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## Article

# Protocol for assessing invasive plant populations

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**Abstract.** In Russian studies, a protocol for assessing the state of populations of invasive plant species is presented for the first time as a description form. Its development and application are important steps in systematic documentation of invasive plant species findings at the regional, national, or international level. The protocol takes account of the main criteria used for a comprehensive impact assessment: environmental impact, species distribution rate, and management complexity. The protocol comprises some additional information to be considered in the studies implemented at transport routes, in introduction institutions, agriculture, and protected areas (SPNAs). We provide the examples of the protocol application in the invasive plant species inventory along the Trans-Siberian Railway (Siberia, Russia) and in the Tsitsin Main Botanical Garden of the Russian Academy of Sciences (Moscow, Russia). The application of the proposed protocol will allow (1) to create the unified system for invasive plant monitoring, (2) to develop the general approaches and criteria for assessing the risk caused by invasive plants, and (3) to unify the data on the protocol application in assessing invasive species populations for their further use by different stakeholders.

**Keywords:** alien species, monitoring, botanical gardens, SPNA, rail and highways, environmental impact

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## Протокол оценки состояния популяций инвазионных видов растений

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**Аннотация.** Впервые в русскоязычной литературе приводится протокол оценки состояния популяций инвазионных видов растений, представленный в виде бланка описания. Его разработка и применение являются важными шагами на пути к систематическому документированию информации об инвазионных видах растений на региональном, национальном или международном уровне. Созданный протокол учитывает основные критерии, используемые для комплексной оценки воздействия: экологическое воздействие, ареал, скорость распространения и сложность управления. Приводится дополнительная информация, которую можно учитывать при исследованиях на транспортных магистралях, в интродукционных учреждениях, частных участках и на особо охраняемых природных территориях (ООПТ). Приведены примеры использования протокола при инвентаризации инвазионных видов растений вдоль Транссибирской железнодорожной магистрали, в Главном ботаническом саду им. Н.В. Цицина РАН (Москва, Россия). Применение предлагаемого протокола позволит: 1) создать единую систему мониторинга инвазионных растений, 2) разработать общие подходы и критерии к оценке риска, причиняемого инвазионными растениями, 3) унифицировать информацию, полученную при использовании протокола оценки популяций инвазионных видов, которая окажется потенциально применимой в организациях с различной ведомственной принадлежностью.

**Ключевые слова:** чужеродный вид, мониторинг, ботанические сады, ООПТ, транспортные магистрали, экологическое воздействие

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## Introduction

The study of invasive species is currently being conducted on a planetary scale (Biological invasions..., 2002, 2011; Encyclopedia..., 2011; Impact..., 2017) since the economic loss and environmental damage they cause are enormous. In Europe, the damage from invasive species, as well as the costs of their monitoring and control amounted to 116.61 billion euros for 1960–2020 (Haubrock et al., 2021). In Russia, economic loss from invasive species is estimated around 1.38 trillion rubles for 2007–2019 (Kirichenko et al., 2021).

The results of invasive species inventories are presented in numerous articles and scientific reports (Crystal-Ornelas and Lockwood, 2020; Invasive species..., 2021; Pagad et al., 2018; Pyšek et al., 2020). Conferences on the problem of invasive species are held annually within the framework of the Neobiota, EMAPi (Ecology and Management of Alien Plant invasions), Weeds, NAISMA (North American Invasive Species Management), etc. At the same time, the unified and representative data on biological invasions remain insufficient (Pagad et al., 2018; Pyšek et al., 2020; Turbé et al., 2017).

Strengthening a collaboration among scientists and conducting investigations using a common methodological framework is critical to reducing the impacts of invasive species on biodiversity and ecosystem services. In this connection, the urgent issue is to develop a standard protocol for describing the populations of invasive species in order to collect the information needed for data analysis, reporting, and policy regarding invasive species (Morse et al., 2004; Randall et al., 2008; Vanderhoeven et al., 2017).

