

Guidelines for Listing, Categorizing and Sharing Information on Plant Taxa Spreading from Cultivation at Public Gardens in North America

A Project of the Public Gardens as Sentinels against Invasive Plants Working Group



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Foreword & Acknowledgements

Due to their status as museums of living plants from around the world, public gardens and arboreta can play a unique and proactive role in assessing which non-native ornamental plants exhibit invasive tendencies*. These institutions have the capacity and expertise to observe the reproduction and spread (or lack there-of) of plant taxa that may not be well known and may not be widely available in the horticultural trade, and they can indicate which taxa may demonstrate early warning signs of becoming invasive.

The Public Gardens as Sentinels against Invasive Plants (PGSIP) working group developed these guidelines with funding from the United States Department of Agriculture's National Institute for Food and Agriculture via the North Central Integrated Pest Management Center. Institutions that have contributed significantly to the working group include: The Morton Arboretum, Chicago Botanic Garden, Dawes Arboretum, Holden Arboretum, Lady Bird Johnson Wildflower Center, Midwest Invasive Plant Network, Missouri Botanical Garden, New York Botanical Garden, Royal Botanical Gardens, and Sustainable Conservation. The information provided in this document represents the key findings and recommendations of the PGSIP working group, which developed out of the Plants on the Move Garden Summit, held in November 2016 and attended by representatives from 26 U.S. and Canadian gardens. The American Public Gardens Association (APGA) published an article describing the background and objectives of PGSIP in 2019 (Dreisilker, K., Ryan, C., Culley, T., and Arcate-Schuler, J. 2019. Public gardens as sentinels against invasive plants. *Public Gardens* 34 (2): 10-13). For more information about PGSIP, including Summit proceedings and the APGA article, visit <https://mipn.org/prevent-detect/#edrr>.

Public Gardens as Sentinels against Invasive Plants is intended to build upon past work and to bolster implementation of existing voluntary codes of conduct for public gardens relative to invasive plants. Particularly, this project advances the St. Louis Declaration on Invasive Plant Species Voluntary Code of Conduct for Botanic Gardens and Arboreta of February 2002, which called for invasive plant assessments, policy decision-making based on these assessments, and improved networking on this issue.

Questions, comments, and/or feedback about this document or initiative can be sent to Michelle Beloskur (mipn@mortonarb.org).

*The authors of these guidelines acknowledge that terminology used in the field of invasion biology is sometimes criticized as being value-laden, with too much emphasis placed on species' global origins, and not enough emphasis on measurable impacts. When taken out of context or used inappropriately, this terminology can contribute to xenophobic sentiments. In developing this document, the authors have endeavored to define terms appropriately and use non-value-laden language.

Cover photo: *Akebia quinata* (five-leaf akebia), James H. Miller, USDA Forest Service via bugwood.org

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Who: Botanic Gardens & Arboreta of North America

What: Observing which non-native plants escape from cultivation

Where: In their collections and on their property, in the context of the regional flora

Why: To signal problematic taxa prior to their becoming invasive

How: Document plant taxa escaping from cultivation by creating, maintaining, and sharing data



Garden curators discuss the reproductive behavior of *Phellodendron amurense* (Amur corktree) at The Morton Arboretum. (Photo: Theresa Culley)

Glossary of Terms

Authority: Any agency or unit of government with the ability to regulate plant species.

Public garden: Per the American Public Gardens Association, a public garden is “an institution that maintains collections of plants for the purposes of public education and enjoyment, in addition to research, conservation, and higher learning. They must be open to the public and the garden's resources and accommodations must be made available to all visitors. Public gardens are staffed by professionals trained in their given areas of expertise and maintain active plant records systems.” Throughout this document, the terms “garden(s),” and “public garden(s),” are used broadly to refer to botanical gardens and arboreta, zoos, college campuses and any other institutions meeting this definition.

Cultivation: The practice of growing plants in desired locations for optimal health and vigor by using horticultural care.

