e.g. in northern Tyrol along major highways, health impact (?)
17	*Solidago*	*canadensis*	Asteraceae	H	North America	i	Essl & Rabitsch (2002), Walter et al. (2005), Essl & Walter (2005)	Frequent along roadsides
18	*Solidago*	*gigantea*	Asteraceae	H	North America	i	Hartmann & Konold (1995), Essl & Rabitsch (2002), Walter et al. (2005)	Frequent along roadsides
19	*Symphyotrichum*	*lanceolatum*	Asteraceae	H	North America	i	Essl & Rabitsch (2002), Essl (pers. com.)	Rare along roadsides

[1] Classification according to Essl & Rabitsch (2002)
Definitions:
"i" - invasive alien species means an alien species whose introduction and/or spread threatens biological diversity
"pi" - potentially invasive alien species means an alien species whose introduction and/or spread has the potential to pose a threat to biological diversity
"n" - not invasive

3.2.2 Germany

In a study from Nehring et al. (2013a; see also https://neobiota.bfn.de/12601.html), 80 selected alien plants have been evaluated for their invasiveness in Germany based on the methodology proposed by Nehring et al. (2013b). From these 80 alien plants, 38 were classified as “invasive” and placed on the “black list” (with the subcategories “action list” and “management list”) while 42 were classified as “potentially invasive” and put on the “grey list” (with the subcategories “action list” and “observation list”). All species were assessed for negative impacts on biodiversity while data on economic and human health impacts were listed but not included in the overall rating.

The evaluation of the habitat preferences of the species placed on the black list (n = 38) showed that only 10 species regularly occur and spread along roadsides. We added from the species placed on the grey list (“action list”) to the country list *Impatiens glandulifera* as it is on the List of Invasive Alien Species of Union concern. Moreover, we put on the list the following species: *Ambrosia artemisiifolia*, *Bunias orientalis* and *Senecio inaequidens* because recent developments showed a continuous spread along roadsides (Table 3).

Table 3: Invasive alien plants that occur and spread along roadsides in Germany. Their life form, origin, classification, key references used and annotations are shown. Species with a green shaded box are the most notable ones. For the definitions regarding the column "life form" see Annex B.

ID	Genus	Species	Family	Life-form	Origin	Classification[1]	key references	Annotations
1	*Ailanthus*	*altissima*	Simaroubaceae	M	Asia	Black List	Kowarik & Säumel (2007), Kowarik & von der Lippe M (2011), https://neobiota.bfn.de/12657.html	Frequent along roadsides
2	*Ambrosia*	*artemisiifolia*	Asteraceae	T	North America	Grey list	Brandes (2009), Nehring et al. (2013a)	Rare along roadsides in warmer parts of Germany
3	*Bunias*	*orientalis*	Brassicaceae	H	W-Asia, E-Europe	Grey list	Brandes (1991), http://neobiota.bfn.de/12653.html, Steinlein et al. (1996)	Frequent along roadsides in warmer parts of Germany
4	*Fallopia*	*japonica*	Polygonaceae	G	Asia	Black List	http://neobiota.bfn.de/12646.html, Leßmeister et al. (2013)	Frequent along roadsides
5	*Fallopia*	*x bohemica*	Polygonaceae	G	Hybrid	Black List	http://neobiota.bfn.de/12644.html	Frequent along roadsides
6	*Fallopia*	*sachalinensis*	Polygonaceae	G	Asia	Black List	http://neobiota.bfn.de/12645.html, Leßmeister et al. (2013)	Frequent along roadsides
7	*Heracleum*	*mantegazzianum*	Apiaceae	H	Caucasus	Black List	Thiele & Otte (2008), Sauerwein (2004), https://neobiota.bfn.de/12641.html	Frequent along roadsides, e.g. Ruhr area, Hesse; listed in the EU Regulation 1143/2014 on invasive alien species
8	*Impatiens*	*glandulifera*	Balsaminaceae	T	India	Grey list	https://neobiota.bfn.de/12639.html	Rare along roadsides, listed in the EU Regulation 1143/2014 on invasive alien species
9	*Lupinus*	*polyphyllus*	Fabaceae	H	North America	Black List	Volz (2003), https://neobiota.bfn.de/12637.html	Frequent along roadsides, e.g in central Germany (Röhn Mountains)
10	*Robinia*	*pseudoacacia*	Fabaceae	M	North America	Black List	http://neobiota.bfn.de/12627.html, Vítková et al. (2017)	Frequent along roadsides

11	*Rosa*	*rugosa*	Rosaceae	N	East Asia	Black List	Brandes (2003), https://neobiota.bfn.de/12626.html	Planted e.g. along the middle-stripe (cf. Brandes 2009)
12	*Senecio*	*inaequidens*	Aceraceae	S	South Africa	Grey list	Griese (1996), Brandes (2009), https://neobiota.bfn.de/12625.html	Frequent along roadsides
13	*Solidago*	*canadensis*	Asteraceae	H	North America	Black List	http://neobiota.bfn.de/12624.html	Frequent along roadsides
14	*Solidago*	*gigantea*	Asteraceae	H	North America	Black List	http://neobiota.bfn.de/12623.html	Frequent along roadsides

[1]Classification according to Nehring et al. (2013a,b)
Definitions:
“Black List” (invasive) - species that cause significant changes in structure and/or function of invaded (semi-)natural ecosystem and management is required
“Grey List” (potentially invasive) - indications exist that these species may cause significant changes in structure and/or function of invaded (semi-)natural ecosystems

3.2.3 Ireland

The National Roads Authority published in 2010 the *Guidelines on The Management of Noxious Weeds and Non-Native Invasive Plant Species on National Roads* (NRA, 2010) and listed the following species: *Fallopia japonica*, *Heracleum mantegazzianum*, *Impatiens glandulifera*, *Gunnera tinctoria*, *Clematis vitalba*, *Rhododendron ponticum* and *Buddleja davidii*, *Crocosmia x crocosmiflora* and *Petasites fragrans*. The two latter species have not been included further, because they were not assessed or were categorized as a species with a low risk of impact, respectively.

We checked the species database from the National Biodiversity Data Centre (http://www.biodiversityireland.ie/projects/invasive-species/). Non-native species were categorized into two groups: high impact invasive species (20) and medium impact invasive species (40) (see for impact categorization Kelly et al., 2013). From the last group only those species were evaluated that were more widely distributed (> 100 records; 13 species).

The evaluation of the habitat preferences of the species of both groups based on literature sources showed that 12 species occur and spread along roadsides (Table 4). Three out of these species are on the List of Invasive Alien Species of Union concern and these are *Gunnera tinctoria*, *Heracleum mantegazzianum* and *Impatiens glandulifera*.

Table 4: Invasive alien plants species that occur and spread along roadsides in Ireland. Their life form, origin, classification, key references used and annotations are shown. Species with a green shaded box are the most notable ones. For the definitions regarding the column “life form” see Annex B.