The purpose of our study is to develop a protocol, which may serve as a tool for assessing, categorizing, and blacklisting invasive alien plant species in accordance with their impact on native species and natural biodiversity. Application of the proposed methodology will allow (1) to create the unified system for invasive plant monitoring, (2) to develop common approaches and criteria for assessing the risk caused by invasive plants, and (3) to unify the information obtained when using a protocol for assessing the populations of invasive species.

The protocol for assessing the populations of invasive plant species is proposed for the first time and, probably, needs further improvement. In turn, this may be achieved only by applying the protocol in practice.

## Material and methods

In order to develop such a protocol for assessing the state of populations of invasive species, the available methods for compiling floristic, geobotanical, and population descriptions were analyzed (Gergiya and Abramova, 2017; Morozova, 2016; Polevaya geobotanika, 1964; Tikhodeeva and Lebedeva, 2015). The most important characteristics of an invasive plant population easily recorded in situ are (1) a life form, (2) a reproduction type, (3) a phenological phase, (3) a footprint, (4) an association with the plant community and habitat (slope exposure, soil type, substrate type, features of anthropogenic impact, etc.), (5) a proportion of juvenile, immature and generative individuals, (6) a projective cover, (7) a population density, and (8) a species share in the given community.

The analyzed and compared methodologies for assessing the impact of invasive species can be applied at the international, national or regional level to any taxonomic group (Morse et al., 2004; Randall et al., 2008; Turbé et al., 2017; Vanderhoeven et al., 2017). The considered methods contain many criteria for invasive species assessment. Our task was to develop the universal protocol (a standard form for field description of invasive plant populations) that would be easy to use and information-rich. To do this, we identified the key protocol parameters based on the considered approaches: the nature of the invasive species impact on ecosystems; the conservation significance of plant communities and native species under threat; the invasive population status; the diversity of habitats colonized by the invasive species; the current trends in secondary range shifts in the region and/or the population size dynamics; the possibility of settling over long distances within the region; the potential ability of species to invade plant communities of high conservation value and to occupy the habitats of rare species both in the study region and at adjacent territories.

In addition, the description protocol for each studied population of an invasive species must include the mandatory sections containing the scientific name of the taxon and its native range, the date of finding, and the name of a collecting person. The assessment sections (overall complexity of controlling the species number, minimal monetary and time costs to combat this species, accessibility (for vehicles) of the territory colonized by invasive species, and status of the invasive species population in relation

to the control measures applied) are proposed to be filled out in office conditions or after the field season termination. The sections in the description form (Fig. 1), which should be filled out in situ, are highlighted in bold for easy use.

The field experience of the authors in studying the populations of invasive plants gained during numerous expedition trips was of great importance for drawing up the protocol. The presented protocol was developed within the framework of the Commission on Invasive Species of the Council of Botanical Gardens of the CIS at the IAAS and approved both by the participants of the VIII International Scientific Seminar “Strategies and Methods of Botanical Gardens for the Conservation and Sustainable Use of Biological Diversity of the Native Flora,” Minsk, Belarus, September 26, 2022 (Vinogradova, 2018) and the All-Russian Scientific and Practical Conference with international participation “Alien Species in Protected Areas,” Saransk, Russia, October 24–26, 2022.

The standard terminology of alien species used in the protocol is given in (Baranova et al., 2018) and definitions of the most important terms – in Appendix. The protocol and instructions for its use are available on the official website of the Tsitsin Main Botanical Garden of the Russian Academy of Sciences (<https://gbsad.ru/iris>).

## Results

The developed protocol for assessing the populations of invasive plant species has five main elements (Fig. 1):

1. Taxonomic status, life form and native range.
2. Environmental impact.
3. Current distribution and population size.
4. Trends in modern distribution and population size.
5. Possibility of controlling the species abundance.

It is recommended to fill out the protocol for each spontaneous invasive population of an alien species. Below, each section is discussed in detail.

### 1. Taxonomic status, life form, and native range

1.1 – Latin name of the species, verified using the World Flora Online database<sup>1</sup>. Collection of herbarium material to verify the identification and/or photographic recording of the plant/population is recommended.