Cultivated areas: Places on a public garden's property where plants are grown using routine and frequent management, including collections and display planting beds and managed turf areas.

Escape from location of cultivation: Expansion of a population of a cultivated plant taxon outside of its location of installation, occurring through seed dispersal and/or vegetative growth. Examples include plants spreading from cultivated beds or formal collections into turf grass or uncultivated areas. Not all expansion beyond the location of cultivation indicates that a plant is or will become an invasive plant.

Expert: Land managers, conservationists, horticulturists, curators, academics, and other professional practitioners specializing in invasive plant research, assessment, or control.

Invasive plant: A plant species that is non-native to the location being considered and whose presence and spread negatively impacts (or is likely to negatively impact) ecological, economic, or human health.

Native plant: A plant species that is indigenous to a bioregion or has arrived through means unrelated to human activity.

Non-native plant: A plant species that was introduced to a bioregion by humans, either deliberately or accidentally.

Glossary of Terms, continued

Sentinel list: A spreadsheet or other document created by a public garden to record and categorize taxa escaping from their locations of cultivation using the methodology described in these guidelines. Plant taxa within the sentinel list are ranked, and not all ranks indicate invasiveness (i.e., a sentinel list should not be construed as an invasive plant list).

Uncultivated areas: Places on a public garden's property that are not routinely and frequently managed for cultivated plants. These may include natural areas, material/equipment storage yards, compost areas, fence lines, property lines, utility rights-of-way, drainage features, windbreaks and hedgerows, among other locations.

Issue Background & Context of Guidelines

The following are the key findings of the Plants on the Move Summit and the subsequent work of the PGSIP working group, which provide the context under which these guidelines have been developed.

- 1. Many public gardens' collections contain plant taxa from around the world, many of which are not common in the horticulture trade in North America.**
- 2. Historically, some plant taxa within public gardens' collections have been found to escape from their locations of cultivation into surrounding landscapes, including natural areas.**
- 3. Gardens have the ability to signal problematic taxa that may be exhibiting invasive behavior prior to their widespread dissemination and spread through the horticulture trade.**
- 4. Gardens have a unique role as they may be the first to observe and record non-native species escaping from their locations of cultivation.**
- 5. Gardens should perceive themselves as leaders and sentinels with the ability to signal problematic taxa during the earliest phase of invasion (see Figure 1), rather than solely as parties responsible for introducing invasive plants.**

Issue Background & Context of Guidelines, continued

6. Prior to PGSIP's work, no formal system or mechanism existed to share information among gardens or with commercial plant propagators, growers, sellers, and landscape designers about plants escaping from cultivation within public gardens.
7. Individual gardens can track which taxa are escaping cultivation as part of an “early alert” network to prevent new invasions.
8. Some gardens already have lists of taxa found escaping from cultivation on their properties, but many do not have a list or any other documentation on this issue.
9. Of those gardens that have developed lists, no consistent methodology has been used, making data compilation and comparison challenging.
10. If gardens across the continent develop and share sentinel lists following a standardized methodology, such as the one presented here, observations can be pooled, and stronger conclusions about taxa that are escaping cultivation can be reached. Collecting and sharing such observations will allow gardens to potentially prevent the spread of new invasive plants in other public gardens and beyond.
11. The data generated by a public garden network will also be useful for the horticulture trade in making decisions about which plants to develop and sell for the commercial market, as well as which to avoid.
12. All public gardens are strongly encouraged to actively participate in this network of gardens tracking new movement of plants originating from their collections. In doing so, gardens can function proactively as sentinels against invasive plants.