ID	Genus	Species	Family	Life-form	Origin	Classification[1]	key references	Annotations
1	*Allium*	*triquetrum*	Alliaceae	G	W-Europe	mi	http://species.biodiversityireland.ie/profile.php?taxonId=28150&taxonDesignationGroupId=26, Booy et al. (2015), Risk Assessment of Allium triquetrum	Found along roadsides, "...with roadside verges the most at risk habitat to future spread." Moderate risk
2	*Buddleja*	*davidii*	Scrophulariaceae	N	Asia	mi	http://species.biodiversityireland.ie/profile.php?taxonId=40247&taxonGroupName=flowering%20plant&taxonDesignationGroupId=26	Widespread & common along roadsides
3	*Clematis*	*vitalba*	Ranunculaceae	N	Europa	mi	Reynolds (2002), http://species.biodiversityireland.ie/profile.php?taxonId=28429&taxonName=Clema&keyword=Catalogue%20of%20Irelands%20Non-native%20Species	Naturalised in hedgerows and along roadsides
4	*Fallopia*	*japonica*	Polygonaceae	G	Asia	hi	Reynolds (2002), O’Sullivan & O’ Halloran (2016), http://species.biodiversityireland.ie/profile.php?taxonId=41674&taxonDesignationGroupId=25	Frequent along roadsides, widely distributed
5	*Fallopia*	*sachalinensis*	Polygonaceae	G	Asia	hi	Reynolds (2002), O’Sullivan & O’ Halloran (2016), http://species.biodiversityireland.ie/profile.php?taxonId=41677&taxonDesignationGroupId=25	Frequent along roadsides, but less widely distributed than *F. japonica*
6	*Fallopia*	*x bohemica*	Polygonaceae	G	Hybrid	hi	Reynolds (2002), O’Sullivan & O’ Halloran (2016), http://species.biodiversityireland.ie/profile.php?taxonId=32516&taxonDesignationGroupId=25	Frequent along roadsides, but less widely distributed than *F. japonica*

7	*Gunnera*	*tinctoria*	Gunneraceae	H	South America	EU	http://species.biodiversityireland.ie/profile.php?taxonId=42051&taxonName=gunnera%20tinctoria, Gioria & Osborne (2013), Sheehy Skeffington & Hall (2011), O'Rourke & Colette O'Flynn (2014)	Frequent? e.g. in Coonemara along roadsides, listed in the EU Regulation 1143/2014 on invasive alien species
8	*Heracleum*	*mantegazzianum*	Apiaceae	H	Caucasus	EU	http://species.biodiversityireland.ie/profile.php?taxonId=29131&taxonName=giant	Rare along roadsides, listed in the EU Regulation 1143/2014 on invasive alien species
9	*Impatiens*	*glandulifera*	Balsaminaceae	T	India	hi	Reynolds (2002), http://species.biodiversityireland.ie/profile.php?taxonId=28772&taxonDesignationGroupId=25	Found on riversides, roadsides, prefers damp ground, listed in the EU Regulation 1143/2014 on invasive alien species
10	*Persicaria*	*wallichii*	Polygonaceae	G	Himalaya	mi	http://species.biodiversityireland.ie/profile.php?taxonId=29165&taxonDesignationGroupId=26, O' Flynn & Duffy (2017)	Scattered distribution but locally abundant along roadsides
11	*Prunus*	*laurocerasus*	Rosaceae	N	Caucasus	hi	http://species.biodiversityireland.ie/profile.php?taxonId=28940&taxonGroupName=flowering%20plant&taxonDesignationGroupId=25; Heart of the Glens invasive species survey 2016 (2017)	Rare along roadsides
12	*Rhododendron*	*ponticum*	Ericaceae	N	Caucasus	hi	Reynolds (2002), http://species.biodiversityireland.ie/profile.php?taxonId=29245&taxonDesignationGroupId=25	Rare? along roadsides, it invades a range of habitats: constructed, industrial or other artificial habitats (disturbed areas)

[1]Classification according to Kelly et al. (2013) & National Biodiversity Data Centre (http://www.biodiversityireland.ie/projects/invasive-species/)

Definitions:

"hi" = risk of High Impact (= score 18+ is a species with a risk of High Impact)

"mi" = risk of Medium Impact

"EU" = listed in the EU Regulation 1143/2014 on invasive alien species

3.2.4 Netherlands

We checked the database Nederlands Soortenregister (http://www.nederlandsesoorten.nl/content/lijsten) for all alien plants that are considered to be invasive (= non-native plant species that came here through human activity and pose a threat to the biodiversity). Almost 62 invasive alien plants have been identified.

The evaluation of the habitat preferences of these species based on literature sources and data bases (https://www.verspreidingsatlas.nl/), risk assessments (https://www.nvwa.nl/onderwerpen/invasieve-exoten/risicobeoordelingen--reactieperiode-invasieve-exoten) and expert consultation showed that 21 species occur and spread along roadsides (Table 5). Two out of the 21 species are on the List of Invasive Alien species of Union concern and these are *Heracleum mantegazzianum* and *Impatiens glandulifera*. Moreover, we put on our list the following species: *Solidago canadensis*, *S. gigantea*, *Fallopia x bohemica* and *F. sachalinensis*, because they are considered to be invasive in other countries and recent developments showed that they spread regularly along roadsides in the Netherlands.

Table 5: Invasive alien plants that occur and spread along roadsides in the Netherlands. Their life form, origin, classification, key references used and annotations are shown. Species with a green shaded box are the most notable ones. For the definitions regarding the column “life form” see Annex B.

ID	Genus	Species	Family	Life-form	Origin	Classification[1]	key references	Annotations
1	*Ailanthus*	*altissima*	Simaroubaceae	M	Asia	i	http://www.nederlandsesoorten.nl, Risk assessment *Ailanthus altissima* (Mill.) Swingle (2013)	Frequent (increasing), "stenige plaatsen langs spoorwegen, langs wegen en langs kanalen en rivieren", south NL
2	*Acer*	*pseudoplatanus*	Aceraceae	M	Europe, W-Asia	i	http://www.nederlandsesoorten.nl, https://www.verspreidingsatlas.nl/0002	Rare, planted for ornamental purpose and used along lanes, along railway tracks
3	*Ambrosia*	*artemisiifolia*	Asteraceae	T	North America	i	Van Vliet et al. (2009), http://www.nederlandsesoorten.nl, https://www.verspreidingsatlas.nl/0048	Frequent along roads, mainly in urban areas
4	*Amelanchier*	*lamarckii*	Rosaceae	N	North America	i	http://www.nederlandsesoorten.nl, https://www.verspreidingsatlas.nl/1852	Rare on slopes along highways in forest areas on sandy soils
5	*Conyza*	*canadensis*	Asteraceae	T	North America	i	http://www.nederlandsesoorten.nl, https://www.verspreidingsatlas.nl/0475	Frequent along roads
6	*Epilobium*	*ciliatum*	Onagraceae	H	North America	i	http://www.nederlandsesoorten.nl	It can easily be found along railways and roads; regarded as *Epilobium ciliatum* Raf.
7	*Fallopia*	*japonica*	Polygonaceae	G	Asia	i	http://www.nederlandsesoorten.nl; https://www.verspreidingsatlas.nl/1873, Duistermaat et al. (2012)	Locally frequent
8	*Fallopia*	*x bohemica*	Polygonaceae	G	Hybrid	pi	http://www.nederlandsesoorten.nl, Duistermaat et al. (2012), https://www.verspreidingsatlas.nl/2487	Rare along roadsides, railway tracks
9	*Fallopia*	*sachalinensis*	Polygonaceae	G	Asia	n	http://www.nederlandsesoorten.nl, https://www.verspreidingsatlas.nl/1875, Duistermaat et al. (2012)	Rare along roadsides, railway tracks
10	*Heracleum*	*mantegazzianum*	Apiaceae	H	Caucasus	i	http://www.nederlandsesoorten.nl; https://www.verspreidingsatlas.nl/0606	Frequent along roads ("Bermen […] o.a. middenbermen van autowege"), listed in the EU Regulation 1143/2014 on invasive alien species