1.2 – Native range of the species.

1.3 – Life form according to a simplified classification (tree/ shrub/ herbaceous perennial rhizomatous or root-sprouting plant/ herbaceous perennial tap- or tassel-rooted plant/ annual herbaceous plant).

1.4 – Mode of reproduction: seed/ vegetative.

1.5 – Location of invasive species findings with indication of geographical coordinates.

1.6 – Date of invasive species finding and collector’s name.

1.7 – Phenological phase. Indication of phenological aspects in combination with other data allows the development of appropriate control measures for an invasive species, or may be used in ecological modeling to help future researchers in determining the life cycle timing of a given species in a particular habitat.

### 2. Environmental impact

2.1 – Area of the invasive species population (m<sup>2</sup>).

2.2 – Characteristics of the habitat indicating the name of the plant community (it is necessary to specify the dominants for each tier of the plant community). In this paragraph, one can reflect the data on a slope exposure, a soil type (or substrate composition), a moisture regime, characteristics of microclimate and anthropogenic impact. This information may be useful as in species identification (as many invasive species are restricted to specific areas) as in future modeling of potential distribution of species.

2.3 – The nature of the invasive species impact on the ecosystem (several options are feasible):

- Significant impact on ecosystem processes and system-wide parameters (transforming species). For example, large-leaf lupine *Lupinus polyphyllus* Lindl. at its outbreak and active

<sup>1</sup> World Flora Online, 2022. Web page. URL: <http://www.worldfloraonline.org> (accessed: 15.10.2022).

**INVASIVE SPECIES POPULATION No.**

1.1 – Latin **name of the species** \_\_\_\_\_

1.2 – Native range of the species \_\_\_\_\_

1.3 – **Life form:** tree  shrub   
herbaceous perennial rhizomatous or root-sprouting plant  herbaceous perennial tap- or tassel-rooted plant  annual herbaceous plant

1.4 – **Reproduction type:** seed  vegetative

1.5 – **Geographical coordinates** N \_\_\_\_\_ E \_\_\_\_\_

1.6 – **Date of finding:** « \_\_\_\_\_ » 20\_\_\_\_ **collector** \_\_\_\_\_

1.7 – **Phenological phase:** vegetation  flowering   
fruiting  vegetation after fruiting

2.1 – **Area of the invasive species population, m<sup>2</sup>** \_\_\_\_\_

2.2 – **Plant community** (to note the dominants for each tier of the plant community) \_\_\_\_\_

**Slope exposure** \_\_\_\_\_ **Soil type** (or the nature of the substrate) \_\_\_\_\_

**Anthropogenic impact** \_\_\_\_\_ **Other data** \_\_\_\_\_

2.3 – **Nature of the impact of the invasive species on the ecosystem:**  
significant impact on ecosystem processes and system-wide parameters (transforming species)   
impact on the structure of the plant community   
impact on the floristic composition of the plant community   
impact on native species

2.4 – Environmental significance of plant communities and native plant species under threat (rare plants, protected areas) \_\_\_\_\_

3.1 – **Status of the invasive population:**  
spontaneous naturalizing population  invasive population   
decreasing size of invasive population (e.g., chemical/mechanical treatment or release of biological control agents)

3.2 – **Ratio of juvenile, immature and generative individuals in the population:** J  I  G

3.3 – **Projective cover of the invasive species, %** \_\_\_\_\_, **population density**, number of individuals per m<sup>2</sup> \_\_\_\_\_, **species share in the community, %** \_\_\_\_\_.