Issue Background & Context of Guidelines, continued

As a means of providing baseline data, representatives of the PGSIP working group presented Plants on the Move Summit findings at two conferences: the American Public Gardens Association's October 2018 Excellence in Plant Collections Management Symposium in Vancouver, B.C., Canada, and the December 2018 Midwest Green Industry Experience in Columbus, OH. Attendees were live-polled to determine their level of interest in this initiative. During the October session, 78% of 60 garden respondents expressed willingness to share observational data related to plants escaping cultivation with no limitations, while an additional 13% would be willing with certain limitations on how that data would be used and shared. Furthermore, 85% of respondents indicated that they would find it beneficial to have access to data and observations from other gardens. Perhaps even more encouraging is that the broader horticulture industry is also interested; 93% of 27 nursery industry attendees at the December session indicated that they would find it helpful to hear from public gardens about the species and cultivars observed spreading from cultivation, presumably to avoid investing in marketing those plants. The full story is found in Dreisilker et al. 2019 (online [here](#) - see full citation on page 2).

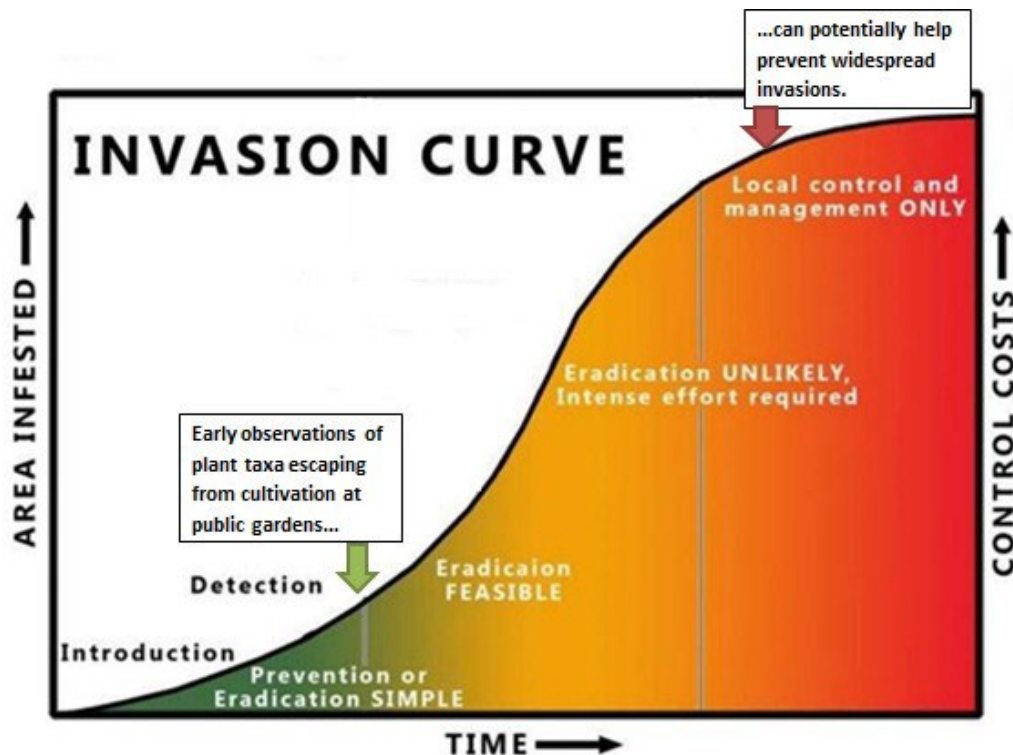


Figure 1: Without intervention, many invasive taxa follow the sigmoid population growth curve seen here, which decreases the feasibility of eradication and control over time as the population expands. However, by sharing their observations, public gardens can contribute to early detection efforts and act as sentinels against new invaders.

(Invasion Curve image courtesy of East Multnomah County, Oregon Soil and Water Conservation District)

Guidelines for Developing & Maintaining a Sentinel Plant List

The Sentinel List Concept

The purpose of these guidelines is to provide a consistent methodology for public garden staff to develop and categorize a list of cultivated taxa observed escaping from their locations of cultivation. The recommendations are meant to guide public gardens in the development and use of independent lists and to encourage data sharing with other gardens in the interest of preventing new plant invasions. These guidelines were developed by the PGSIP Working Group whose membership represents six public gardens and one invasive plant council. PGSIP's primary goal is to encourage, capture and pool public gardens' information about taxa demonstrating an ability to escape cultivation to improve the quality and quantity of data available for drawing conclusions about overall invasiveness.