11	*Impatiens*	*glandulifera*	Balsaminaceae	T	India	i	http://www.nederlandsesoorten.nl; https://www.verspreidingsatlas.nl/1862	Rare along roads, "… langs spoorwegen (spoorbermen)...", listed in the EU Regulation 1143/2014 on invasive alien species
12	*Matricaria*	*discoidea*	Asteraceae	T	North America	i	http://www.nederlandsesoorten.nl, https://www.verspreidingsatlas.nl/0796	Frequent along roads (widley distributed in NL)
13	*Oenothera*	*biennis*	Onagraceae	H	North America	i	http://www.nederlandsesoorten.nl	Rare along roads (not major roads), central and south NL
14	*Panicum*	*dichotomiflorum*	Poaceae	T	North America	i	http://www.nederlandsesoorten.nl, https://www.verspreidingsatlas.nl/5461	Rare along major roads (not widley distributed in NL)
15	*Pinus*	*sylvestris*	Pinaceae	M	S-Europe	i	http://www.nederlandsesoorten.nl	Rare, on slopes in forest areas on sandy soil
16	*Prunus*	*serotina*	Rosaceae	M	North America	i	http://www.nederlandsesoorten.nl	Rare, on slopes in forest areas on sandy soil
17	*Rosa*	*rugosa*	Rosaceae	N	East Asia	i	Risk assessment *Rosa rugosa* Thunb. ex Murray (2013), http://www.nederlandsesoorten.nl, Bakker et al. (2011), https://www.verspreidingsatlas.nl/1085	Frequent along roadsides, mainly coastal areas
18	*Senecio*	*inaequidens*	Asteraceae	S	South Africa	i	http://www.nederlandsesoorten.nl, https://www.verspreidingsatlas.nl/1733	Frequent, along all major highways
19	*Sisymbrium*	*altissimum*	Brassicaceae	H/T	Asia, E-Europe	i	http://www.nederlandsesoorten.nl, https://www.verspreidingsatlas.nl/1208	Locally in Zeeland, Holland, rare along rodasids
20	*Solidago*	*canadensis*	Asteraceae	H	North America	n	http://www.nederlandsesoorten.nl; https://www.verspreidingsatlas.nl/1890	Locally frequent
21	*Solidago*	*gigantea*	Asteraceae	H	North America	n	http://www.nederlandsesoorten.nl; https://www.verspreidingsatlas.nl/1221	Locally frequent

[1]Classification according to http://www.nederlandsesoorten.nl/content/lijsten
Definitions:
"i" = invasive (invasief)
"pi" = potentially invasive (potentieel invasief)
"n" = not invasive (niet invasief)

3.2.5 Norway

The Norwegian Public Roads Administration (http://www.vegvesen.no/en/) published a leaflet *Fremmde og invaderende plantearter i spredning langs veg* and that includes the following species: *Heracleum mantegazzianum*, *H. persicum*, *Fallopia japonica*, *F. sachalinensis*, *Lupinus polyphyllus*, *Bunias orientalis*, and *Impatiens glandulifera*.

Moreover, Gederaas et al. (2012) published *Alien species in Norway – with the Norwegian Black List 2012* (http://www.artsdatabanken.no/Pages/201621). The assessment assigned alien plants to one of five risk categories. Alien plants in the two highest categories “severe impact” (SE = actually or potentially ecologically harmful species and have the potential to become established across large areas; n = 71) and “high impact” (HI = either a restricted/moderate ability to spread, but cause at least a medium ecological effect, or alternatively only a minor ecological effect but have a high invasion potential; n = 65) have been evaluated. The complete details of the ecological impact assessment scheme have been published by Sandvik et al. (2013).

HI and SE species assigned to the habitat constructed sites (= housing areas, industrial sites, sand pits, roads, golf courses and other sport grounds; Gederaas et al., 2012) have been selected from the list. In a further step, these species have been assessed for their frequent occurrence along roadsides. The evaluation was based on literature sources and databases (http://www.floranordica.org/, https://www.nobanis.org/, http://artskart1.artsdatabanken.no, http://www2.artsdatabanken.no/faktaark, https://www.artsdatabanken.no/).

The results showed that 45 species occur and spread along roadsides (Table 6). Three out of the 45 species are on the List of Invasive Alien Species of Union concern and these are *Impatiens glandulifera, Heracleum mantegazzianum* and *H. persicum*.

Table 6: Invasive alien plants that occur and spread along roadsides in Norway. Their life form, origin, classification, key references used and annotations are shown. Species with a green shaded box are the most notable ones. For the definitions regarding the column "life form" see Annex B.

ID	Genus	Species	Family	Life-form	Origin	Classification[1]	key references	Annotations
1	*Acer*	*pseudoplatanus*	Aceraceae	M	Europe, W-Asia	SE	Gederaas et al. (2012), http://www2.artsdatabanken.no/faktaark/, Fremstad & Elven (1996)	Common along roadsides, planted species, widely distributed in NO
2	*Alchemilla*	*mollis*	Rosaceae	H	Caucasus, W-Asia	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N63193	Rare along roadsides
3	*Amelanchier*	*spicata*	Rosaceae	N	North America	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, http://databank.artsdatabanken.no/FremmedArt2012/N63214	Rare along roadsides
4	*Anthyllis*	*vulneraria subsp. carpatica*	Fabaceae	H	Europe	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N61852	Rare along roadsides (planted)
5	*Berberis*	*thunbergii*	Berberidaceae	N	Asia	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, http://www2.artsdatabanken.no/faktaark/	Rare along roadsides
6	*Bergenia*	*cordifolia*	Saxifragaceae	H	Asia (Russia)	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N63589	Rare along roadsides
7	*Bunias*	*orientalis*	Brassicaeae	H	W-Asia, E-Europe	HI	Gederaas et al. (2012), http://www2.artsdatabanken.no/faktaark/, http://databank.artsdatabanken.no/FremmedArt2012/N61090	Frequent along roadsides, S-Norway
8	*Calystegia*	*sepium* subsp. *spectabilis*	Convolvulaceae	G	Russia (Siberia), Japan	SE	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N63649	Frequent along roadsides in urban areas
9	*Centaurea*	*montana*	Asteraceae	H	Europe	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N60450	Rare along roadsides, more often forest edges