3.4 – **Area occupied by the invasive species in the region, m<sup>2</sup>** (if known) \_\_\_\_\_

3.5 – Diversity of habitats, into which the invasive species invades (list) \_\_\_\_\_

4.1 – Current trend of changes in the secondary range in the region or changes in population abundance (if known) \_\_\_\_\_

4.2 – The share of the potential habitat currently occupied in the region, % \_\_\_\_\_

4.3 – The possibility of the species spreading over long distances within the region \_\_\_\_\_

4.4 – The potential ability of the species to invade plant communities of high conservation value and to colonize \_\_\_\_\_ the \_\_\_\_\_ habitats \_\_\_\_\_ of \_\_\_\_\_ rare \_\_\_\_\_ species

4.5 – The species findings in plant communities of high conservation value, or in habitats of rare species \_\_\_\_\_ in \_\_\_\_\_ adjacent \_\_\_\_\_ regions

5.1 – General complexity of managing the species' dispersal \_\_\_\_\_

5.2 – Minimum monetary and time costs for combating this species \_\_\_\_\_

5.3 – Accessibility of the territory into which the invasive species has invaded for vehicles \_\_\_\_\_

5.4 – Population status regarding the measures taken to combat the invasive species:  
1) invasive population was detected, control of invasive species was not carried out   
2) an invasive population has been discovered; during the study, some methods of combating the invasive species (chemical, mechanical, etc.) were used   
3) invasive population, on which some method of combating the invasive species was previously applied

**Fig. 1.** Description form for invasive species population.

growth displaces native plants and nitrifies the soil thereby changing the composition of soil organisms, including the entomofauna. The danger of transforming species is in their disruption of natural succession processes. Even if an invasive species is completely removed that is generally unreal, the original plant community is unable to restore itself (e.g. not a meadow but ruderal community will be formed in the area colonized by the invasive lupine population) (Vinogradova et al., 2014).

- Impact on the structure of the plant community. The formation of a separate tier by an invasive species, a change in the crown density of a shrub layer or a projective cover of the herbaceous layer (or even their disappearance) are vivid examples. The introduction of thicket shadbush *Amelanchier spicata* (Lam.) K. Koch into the community of green moss pine forests of Bryansk Oblast (Russia) has resulted in the formation of a shrub layer consisting exclusively of thicket shadbush (Panasenko, 2022) and the appearance of the pine forest-thicket shadbush-dead moss association with lower floristic diversity.
- Impact on the floristic composition of the plant community. As a rule, invasive plant species have a significant effect on the floristic composition of the communities proportionally with their abundance. This is manifested through shading, competition for water or nutrients, allelopathy, and increased abundance of invaders. There are quite a large number of examples of a considerable reduction in the number of native species in plant communities dominated by boxelder maple *Acer negundo* L. (Veselkin and Dubrovin, 2019).
- Impact on native species. These may be parasitism, hybridization, displacement (replacement). A classic example is the displacement of a native European species, three-lobe beggarticks *Bidens frondosa* L., by the North American invasive species – devil's beggarticks *B. frondosa* L. (Galkina et al., 2015).

2.4 – Environmental significance of plant communities and native plant species under threat.

3. Current distribution and population size

3.1 – Status of the invasive population:

- spontaneous naturalizing population;
- invasive population;
- decreasing size of invasive population. In this case, the extinction of a local population is assumed to have occurred as a result of human intervention (e.g., chemical/mechanical treatment or release of biological control agents).

3.2 – Ratio of juvenile, immature and generative individuals in the population (%).

3.3 – Projective cover of the invasive species (%), population density (number of individuals per m<sup>2</sup>), species share in the community (%).

3.4 – Area occupied by the invasive species in the region, m<sup>2</sup> (if known).

3.5 – Diversity of habitats, invaded by the alien species (list). Since invasive species in the region occupy both anthropogenically disturbed and natural habitats, it is advisable, when filling out the protocol, to be guided by a habitat classification that takes this aspect into account.

4. Trends in modern distribution and population size

4.1 – Current trend of changes in the secondary range in the region or in population abundance (if known).

4.2 – Share of the potential habitat currently occupied in the region (% , if known).

4.3 – Possibility of the species spread over long distances within the region.

4.4 – Potential ability of the species to invade plant communities of high conservation value and to colonize the habitats of rare species.

4.5 – Species findings in plant communities of high conservation value, or in habitats of rare species in the adjacent regions.

5. Possibility of controlling the species abundance

5.1 – General complexity of managing the species dispersal (necessary to specify: probable, impossible, feasible at certain conditions, etc.).