Public gardens of all sizes are encouraged to make a sentinel list. Within each garden, any staff member(s) or volunteer(s) with sufficient expertise on the plant collections and their horticultural care, along with highly developed plant identification skills, can contribute to list development. This includes curators, horticulturists and gardeners, plant records staff, naturalists, and any other individuals with the capacity to recognize and share observations about taxa escaping from their locations of cultivation. It is important to ensure a comprehensive effort that staff or volunteers with familiarity with different garden areas and plant collections participate so that a comprehensive understanding of population behavior is captured.

A garden's sentinel list is intended to capture the population changes of cultivated plant taxa as they expand away from their locations of cultivation even if routine garden maintenance, particularly weeding, prevents them from expanding. A garden's sentinel list is expected to contain only a small subset of its total collection's taxa, as many taxa will not meet the threshold for placement on the list. The list primarily includes taxa that are currently or were previously present within a garden's plant collections. However, it may also include taxa cultivated on other land owned and managed by the garden, such as nurseries, private gardens, etc., as long as the garden can use its expertise to accurately characterize the population changes. A garden's characterization of a taxon's observed spread is captured through a ranking process described in detail in the following section.

A garden's sentinel list should not be construed in its entirety as an invasive plant list, because placing a taxon on the list does not necessarily mean it is invasive (e.g., lower ranked taxa will not meet the threshold for invasiveness). A garden's list is also not meant to be a predictive indicator or risk assessment of invasiveness. However, a garden's list may include taxa that have been determined by state or regional authorities to be invasive, even if such taxa are no longer part of a garden's collection. These taxa may occur spontaneously as legacies of former accessions or due to propagules arriving from off site.

The Sentinel List Concept, continued

Lists may also include taxa that have been prohibited through regulation, the garden's internal policy, or as a result of published research on their invasiveness. Such species are likely to be extensively documented in the regional flora. While sentinel lists may include known invasive species, the greatest value of developing and comparing the lists is in compiling information about taxa that are not broadly recognized as invasive by authorities and not already widespread in regional flora. These taxa may be at the left side of the invasion curve in Figure 1 where early action to prevent invasiveness is possible.

A garden's list is intended to inform and document internal decision making related to taxa that escape cultivation. The garden staff uses its list to guide management of the garden and outreach messaging. These guidelines include recommended management activities that vary by rank on the list. Gardens can use their list to guide management activities, mainly by:

1. Conveying past or current collections management decisions and helping to inform future decisions (e.g., to remove, monitor, or prohibit certain species)
2. Conveying past or current natural area management decisions and helping to inform future decisions (e.g., placing species under active management, monitoring for species presence)
3. Enabling the comparison and relative ranking of species escaping cultivation based on observations of species' behavior onsite
4. Cataloging onsite observations
5. Informing institutional messaging and decision making about species escaping cultivation, particularly those showing greater invasive potential (e.g., actively discourage, do not promote, do not include in plant sales and seed exchanges)
6. Incorporating the list and its associated metadata into the organization's plant and natural area records. Permanent plant records should include information about the population of escaped species. Link plant records with natural area records, if applicable.

A garden's sentinel list should be shared with other North American gardens to improve the sector's collective knowledge of observed spread behavior. To accomplish this, a shared database has been developed to collect and store data from gardens across North America (see page 15). As gardens begin developing their independent lists and entering information into the shared database, it will become a resource that participating gardens can query for various purposes, such as to inform plant risk assessments or plant development programs. However, it is at the discretion of each garden whether its list is made public as an attributable, stand-alone document.