10	*Cerastium*	*tomentosum*	Caryophyllaceae	C	S-Europe	SE	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N61439	Rare along roadsides
11	*Cotoneaster*	*divaricatus*	Rosaceae	N	Asia	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx	Rare along roadsides, more often forest edges, woodland
12	*Cotoneaster*	*lucidus*	Rosaceae	N	Asia	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, http://databank.artsdatabanken.no/FremmedArt2012/N63238	Rare along roadsides, more often forest edges, woodland
13	*Epilobium*	*ciliatum*	Onagraceae	H	North America	SE	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N62797, http://www2.artsdatabanken.no/faktaark/	Rare along roadsides; in many habitats; includes *Epilobium ciliatum* subsp. *ciliatum* (=name is a synonym of *Epilobium ciliatum* Raf.) & *E. ciliatum* subsp. *glandulosum (*=name of an infraspecific taxon of *Epilobium ciliatum* Raf.)
14	*Fallopia*	*japonica*	Polygonaceae	G	Asia	SE	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N86678, Fremstad & Elven (1997)	Frequent along roadsides
15	*Fallopia*	*x bohemica*	Polygonaceae	G	Hybrid	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, Fremstad & Elven (1997)	Frequent along roadsides
16	*Fallopia*	*sachalinensis*	Polygonaceae	G	Asia	SE	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N86679, Fremstad & Elven (1997)	Frequent along roadsides
17	*Heracleum*	*mantegazzianum*	Apiaceae	H	Caucasus	SE	Gederaas et al. (2012), Klingenstein (2007), http://www.floranordica.org, http://databank.artsdatabanken.no/FremmedArt2012/N60287, Fremstad & Elven (2006)	Frequent along roadsides, listed in the EU Regulation 1143/2014 on invasive alien species
18	*Heracleum*	*persicum*	Apiaceae	H	W-Asia	SE	Gederaas et al. (2012), http://www.floranordica.org, Meier et al. (2017), Rijal et al. (2016), Fremstad & Elven (2006), http://databank.artsdatabanken.no/FremmedArt2012/N60288	Frequent along roadsides, listed in the EU Regulation 1143/2014 on invasive alien species
19	*Impatiens*	*parviflora*	Balsaminaceae	T	Inda	SE	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N61723	Rare along roadsides

20	*Impatiens*	*glandulifera*	Balsaminaceae	T	India	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, http://www2.artsdatabanken.no/faktaark/	Common along roadsides, listed in the EU Regulation 1143/2014 on invasive alien species
21	*Laburnum*	*alpinum*	Fabaceae	N	Europe	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, http://www2.artsdatabanken.no/faktaark/	Rare along roadsides
22	*Linaria*	*repens*	Scrophulariaceae	G	Europe	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx	Rare along roadsides
23	*Lonicera*	*involucrata*	Caprifoliaceae	N	North America	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N61674	Rare along roadsides
24	*Lotus*	*corniculatus*	Fabaceae	H	Europe	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, http://databank.artsdatabanken.no/FremmedArt2012/N61932	Common along roadsides (planted along roadsides)
25	*Lupinus*	*polyphyllus*	Fabaceae	H	North America	SE	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N61942, Elven & Fremstad (2000)	Frequent along roadsides, also planted along roadsides for soil stabilization; south Norway, scattered in the north, but has been recorded in all counties
26	*Lupinus*	*nootkatensis*	Fabaceae	H	North America	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, Elven & Fremstad (2000)	Frequent along roadsides, also planted along roadsides for soil stabilization
27	*Lupinus*	*perennis*	Fabaceae	H	North America	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, Elven & Fremstad (2000)	Frequent along roadsides, also planted along roadsides for soil stabilization
28	*Malus*	*domestica*	Rosaceae	M	Cultivated plant	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx	Very rare along roadsides
29	*Melilotus*	*albus*	Fabaceae	T/H	S-Europe, W-Europe	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, http://databank.artsdatabanken.no/FremmedArt2012/N61957	Rare along roadsides, also *M. altissimus* (HI)
30	*Myrrhis*	*odorata*	Apiaceae	H	Europe (Alps)	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, http://databank.artsdatabanken.no/FremmedArt2012/N60303	Rare along roadsides

31	*Odontites*	*vernus*	Scrophulariaceae	T	Europe	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx	Rare along roadsides
32	*Petasites*	*japonicus*	Asteraceae	H	Asia	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N60724, http://databank.artsdatabanken.no/FremmedArt2012/N60725	Rare along roadsides, also *Petasites hybridus* (origin: Europe, Mediterranean)
33	*Prunus*	*cerasus*	Rosaceae	M	S-Euope, W-Asia	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N63330	Rare along roadsides
34	*Rosa*	*rugosa*	Rosaceae	N	East Asia	SE	Gederaas et al. (2012), http://artskart1.artsdatabanken.no/Default.aspx, http://www2.artsdatabanken.no/faktaark/, Fremstad (1997), Bruun (2005)	Frequent along roadsides, planted species along roadsides
35	*Sambucus*	*racemosa*	Caprifoliaceae	N	Europe	HI	Gederaas et al. (2012), Fremstad & Elven (1999), http://databank.artsdatabanken.no/FremmedArt2012/N61663	Rare along roadsides; widely distributed in many habitats (incl. roadsides)
36	*Senecio*	*inaequidens*	Aceraceae	S	South Africa	HI	Gederaas et al. (2012), Often (1997), http://databank.artsdatabanken.no/FremmedArt2012/N60756	Rare along roadsides, also *S. viscosus* (HI)
37	*Solidago*	*canadensis*	Asteraceae	H	North America	SE	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N60776, Sunding (1989), Kabuce & Priede (2010)	Frequent along roadsides, S-Norway
38	*Solidago*	*gigantea*	Asteraceae	H	North America	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N60777, Sunding (1989)	Rare along roadsides
39	*Sorbaria*	*sorbifolia*	Rosaceae	N	Asia	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N63440	Frequent along roadsides (very common in N)
40	*Sorbus*	*mougeotii*	Rosaceae	N/M	Europe	SE	Gederaas et al. (2012), http://www2.artsdatabanken.no/faktaark/, http://databank.artsdatabanken.no/FremmedArt2012/N63453	Rare along roadsides, also *S. intermedia* (SE)