5.2 – Minimum monetary and time costs for combating this species.

5.3 – Accessibility (for vehicles) of the territory colonized by the invasive species.

5.4 – Population status regarding the measures undertaken to combat the invasive species:

- Invasive population was detected, control over the invasive species was not carried out;

- Invasive population was discovered; some methods of combating the invasive species (chemical, mechanical, etc.) were applied during the study;
- Invasive population previously was exposed to a method for combating the invasive species.

Filling-up of the last section will give the information to subsequent users about monitoring or processing of the population.

Specific additional information is required for different groups of national economic objects. Key areas for monitoring invasive species are: (1) transport routes (primarily roads and railways); (2) introduction and landscaping institutions; (3) protected areas; (4) private land plots. The specifics of filling out the invasive species control protocols for each of the key areas are described below.

### **Transport routes**

Transport communications are one of the concentrated forms of human impact on natural ecosystems characterized by significant involvement of alien plant species. Road density is positively correlated with increased colonization by alien species (Dark, 2004; Senator, 2013).

The plant communities of transport routes are influenced by physical-geographical, technical-operational (Senator et al., 2012) and socio-economic factors (traffic intensity, traffic volume, distance from built-up areas of settlements, urbanization degree, etc.). It is important to reflect these data in the protocol. Their application in the analysis of the flora of the Trans-Siberian Railway demonstrates that in terms of influence on the local railroad flora, socio-economic factors form the series (in descending order): passenger traffic → population density → population size → settlement area (Kotenko and Vinogradova, 2022). Their impact on the number of native plant species of the railroad-related flora and on the number of juvenile specimens (both native and alien) is extremely insignificant.

It is noteworthy that control measures for invasive species on roads and railways vary depending on habitats. As a rule, nonspecific herbicides are used on the road surface, mowing – on slopes, and mechanical removal of plants – in drainage ditches. Therefore, the protocol must also reflect the exact habitat of the invasive species.

The understanding of mechanisms of invasive plant species dispersal and colonization along transport routes is the most important condition for preventing and regulating such invasions.

### **Introduction institutions (botanical gardens, arboretums, nurseries)**

Introduction institutions are important centers for studying floristic diversity and potential sources of alien species, including invasive ones (Vinogradova et al., 2020; Tkachenko, 2013; Shinder et al., 2021).

The classification of introduced species by the invasive activity status has been developed in the Tsitsin Main Botanical Garden of Russian Academy of Sciences (MBG RAS) (Vinogradova et al., 2020; see Table 1). Using this method, lists of alien species of spontaneous flora were compiled for the MBG RAS and botanical gardens of the Belarusian State University<sup>2</sup>, Batumi Shota Rustaveli State University (Gvarishvili and Lomtadze, 2013), Voronezh State University (Lepeshkina, 2017), Tver State University (Notov and Notov, 2012), and Immanuel Kant Baltic Federal University (Gubareva and Glukhovskikh, 2013).

In the MBG RAS, the status of invasive species activity was assessed both in the garden in general and at certain expositions. For instance, a comparison of naturalized and non-naturalized species was carried out to identify signs that contributed to the potential invasion success at the exposition of the flora of the Caucasus (Sokolova et al., 2022). In total, 57 species (4.5%) out of 1246 intentionally introduced taxa naturalized successfully, and 12 species (less than 1%) actually “escaped” beyond the exposition for the last 76 years. Another 17 species entered the naturalization phase in 2020–2023 (Vinogradova et al., 2020). Species from the families Apiaceae and Boraginaceae are characterized by the greatest degree of naturalization. Representatives of the subalpine tall grass and forest communities of the Caucasus demonstrate high adaptation to the conditions of Moscow city. Not a single species, confined to semi-deserts, arid woodlands, mountain xerophytic communities, steppes, alpine meadows, high-mountain rocks and screes, including subtropical forests of Colchis and Talish, have become invasive. Among naturalizing plants, short-rhizome and long-rhizome perennial herbaceous plants predominate.