Creating and Ranking a Sentinel List

A garden's list should be generated based on observation of its accessioned taxa and their progeny, and the taxa should be ranked based on context both internal and external to the garden. The internal context refers to the specific observations within the properties managed by the garden that primarily includes the current and historic observations of population spread and escape from cultivated locations, including population size and density, distance of spread, and location of spread. Each garden varies in area occupied, so the internal context will vary depending on how each garden is physically organized in the landscape. Furthermore, gardens will have varying degrees of opportunity for spontaneous populations to establish based on characteristics such as how extensively the garden is cultivated and whether the garden contains uncultivated natural areas. External context refers to taxa that are represented in the flora of the garden's immediate region, the extent to which they have been considered invasive by regional experts and authorities, and their historical and current distribution through the horticulture trade.

Step 1: Generate a List of Plant Taxa

The first step is for garden staff and other participants to generate a raw list of all taxa that are not part of the native flora of the garden's immediate region and that have been observed spreading from their intended locations of cultivation onsite. Referencing a published regional flora may assist in determining whether to consider a taxon as native. Generating a list initially in a spreadsheet is suitable as it can later be imported to the shared database, as explained below. Plant spread may be through sexual or vegetative reproduction, and may be relatively local, such as into nearby beds or turf grass neighboring the accessioned specimen, or distant, into uncultivated areas, and even outside of the garden property. The spontaneous population of any given taxon outside of its location of cultivation may be very small (one to several individuals or stems) or very large (hundreds to thousands of individuals or stems). The spreading population may consist of seedlings or mature individuals capable of dispersing propagules.

Ideally, the observations that underpin the raw list will have been documented in some formal way. However, it is entirely possible that this highly valuable information will only exist within the memories of garden staff and/or volunteers. These situations should be documented within the raw list as personal communications, staff observations, etc., particularly to help establish an initial list for the garden. However, once the initial list is developed and includes this initial information, the standardized, data-driven approach of adding species should be followed as outlined in Tables 2-4 (pages 18 & 19).

Correct identification of plants to the species level is critical for generating this list. Identification of taxa observed escaping from their locations of cultivation should be verified by collecting a voucher specimen and submitting to a local herbarium for verification and potential inclusion in the herbarium collection. Gardens are encouraged to tolerate some seedling development where feasible to facilitate proper identification. If garden policy prevents this, then alternative means of properly identifying the seedlings, such as transplanting to other locations or training staff on seedling identification, are recommended.

Creating and Ranking a Sentinel List, continued

In rare cases, such as when hybridization complicates identification, gardens may temporarily submit a record that only specifies the genus (e.g., *Malus* sp.). Once identification has been confirmed, the record should be edited to specify the species. When possible, gardens should list taxa at the subspecies, variety, or cultivar level. This can be done during initial list development or during subsequent updates as capacity allows. In instances where gardens are growing cultivars promoted for reduced fertility, conducting scientific trials evaluating their fertility is recommended.

Step 2: Rank the Listed Taxa

The next step is ranking the taxa on the list as Watchlist, Potentially Invasive, Invasive, or Assessed as Invasive. Definitions and explanations of each category developed by the PGSIP working group follow.

Watchlist Category: Characteristics and Policy Recommendations

This category represents taxa that have been observed spreading in or around their sites of cultivation, but rarely, if ever, occur in uncultivated areas. Reports of these taxa occurring in the regional flora are either absent or rare and isolated, and these taxa are highly unlikely to be described as invasive by authorities and/or experts in the region where the garden is located. This category may be used by public gardens to observe and record the reproductive and spreading behavior of taxa that are obscure and little known in commercial horticulture and elsewhere, or that may be exhibiting changes in reproductive capacity or growing range in response to climate change. The spreading of taxa ranked in this category may be an early signal of potential invasiveness, though it is entirely possible that these taxa will never spread sufficiently to pose an invasive threat. Gardens need not consider *Watchlist* taxa invasive, but these taxa may be of most interest for further comparison of observations with other gardens in the same geographic region.