41	*Swida*	*sericea*	Cornaceae	N/M	North America	SE	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N61632	Rare along roadsides; widely (planted) distributed in many habitats (incl. roadsides); syn. *Cornus sericea*
42	*Swida*	*alba*	Cornaceae	N/M	E-Asia	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N61630	Rare along roadsides; widely (planted) distributed in many habitats (incl. roadsides); syn. *Cornus alba;* also *S. serica*
43	*Syringa*	*vulgaris*	Oleaceae	N/M	SW-Europe	HI	Gederaas et al. (2012), http://databank.artsdatabanken.no/FremmedArt2012/N62376	Rare along roadsides; widely distributed in many habitats
44	*Vinca*	*minor*	Apocynaceae	C	Europe, Asia	SE	Gederaas et al. (2012, http://databank.artsdatabanken.no/FremmedArt2012/N62127	Rare along roadsides
45	*Viola*	*odorata*	Violaceae	H	Europe	SE	Gederaas et al. (2012), http://www2.artsdatabanken.no/faktaark/	Rare along roadsides; widely distributed in many habitats

[1]Classification according to Gederaas et al. (2012)
Definitions:
"HI" = high impact: either a restricted/moderate ability to spread, but cause at least a medium ecological effect, or alternatively only a minor ecological effect but have a high invasion potential
"SE" = severe impact: actually or potentially ecologically harmful species and have the potential to become established across large areas

3.2.6 Slovenia

In Slovenia, a national inventory of alien plants was published in 2012 (Jogan et al., 2012; Jogan, 2013, see also http://www.bioportal.si/neobiota.php). All alien plants have been assigned to five categories. In total, 32 alien plants were classified as invasive (category 5 = “invazivnost”, i.e. quickly spreading naturalized alien plants, that cause significant changes in structure and/or function of invaded (semi)natural ecosystem; alien plants that were only harmful to human/domestic animals/economy and ephemerophytes were not classified as invasive). Moreover, 71 species assigned to category 4 (“naturalizirano” = potentially invasive) were briefly checked.

The evaluation of the habitat preferences of the species based on literature sources and expert consultation showed that 29 species occur and spread along roadsides (Table 7). One out of the 29 species is on the List of Invasive Alien Species of Union concern and that is *Impatiens glandulifera*.

According to Zelnik (2012) the most frequent invasive alien plants along the traffic infrastructure (railway, roads) were the following: *Ambrosia artemisiifolia, Erigeron annuus*, *Impatiens parviflora*, *Robinia pseudoacacia*, *Solidago gigantea* and *S. canadensis*.

Table 7: Invasive alien plants that occur and spread along roadsides in Slovenia. Their life form, origin, classification, key references used and annotations are shown. Species with a green shaded box are the most notable ones. For the definitions regarding the column "life form" see Annex B.

ID	Genus	Species	Family	Life-form	Origin	Classification[1]	key references	Annotations
1	*Acer*	*negundo*	Aceraceae	M	North America	i	Jogan et al. (2012), Jogan (pers. com.)	Rarely along roadsides
2	*Ailanthus*	*altissima*	Simaroubaceae	M	Asia	i	Jogan et al. (2012), Rozman et al. (2016), Jogan (pers. com.)	Frequently along roadsides
3	*Ambrosia*	*artemisiifolia*	Asteraceae	T	North America	i	Jogan & Vreš (1998), Jogan et al. (2012), Rozman et al. (2016), Jogan (pers. com.), Zelnik (2012), Šilc (2002)	Frequent along roadsides
4	*Artemisia*	*verlotiorum*	Asteraceae	H	Asia	pi	Jogan et al. (2012), Notulae ad floram Sloveniae (2010)	Rare along roadsides
5	*Berberis*	*thunbergii*	Berberidaceae	N	Asia	i	Jogan et al. (2012), Jogan (pers. com.)	Rare along roadsides
6	*Bidens*	*frondosa*	Asteraceae	T	North America	i	Jogan et al. (2012), Jogan (pers. com.)	Rare along roadsides
7	*Broussonetia*	*papyrifera*	Moraceae	M	Asia	pi	Jogan et al. (2012), Glasnović & Pečnikar (2010)	Rare along roadsides
8	*Buddleja*	*davidii*	Scrophulariaceae	N	Asia	i	Jogan et al. (2012), Jogan (pers. com.)	Rare along roadsides
9	*Cuscuta*	*campestris*	Cuscutaceae	T	North America	i	Jogan et al. (2012), Jogan (pers. com.)	Rare along roadsides
10	*Dittrichia*	*graveolens*	Asteraceae	T	Mediterranean	pi	Jogan et al. (2012), Frajman & Kaligarič (2009)	Frequent along roadsides (all major highways)

11	*Duchesnea*	*indica*	Rosaceae	H	Asia	i	Jogan et al. (2012), Jogan (pers. com.)	Rare along roadsides
12	*Epilobium*	*ciliatum*	Onagraceae	H	North America	pi	Jogan et al. (2012), Krajšek & Jogan (2004)	Rare along roadsides,road margins in urban areas, forest roads (syn. *E. adenocaulon* Hausskn.)
13	*Erigeron*	*annuus*	Asteraceae	T	North America	i	Jogan et al. (2012), Rozman et al. (2016), Jogan (pers. com.), Zelnik (2012)	Frequent along roadsides
14	*Fallopia*	*japonica*	Polygonaceae	G	Asia	i	Krajšek & Jogan (2011), Jogan et al. (2012), Jogan (pers. com.)	Frequent along roadsides
15	*Fallopia*	*x bohemica*	Polygonaceae	G	Hybrid	i	Krajšek & Jogan (2011), Jogan et al. (2012), Jogan (pers. com.)	Frequent along roadsides
16	*Fallopia*	*sachalinensis*	Polygonaceae	G	Asia	i	Krajšek & Jogan (2011), Jogan et al. (2012), Jogan (pers. com.)	Rare along roadsides
17	*Helianthus*	*tuberosus*	Asteraceae	G	North America	i	Jogan et al. (2012), Rozman et al. (2016), Jogan (pers. com.)	Rare along roadsides
18	*Impatiens*	*glandulifera*	Balsaminaceae	T	India	i	Jogan et al. (2012), Jogan (pers. com.)	Locally so frequent, that it occurs also along roads, listed in the EU Regulation 1143/2014 on invasive alien species
19	*Impatiens*	*parviflora*	Balsaminaceae	T	Asia	i	Jogan et al. (2012), Jogan (pers. com.), Zelnik (2012)	Locally so frequent, that it occurs also along roads
20	*Lonicera*	*japonica*	Caprifoliaceae	N	E-Asia	i	Jogan et al. (2012), Jogan (pers. com.)	Rare along roadsides
21	*Lupinus*	*polyphyllus*	Fabaceae	H	North America	i	Jogan et al. (2012), Rozman et al. (2016)	Frequent along roadsides
22	*Parthenocissus*	*quinquefolia*	Vitaceae	N	North America	i	Jogan et al. (2012), Jogan (pers. com.)	Rare along roadsides, more in the riparian zone
23	*Physocarpus*	*opulifolius*	Rosaceae	N	North America	i	Jogan et al. (2012), Jogan (pers. com.)	Rare along roadsides
24	*Robinia*	*pseudoacacia*	Fabaceae	M	North America	i	Jogan et al. (2012), Zelnik (2012)	Frequent along roadsides
25	*Rudbeckia*	*laciniata*	Asteraceae	H	North America	i	Jogan et al. (2012), Jogan (pers. com.)	Rare along roadsides