<sup>2</sup> Rasteniya, kotorye dichayut v TsBS NAN Belarusi [Plants that run wild in the Central Botanical Garden of the Belarus National Academy of Sciences]. Web page. URL: <http://hbc.bas-net.by/hbcinfo/wildingmi.php> (accessed: 15.10.2022).

Hence, the following species have the highest probability of transition from intentionally introduced to invasive:

- representatives obtained from other introduction institutions, not from the native range;
- representatives of the subalpine tall grass and forest belt of the mountains of the Central and Western Caucasus (in the Central European part of Russia at least);
- representatives of the families Apiaceae, Caprifoliaceae, Asteraceae, and Asparagaceae;
- short-rhizome perennial herbaceous plants capable of self-renewal both by seed and vegetative methods.

Cultivated plants with such a set of traits require the increased measures to control their spread. The results of the analysis of the invasive species activity of the Caucasian flora will be used to prevent the introduction of aggressive alien plants into culture and to develop a scientifically based approach to plant display.

### **Protected areas**

Unlike many world countries, the fight against alien species in SPNAs of the Russian Federation is not permitted by law. Repeated appeals by scientists of the Russian Academy of Sciences to the Ministry of Natural Resources and Ecology of the Russian Federation have not brought to desired results. Measures to destroy invasive species (for example, hogweed or ragweed) by employees of protected areas are carried out unsystematically and require numerous approvals from the local administrations (Vinogradova et al., 2022). No doubts, this situation in the near future will be changed because invasive species combating in SPNAs is especially relevant. Here, costs should be used for conservation the communities of high conservation value. Therefore, the deliberate introduction of alien ornamental plants for landscaping the central estate and cordon territories in nature reserves and national parks should be prohibited. Similar to other countries, local administrations must support campaigns on invasive plants control (Vinogradova, 2018).

### **Private land plots**

Since the status of private property does not allow visiting agricultural lands directly, recording of invasive species can be implemented in private gardens (accessible with the permission of the owner), in cemeteries, along the fences of private property, and in the areas where waste plant material is disposed. In some publications (Pergl et al., 2016), the list of alien species capable of naturalization also includes potted plants that winter indoors, but stay in the garden in summer. In our opinion, it is incorrect even for alien species, not mentioning invasive ones.

### **Discussion**

Much information has been published about the impact of invasive plant species on native species, communities, and ecosystems. However, the data on the rate and patterns of their spread and effect on native species are available only for a small number of well-studied species (Randall et al., 2008). According to the preliminary estimates, there are 354 species of invasive plants in the Russian Federation (Vinogradova et al., 2020), but the most complete information is available only for some of them, i.e. boxelder maple *Acer negundo* (Vinogradova et al., 2022), annual ragweed *Ambrosia artemisiifolia* L. (Afonin et al., 2022a), giant ragweed *Ambrosia trifida* L. (Afonin et al., 2022b), black chokeberry *Aronia mitschurinii* (= *Sorbaronia mitschurinii*) A.K. Skvortsov et Maitul. (Vinogradova and Kuklina, 2014), rag sumpweed *Cyclachaena xanthiifolia* (Nutt.) Fresen (Kurdyukova, 2021), Sosnowsky hogweed *Hieracium sosnowskyi* Manden. (Dalke et al., 2015), black locust *Robinia pseudoacacia* L., large-leaved lupine *Lupinus polyphyllus*, false indigo bush *Amorpha fruticosa* L., Siberian peashrub *Caragana arborescens* Lam., fodder galega *Galega orientalis* Lam. (Vinogradova et al., 2014), etc.

The development of the protocol for assessing invasive plant populations is important for systematical documentation of invasive plant species nationwide. Typically, such protocols are used only to evaluate one of three areas: environmental, economic, or social impact (Turbé et al., 2017). Protocols containing overall impact assessments are less common. The originally developed protocol (present study) takes into account the main criteria used for the comprehensive impact assessment: ecological impact, range, rate of distribution, and management complexity (Randall et al., 2008). Foreign investigators pay attention to the potential of implementation and dissemination (Turbé et al., 2017), which is provided in the present protocol as well.