Taxa ranked as *Watchlist* will generally follow the example scenarios outlined in Table 1 below. Spontaneous individuals are generally found close to the original cultivated plant(s), typically in the same or adjacent garden beds, and the escaped populations within the garden are small. Gardens should consider the higher rank of *Potentially Invasive* if: spontaneous individuals are found at greater distances from the contributing collections plants, they are increasingly found in uncultivated areas, dense growth and/or thicket formation is observed, or the taxa must be continually managed or controlled through routine weeding. Determining whether to categorize a taxon as *Watchlist* versus *Potentially Invasive* may prove to be more difficult for smaller or highly cultivated gardens that do not manage natural areas or otherwise have much space where spontaneous populations can establish. Under these conditions, ranking a taxon appropriately may require stronger data from sources outside the garden, such as observations from nearby properties, stronger representation in the regional flora, or some recognition of concern by experts or authorities.

Watchlist Category, continued

Public gardens are encouraged to take the following actions in regard to taxa ranked *Watchlist*:

- Document any new populations representing range expansion under consultation of herbaria registered in Index Herbariorum.
- Develop and initiate a monitoring program to watch for any further spread.
- Train garden staff and/or volunteers to recognize, document and report any new spontaneous populations, particularly when found in uncultivated areas.
- Monitor for any viable seed production among cultivars bred for reduced fecundity or sterility.
- Exercise caution in promoting these taxa to external audiences. Review ranking on an annual or biennial basis with the appropriate team of individuals from the organization.

Potentially Invasive Category: Characteristics and Policy Recommendations

Taxa ranked *Potentially Invasive* have established populations that often occur at considerable distance from the contributing collections plants and/or are growing in uncultivated areas on or outside of the garden's property, or the established populations may be consistently managed or controlled to prevent spread within the garden. They may or may not be reported in the flora of the region of the garden. There may even be conflicting assessments of invasiveness from authorities and experts. In instances where a taxon is not present in the regional flora but is spreading onsite at a garden, the garden should rank the taxon as *Potentially Invasive* based on the degree of management required to prevent spread and the observed thresholds for population, distance from cultivated sources, or locations of population as outlined in Table 1.

In instances where a taxon is present in the regional flora of the garden the taxon should only be ranked *Potentially Invasive* if the population size observed onsite is low. Unlike *Potentially Invasive* taxa, *Invasive* taxa are likely to already have extensive populations in the regional flora. Determining whether to categorize a taxon as *Potentially Invasive* versus *Invasive* may prove to be more difficult for smaller or highly cultivated gardens that do not manage natural areas or otherwise have much space where spontaneous populations can establish. Under these conditions, ranking a taxon appropriately may require stronger data from sources outside the garden, such as observations from nearby properties, stronger representation in the regional flora, or more frequent recognition by experts or authorities of its invasiveness.

Potentially Invasive Category, continued

Public gardens are encouraged to take the following actions in regard to taxa ranked *Potentially Invasive*:

- Document any new populations representing range expansion under consultation of herbaria registered in Index Herbariorum.
- Develop a deaccession plan to remove the contributing collections plants over a specified timeframe.
- Communicate decision to deaccession taxa to staff responsible for plant purchasing and accessioning to prevent reintroduction.
- Only cultivars incapable of contributing to population expansion should be considered for use.
- Remove all spontaneous populations on property with a goal of eradication.
- If taxa are known to have spread beyond the garden property, communicate with neighbors of their presence and offer technical support for their identification and control.
- Actively discourage their use. Do not promote, distribute, and sell these taxa through garden operations.
- Inform plant propagator and nursery industry contacts of garden's observations.
- Consider flagging remaining accessions if left within the garden as *Potentially Invasive* and provide alternatives on any public lists or databases of horticultural plants, through plant clinics and educational programs, etc.