26	*Senecio*	*inaequidens*	Asteraceae	S	S-Africa	pi	Jogan et al. (2012), Glasnović & Pečnikar (2010)	Rare along roadsides (but frequent in Promorska)
27	*Solidago*	*canadensis*	Asteraceae	H	North America	i	Jogan et al. (2012), Rozman et al. (2016), Jogan (pers. com.), Zelnik (2012)	Frequent along roadsides
28	*Solidago*	*gigantea*	Asteraceae	H	North America	i	Jogan et al. (2012), Rozman et al. (2016), Jogan (pers. com.), Zelnik (2012)	Frequent along roadsides
29	*Sporobolus*	*neglectus*	Poaceae	T	North America	pi	Jogan et al. (2012), Jogan (2017)	Frequent along roadsides (major highways); also *Sporobolus vaginiflorus*

[1]Classification according to Jogan et al. (2012), Jogan (2013)
Definition:
"i" = invasive quickly spreading naturalized alien plants, that cause significant changes in structure and/or function of invaded (semi-)natural ecosystem
"pi" = potentially invasive (categorised as “naturalizirano”)

3.2.7 Sweden

Wissman et al. (2015) published the study *Invasiva arter i Infrastruktur* and listed the following species: *Lupinus polyphyllus, Impatiens glandulifera, Heracleum mantegazzianum, Solidago canadensis* and *Fallopia japonica*.

Recently, Tyler et al. (2015) assessed 721 presently established vascular plant and bryophyte species in Sweden for their invasiveness. A compound general index of invasive concern has been proposed and calculated for all species. The authors showed that 30 species obtained an index-of-invasive-concern value greater than 20 and these are considered to be the most problematic species. This group of 30 species and those with an index value of 15 to 20 (here only species with a presence day frequency > 5, i.e. more than 2.500 populations in Sweden; 14 species) were evaluated.

The evaluation of the habitat preferences of the species listed in Tyler et al. (2015) based on literature sources, databases (Den virtuella floran – http://linnaeus.nrm.se/flora/welcome.html; Flora Nordica – http://www.floranordica.org/, https://www.nobanis.org/) and expert consultation showed that 24 species occur and spread along roadsides (Table 8). Three out of the 24 species are on the List of Invasive Alien Species of Union concern and these are *Impatiens glandulifera*, *Heracleum mantegazzianum* and *H. persicum*.

Table 8: Invasive alien plants that occur and spread along roadsides in Sweden. Their life form, origin, classification, key references used and annotations are shown. Species with a green shaded box are the most notable ones. For the definitions regarding the column "life form" see Annex B.

ID	Genus	Species	Family	Life-form	Origin	Classification[1]	key references	Annotations
1	*Amelanchier*	*spicata*	Rosaceae	N	North America	i	Tyler et al. (2015), http://www.dalafloran.se/artindex.htm	Frequent along roadsides, common throughout large parts of the country and/or very frequent in some regions
2	*Amelanchier*	*confusa*	Rosaceae	N	Not known	i	Tyler et al. (2015), http://www.dalafloran.se/artindex.htm	Very rare along roadsides; the speices is suppiosed to be *Amelanchier confusa* Hylander (syn. *Amelanchier* × *grandiflora* Rehder)
3	*Anthyllis*	*vulneraria* subsp. *carpatica*	Fabaceae	H	Europe	(i)	Tyler et al. (2015), http://linnaeus.nrm.se/flora/di/faba/anthy/anthvul.html, http://www.dalafloran.se/artindex.htm	Frequent along roadsides, data from *Anthyllis vulneraria* s.l
4	*Cerastium*	*tomentosum*	Caryophyllaceae	C	S-Europe	(i)	Tyler et al. (2015), http://linnaeus.nrm.se/flora/di/caryophylla/ceras/ceratom.html, http://www.dalafloran.se/artindex.htm	Rare along roadsides
5	*Conyza*	*canadensis*	Asteraceae	T/H	North America	(i)	Tyler et al. (2015), http://linnaeus.nrm.se/flora/di/astera/conyz/conycan.html, http://www.dalafloran.se/artindex.htm	Rare along roadsides, e.g. S-Sweden
6	*Epilobium*	*ciliatum*	Onagraceae	H	North America	i	Carlsson & Persson (2007), Tyler et al. (2015), http://linnaeus.nrm.se/flora/di/onagra/epilo/epilade.html, http://www.dalafloran.se/artindex.htm, http://linnaeus.nrm.se/flora/di/onagra/epilo/epilcil.html	Common along roadsides, includes also *Epilobium adenocaulon* Hausskn. or Rydb. [sic!] (syn. of *Epilobium ciliatum* Raf.)
7	*Fallopia*	*japonica*	Polygonaceae	G	Asia	W	Wissman et al. (2015), http://www.dalafloran.se/artindex.htm	Rare along roadsides
8	*Heracleum*	*mantegazzianum*	Apiaceae	H	Caucasus	(i)	Wissman et al. (2015), http://www.dalafloran.se/artindex.htm	Listed in the EU Regulation 1143/2014 on invasive alien species
9	*Heracleum*	*persicum*	Apiaceae	H	W-Asia	(i)	http://www.floranordica.org/Review/-Review_public/accounts/Heracleum.html#persicum	Rare along roadsides, recently introduced in the northern provinces, listed in the EU Regulation 1143/2014 on invasive alien species