Similar protocols (Morse et al., 2004; Randall et al., 2008) have too detailed content; their compilation is time-consuming for a field researcher. For example, just a guide to such a protocol contains 40 pages (Morse et al., 2004). Our invasive species assessment protocol is user friendly; it allows to collect the information needed at every level of invasive species management, i.e. local, regional, national, and international. This protocol ensures compatibility of the data with the results of existing inventories of invasive species. According to minimum standards of this protocol, the additional information about the process and nature of invasion of a particular alien species is required.

## Conclusions

The developed protocol is a tool for assessing, categorizing, and blacklisting invasive plant species by their impact on native species and plant communities. We present certain peculiarities and additional information to be considered when conducting research at transport routes, in introduction institutions, SPNAs and private land plots.

We highly anticipate response to the presented methodology and improvements to the protocol based both on the user experience and as the data on the impact, rate and spread of invasive plant species become available.

**Table 1.** Additional information for filling out invasive species control protocols for some objects.

<b>Transport routes</b>	<p>Habitat characteristics:</p> <ol style="list-style-type: none"> <li>(1) road surface;</li> <li>(2) slopes;</li> <li>(3) drainage ditch;</li> <li>(4) adjacent territory (indicate the distance – up to 5 m, 10 m or more than 10 m from the road).</li> </ol> <p>For railways, additional characteristics of the location of invasive species findings are specified:</p> <ol style="list-style-type: none"> <li>(1) stage;</li> <li>(2) passing station;</li> <li>(3) freight station;</li> <li>(4) passenger station in the city;</li> <li>(5) passenger station in another locality;</li> <li>(6) railway junction.</li> </ol>
<b>Introduction institutions</b>	<p>Status 1: the alien species widespread both on the territory of the institution and beyond.</p> <p>Status 2: the species actively spreading throughout the territory of the institution not occupied by the collection.</p> <p>Status 3: the species that has formed local spontaneous populations outside the collection, and in the case of vegetative growth – resistant clones lost their physical connection with mother plants.</p> <p>Status 4: the species recorded at least once outside the collection area.</p>
<b>Protected areas (SPNA)</b>	<ol style="list-style-type: none"> <li>(1) the species noted only on the cordon (or any other economic territory);</li> <li>(2) the species found along roads;</li> <li>(3) at least a few plants noted in natural communities;</li> <li>(4) the species has formed stable invasive populations.</li> </ol>
<b>Private land plots</b>	<ol style="list-style-type: none"> <li>(1) the species noted along the boundaries of private land plots, on the territory of garden plots and cooperatives, including abandoned gardens;</li> <li>(2) the species noted in cemeteries;</li> <li>(3) the species found in landfills and waste heaps;</li> </ol>

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**APPENDIX**

**Habitat** is a territory or water area occupied by a species population and characterized by its inherent ecotope conditions.

**Invasive plants** are alien plants that have invaded an area and then naturalized in natural, semi-natural and anthropogenic habitats causing a negative impact on native species and communities.

**Native plants** are the plants, existence of which in a specific area is associated with the processes of natural florogenesis. Synonyms: local plants, indigenous plants, native plants.

**Native range** is the taxon range formed as a result of the process of natural florogenesis. Synonym: primary habitat.

**Plant communities of high conservation value** are communities that occupy a limited area in the region, or are located on the border of the distribution of the corresponding type of vegetation (possibly isolated from the main part of the range), or contain relict, endemic or protected species. Synonym: particularly valuable plant communities.

**Potential habitat** is an area suitable for a species settling across the entire complex of basic environmental factors that limit its distribution. Synonym: ecological habitat.

**Secondary habitat** is the area colonized by an alien taxon and formed as a result of its dispersal from its primary range to other territories under the influence of natural and anthropogenic factors and/or its subsequent spread from the centers of introduction.

**Species population control** is a system of measures to combat invasive species.

**Transforming species** are invasive species that actively invade natural plant communities, affect the ecosystem in general, disrupt natural succession processes, and cause significant environmental damage and economic loss.