Invasive Category: Characteristics and Policy Recommendations

This category represents taxa that have been observed and thoroughly documented spreading from cultivation both within the garden and outside of the garden's property. Taxa in this category may have been deaccessioned due to invasiveness prior to the public garden developing a formal list or policy regarding plants escaping cultivation. Invasive taxa are likely well documented in the regional flora. Records may show the distribution and population sizes of these taxa expanding over time. Populations of these taxa are generally not highly localized. In some cases, Invasive taxa may be considered widespread on state or provincial scales.

Many experts and authorities usually already recognize these taxa as invasive, and a substantial body of literature related to invasive impacts may already exist. They are likely to be either listed or regulated as invasive by invasive plant councils or jurisdictional authorities. Gardens may wish to consult council or authority lists, though it is not absolutely required. In using this ranking, gardens are generally not declaring taxa invasive based solely on their observations, but are using their observations to confirm or reinforce an existing understanding of invasiveness.

Invasive Category, continued

Non-native taxa abundant in the regional flora that also occur at the garden in large populations or in uncultivated areas should be ranked as *Invasive* as indicated in Table 1 below. *Invasive* taxa have a well-documented presence in the regional flora and will have established multiple self-replicating populations outside of cultivation across the region. The distribution threshold supporting the *Invasive* ranking requires professional judgement. It is recommended that in the course of ranking, gardens consult regional herbaria, published flora, jurisdictional s-ranks, and databases used to catalogue invasive species distribution (e.g., [iMapInvasives](#), [EDDMapS](#), etc.), as well as direct observations of staff. *Invasive* taxa may have historically been part of the ornamental plant trade, resulting in horticultural introductions which may have aided in contributing to the population size and high degree of distribution. Propagules may continuously arrive on the garden property from off-site.

Public gardens are encouraged to take the following actions in regard to taxa ranked as *Invasive*:

- Document any new populations representing range expansion under consultation of herbaria registered in Index Herbariorum.
- Develop and fully implement a deaccession plan such that taxa in this category are no longer represented in collections or displays, allowing for a garden's discretion with respect to research and education.
- Communicate decision to deaccession to staff responsible for plant purchase/accessioning to prevent reintroduction.
- Only cultivars incapable of contributing to population expansion should be considered for use.
- Control spontaneous populations on property with a goal of preventing population growth and spread. Eradication is not likely practical due to large regional population.
- Actively discourage their use. Do not promote, distribute, and sell these taxa through garden operations.
- Denote taxa as *Invasive* within garden publications and outreach materials.
- Provide appropriate alternatives to these taxa on any public lists or databases of horticultural plants, through plant clinics and educational programs, etc.

Table 1: Scenarios of non-native plants escaping from their locations of cultivation with recommended rankings. The suggested thresholds for population size and distance from source are not absolute and are recommended thresholds to use while ranking taxa. Professional judgement should always be used to evaluate situations falling on or near those thresholds.

Abundant in the regional flora?	# escaped individuals or stems observed	Distance of spread from contributing collections plants	Are spontaneous individuals observed in uncultivated areas?	Recommended Rank
No	Less than 100	Less than 100 yards or meters	No	<i>Watchlist</i>
No	Less than 100	Less than 100 yards or meters	Yes	<i>Watchlist</i>
No	Less than 100	More than 100 yards or meters	No	<i>Watchlist</i>
No	Less than 100	More than 100 yards or meters	Yes	<i>Watchlist</i>
No	Over 100	Less than 100 yards or meters	No	<i>Watchlist</i>
No	Over 100	Less than 100 yards or meters	Yes	<i>Potentially Invasive</i>
No	Over 100	More than 100 yards or meters	No	<i>Potentially Invasive</i>
No	Over 100	More than 100 yards or meters	Yes	<i>Potentially Invasive</i>
Yes	Less than 100	Less than 100 yards or meters	No	<i>Potentially Invasive</i>
Yes	Less than 100	Less than 100 yards or meters	Yes	<i>Potentially Invasive</i>
Yes	Less than 100	More than 100 yards or meters	No	<i>Potentially Invasive</i>
Yes	Less than 100	More than 100 yards or meters	Yes	<i>Invasive</i>
Yes	Over 100	Less than 100 yards or meters	No	<i>Invasive</i>
Yes	Over 100	Less than 100 yards or meters	Yes	<i>Invasive</i>
Yes	Over 100	More than 100 yards or meters	No	<i>Invasive</i>
Yes	Over 100	More than 100 yards or meters	Yes	<i>Invasive</i>