10	*Impatiens*	*glandulifera*	Balsaminaceae	T	India	i	Tyler et al. (2015), Wissman et al. (2015), http://www.dalafloran.se/artindex.htm	Frequent along roadsides, listed in the EU Regulation 1143/2014 on invasive alien species
11	*Lamiastrum*	*galeobdolon*	Lamiaceae	C	Cultivated plant	i	Tyler et al. (2015), http://www.dalafloran.se/artindex.htm	Very rare along roadsides, there are two species mentioned: L. *galeobdolon* subsp. *argentatum* und subsp. *montanum*
12	*Lonicera*	*caprifolium*	Caprifoliaceae	N	Europe	(i)	Tyler et al. (2015), http://www.dalafloran.se/artindex.htm	Very rare along roadsides (e.g. Slättberg/Dalarna)
13	*Lupinus*	*polyphyllus*	Fabaceae	H	North America	(i)	Tyler et al. (2015), Wissman et al. (2015), Brobäck (2015), http://linnaeus.nrm.se/flora/di/faba/lupin/lupipol.html, http://www.dalafloran.se/artindex.htm	Frequent along roadsides, common throughout large parts of the country and/or very frequent in some regions
14	*Medicago*	*sativa* subsp. *sativa*	Fabaceae	T/H	Asia	(i)	http://linnaeus.nrm.se/flora/di/faba/medic/medisat.html, Tyler et al. (2015), http://www.dalafloran.se/artindex.htm	Rare along roadsides
15	*Phedimus*	*spurius*	Crassulaceae	C	Caucasus	(i)	Tyler et al. (2015), http://linnaeus.nrm.se/flora/di/crassula/sedum/seduspu.html, http://www.dalafloran.se/artindex.htm	Rare along roadsides, syn. *Sedum spurium*
16	*Rosa*	*rugosa*	Rosaceae	N	East Asia	i	Tyler et al. (2015), Weidema (2006), Bruun (2005), http://linnaeus.nrm.se/flora/di/rosa/rosa/rosarug.html	Spreads along roads and motorways, planted along highways; common throughout large parts of the country and/or very frequent in some regions
17	*Sambucus*	*racemosa*	Caprifoliaceae	N	Europe, W-Asia	(i)	Tyler et al. (2015), http://www.dalafloran.se/artindex.htm	Frequent along roadsides (e.g. Dalarna)
18	*Senecio*	*inaequidens*	Aceraceae	S	South Africa	i	Tyler et al. (2015), http://www.dalafloran.se/trollius/nr_46_15.pdf.	Rare along roadsides
19	*Senecio*	*leucanthemifolius*	Asteraceae	T/H	E-Europe, W-Asia	(i)	Tyler et al. (2015), http://linnaeus.nrm.se/flora/di/astera/senec/senever.html	Rare along roadsides, syn. *S. vernalis* (?)
20	*Solidago*	*canadensis*	Asteraceae	H	North America	i	Tyler et al. (2015), Wissman et al. (2015), http://linnaeus.nrm.se/flora/di/astera/solid/solican.html, http://www.dalafloran.se/artindex.htm	Frequent along roadsides

21	*Solidago*	*gigantea*	Asteraceae	H	North America	i	Tyler et al. (2015), Wissman et al. (2015), http://www.dalafloran.se/artindex.htm, http://linnaeus.nrm.se/flora/di/astera/solid/soligig.html	Frequent along roadsides
22	*Spiraea*	*billardii*	Rosaceae	N	Hybrid	(i)	Tyler et al. (2015), http://www.dalafloran.se/artindex.htm	Rare along roadsides
23	*Trifolium pratense*	var. *sativum*	Fabaceae	H	Europe	i	Tyler et al. (2015), http://linnaeus.nrm.se/flora/di/convolvula/calys/calysep.html, http://www.dalafloran.se/artindex.htm	Frequent along roadsides, infraspecific taxon of the *Trifolium pratense,* common in some regions
24	*Verbascum*	*speciosum*	Scrophulariaceae	H	Europe (Austria)	(i)	Tyler et al. (2015), http://linnaeus.nrm.se/flora/di/scrophularia/verba/verbspe.html, http://www.dalafloran.se/artindex.htm	Rare along roadsides

[1]Classification according to Tyler et al. (2015) & Wissman et al. (2015)
Definitions:
"i" = index value >20 (= most problematic species)
"(i) = index value 15-20
"W" = listed in Wissman et al. (2015)

3.3 Characteristics of invasive alien plants along roadsides

The list of invasive alien plants that occur along roadsides assembled in this part of the project comprises 89 species within 31 plant families. The plant families Rosaceae (18), Asteraceae (16) and Fabacaeae (10) contained the most species. The majority of the invasive alien plants occurs only in one or two of the assessed countries, while thirteen species (14%) are currently known to occur along roadsides in more than four of the seven countries (Table 9). The highest and lowest numbers of invasive alien plants have been identified for Norway (45) and Ireland (12), respectively.

Concerning composition of the species by life form, they comprised of nearly 56% herbaceous (geophytes, hemicryptophytes, and therophytes) and 44% woody (makrophanerophytes, nanophanerophytes, hemiphanerophytes, and chamaephyte). Most of the listed invasive alien plants have been intentionally introduced as ornamental plants (65%) and cultivation or forestry purposes (15%). Other species have been unintentionally introduced e.g. as a contaminant (17%) or have immigrated without direct action of humans (3%). The majority of the species originates from North America and Asia.

3.4 Most notable invasive alien plants

The observed differences in the number of invasive alien plants along roadsides between the study countries are most likely due to the methods used for the assessment and categorization of invasiveness of the alien plants in each country (cf. Essl et al., 2011) which in turn led to varying initial numbers of invasive alien plants. Table 9 and Annex C shows the most frequently mentioned invasive alien plants in the selected countries. Each country has a set of most notable (= high impact, frequent and/or species is on the List of Invasive Alien Species of Union concern) invasive alien plants, as briefly described below.

3.4.1 Austria

In Austria, predominant invasive alien plants are the *Solidago*-species (*S. canadensis*, *S. gigantea*) as well as the *Fallopia*-species (*F. japonica, F. x bohemica, F. sachalinensis*). They may form conspicuous roadside monocultures in which one species covers the ground. Notable invasive tree and shrub species along roadsides are *Ailanthus altissima* and *Robinia pseudoacacia*. Although found to be rare along roadsides, *Heracleum mantegazzianum*, *Asclepias syriaca*, and *Impatiens glandulifera* warrant control because they are listed in the EU Regulation 1143/2014. Moreover, roadsides are frequently colonised in eastern Austria by *Ambrosia artemisiifolia* and *Senecio inaequidens*.

3.4.2 Germany

Likewise in Germany, the priority invasive alien plants along roadsides are the *Solidago*-species (*S. canadensis*, *S. gigantea*) as well as the *Fallopia*-species (*F. japonica, F. x bohemica, F. sachalinensis*). Woody invasive roadside plants include Ailanthus altissima and *Robinia pseudoacacia*. Although found to be rare along roadsides, *Impatiens glandulifera* is listed in the EU Regulation 1143/2014 as well as *Heracleum mantegazzianum*. However, the latter species and *Lupinus polyphyllus* and *Rosa rugosa* can be frequently found in some regions in Germany.

Table 9: Most frequently mentioned invasive alien plants along roadsides in each country.

Species	Country						
	AT	DE	NL	IR	NO	SE	SI
*Impatiens glandulifera**	x	x	x	x	x	x	x
Fallopia japonica	x	x	x	x	x	x	x
*Heracleum mantegazzianum**	x	x	x	x	x	x	
Fallopia sachalinensis	x	x	x	x	x		x
Fallopia x bohemica	x	x	x	x	x		x
Solidago gigantea	x	x	x		x	x	x
Solidago canadensis	x	x	x		x	x	x
Senecio inaequidens	x	x	x		x	x	x
Ambrosia artemisiifolia	x	x	x				x
Ailanthus altissima	x	x	x				x
Lupinus polyphyllus		x			x	x	x
Epilobium ciliatum		x			x	x	x
Rosa rugosa		x	x		x	x	

* Species are on the List of Invasive Alien Species of Union concern (EU Regulation 1143/2014)

3.4.3 Ireland

In Ireland, major invasive alien plants along roadsides are the *Fallopia*-species (*F. japonica*, *F. x bohemica*, *F. sachalinensis*) and *Buddelja davidii*, and although considered to be rare along roadsides also both shrubs *Rhododendron ponticus* and *Prunus laurocerasus. Heracleum mantegazzianum, Gunnera tinctoria*, and *Impatiens glandulifera* warrant control because they are listed in the EU Regulation 1143/2014.

3.4.4 Netherlands

In the Netherlands, frequent invasive alien plants along roadsides are *Ailanthus altissima* and *Ambrosia artemisiifolia*, *Conyza canadensis*, and *Senecio inaequidens*. *Fallopia japonica* is of great importance while *F. x bohemica* and *F. sachalinensis* can also be found, but both seem to be rare. Likewise in other countries *Heracleum mantegazzianum*, *Rosa rugosa*, *Epilobium ciliatum* are typical roadside plants. Both *Solidago*-species are not considered to be invasive, but occur locally along roadsides.

3.4.5 Norway

In Norway, many invasive alien plants along roadsides have been identified. Among the EU listed species *Heracleum mantegazzianum*, *H. persicum* and *Impatiens glandulifera* these are *Lupinus polyphyllus*, the *Fallopia*-species (*F. japonica*, *F.* x *bohemica*, *F. sachalinensis*). *Rosa rugosa*, *Solidago canadensis* (*S. gigantea* – rarely distributed), but also *Bunias orientalis* and *Sorbaria sorbifolia* warrant attention.

3.4.6 Slovenia

The most notable invasive alien plants in Slovenia are annual herbaceous *Ambrosia artemisiifolia* and *Erigeron annuus*. The woody species *Ailanthus altissima* can be commonly found in the roadside habitat, which applies to a lesser extent to *Robinia pseudoacacia*. Likewise in the other countries the *Fallopia*-species (*F. japonica*, *F. x bohemica*, *F. sachalinensis*) and *Solidago*-species (*S. gigantea, S. canadensis*) are problematic. *Impatiens glandulifera* and *I. parviflora* are considered very frequent in Slovenia, thus both also occur also along roadsides. *Lupinus polyphyllus* is mentioned to be frequent in Alpine region (Pohorje, Kozjak, Karawanken) and in the vicinity of Ljubljana.

3.4.7 Sweden

The EU wide listed species *Heracleum mantegazzianum, H. persicum*, and *Impatiens glandulifera* can be regularly found along roadsides, as well as *Lupinus polyphyllus*, *Rosa rugose* and the *Solidago*-species. A few other roadsides invasive alien plants are common along roadsides like *Amelanchier spicata*, *Anthyllis vulneraria* subsp. *carpatica*, *Epilobium ciliatum*, *Sambucus racemose*, and *Trifolium pratense* var. *sativum*. *Fallopia japonica* (also *F. x bohemica, F. sachalinensis*) does occur in Sweden, however it is considered to be rare along roadsides.

4 Further work

Data on invasive alien plants gathered from the questionnaire (work package 3) and further discussion during the project will be evaluated and thus, additional species may be included (or excluded) at a later stage.

5 Dissemination

The lists of invasive alien plants in the selected countries will be presented on the website (http//:www.controlinroad.org). A publication is in preparation (journal *EPPO Bulletin*) and the results of this deliverable will be presented at the European Weed Science Conference (http//:www.ewrs2018.org/). It is also planned to present and discuss the results during the Panel Meeting of Invasive Alien Plants of the European and Mediterranean Plant Protection Organization (EPPO, https://www.eppo.int/) in 2018.

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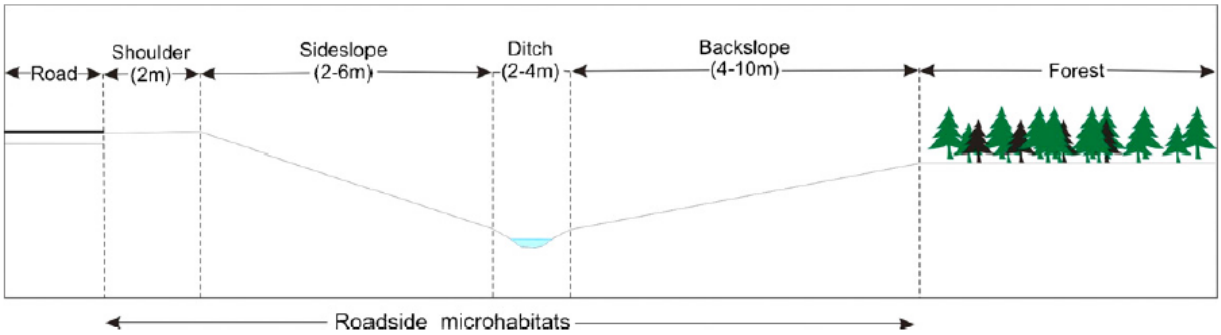
Annex A: Example of a cross section of a road (pavement) and its roadside

Example of a cross section of a road (pavement) and its roadside with different vegetated strips and microhabitats (from Karim & Malik 2008).



Annex B: Definitions of the letters for the life forms

Life form*	Definition
G (geophyte)	hemicryptophytes that survive unfavourable seasons in the form of a rhizome, bulb, tuber or rootbud. The term tuber is used here in a broad sense and includes every storage organ that is not a rhizome, bulb or rootbud
C (chamaephyt)	stems: herbaceous and/or woody and persisting for several years buds: on or just above soil level, never above 50 cm
H (hemicryptophyte)	stems: herbaceous, often dying back after the growing season, with shoots at soil level surviving buds: just on or below soil level
T (therophyte)	plants that survive unfavourable seasons in the form of seeds and complete their life-history during the favourable season
N (nanophanerophyte)	stems: woody and persisting for several years buds: above soil level but normally below 3 m, e.g.: shrubs
M ([makro-]phanerophyte)	stems: woody and persisting for several years buds: normally above 3 m, e.g.: small and large trees
S (hemiphanerophyte)	resting buds are situated on woody, basally ramified shoots up to a height of ca. 50 cm (dwarf shrub) or on the only basally lignified parts of higher shoots, which do not become lignified in their upper parts but die down periodically

* Based on BiolFlor (http://www2.ufz.de/biolflor/index.jsp) and WCSP (http://apps.kew.org/wcsp/).

Annex C: Examples of frequent invasive alien plants along roadsides

(1) *Ailanthus altissima* (2) *Fallopia japonica*, (3) *Solidago* spp., (4) *Buddleja davidii*, (5) *Fallopia sachalinensis*, and (6) *Ambrosia artemisiifolia* (Photos: S. Follak).