Assessed as Invasive Category: Characteristics and Policy Recommendations

Taxa are given this rank based on the outcome of a literature review and/or a formal risk assessment process conducted by the garden. These taxa may or may not be currently found within the collection or have been grown in the garden's collection in the past. This category applies when gardens have engaged in formal literature-based invasive plant assessments. This category is used only when a garden has made a decision to classify taxa as invasive using information that is not observation-based. The goal of risk assessments is to use published information about a taxon's biology, its invasiveness under similar growing conditions, and harm associated with its spread to draw conclusions about its likelihood of becoming invasive.

Public gardens are encouraged to take the following actions in regard to taxa ranked *Assessed as Invasive*:

- Document any new populations representing range expansion under consultation of herbaria registered in Index Herbariorum.
- Develop and fully implement a deaccession plan such that taxa in this category are no longer represented in collections or displays, allowing for a garden's discretion with respect to research and education.
- Communicate decision to deaccession to staff responsible for plant purchase/accessioning to prevent introduction.
- Only cultivars incapable of contributing to population expansion should be considered for use.
- Prohibit accessioning and purchase of taxa categorized as *Assessed as Invasive*.
- Actively discourage their use. Do not promote, distribute, and sell these taxa through garden operations.
- Denote taxa as *Assessed as Invasive* and provide alternatives on any public lists or databases of horticultural plants, through plant clinics and educational programs, etc.

Maintaining the Sentinel List

A garden should periodically perform a comprehensive review of its sentinel list to (a) ensure that newly observed species are added to the list in a timely manner, and (b) adjust the ranks of previously ranked taxa as necessary based on new information. These updates should then be added to the PGSIP database as new records (see next section - Sharing the Sentinel List).

Sharing the Sentinel List

The PGSIP Working Group has developed a restricted-access online database as a repository for public gardens' sentinel lists. The database is located at <http://pgsip.mortonarb.org/Bol/pgsip>. At present, access is only granted by request and is only available to staff or other authorized representatives of public gardens. Staff may request access through the [registration link](#) on the website. Gardens are strongly encouraged to upload their lists to the database, so that trends can be assessed across geographic regions. In addition to adding data, registered users may also browse [existing data and view other participating gardens' lists](#). A full database user's guide is available.

PGSIP is working to develop a limited version of the database that will allow stakeholders outside of the public garden sector to view records in the database that have been scrubbed of all identifying information and geolocation obscured to the state and province level. In the future, we also plan to develop a protocol for sharing synthesized findings with outside audiences, including plant propagators, landscape architects, and invasive plant councils. This protocol will be shared with all database users prior to implementation. Gardens are highly encouraged to independently share their lists with other gardens in their bioregion and local partners interested in plants escaping cultivation. However, PGSIP will never share data with non-garden audiences such that records are attributable to any specific garden.

Table 2: Recommended data parameters for a Public Garden Sentinel List that provide characterization of the spontaneous/escaped population. Parameters marked with an asterisk are required and must be included for entry of records into the PGSIP database.

Parameter	Description
Taxon name*	Scientific name of taxon
Taxon ranking*	The garden's assigned rank for taxon (i.e., Watchlist, Potentially Invasive, Invasive, Assessed as Invasive)
Abundance in the regional flora*	Is the taxon abundant in the regional flora?
Decision date	Date (approximate) when garden first became concerned about taxon's escape from cultivation or assessed the taxon for invasiveness
Mode of reproduction	Is spontaneous population resultant from vegetative spread or sexual reproduction, and the primary mode of seed dispersal for the latter
Population size*	An estimate of the size of the spontaneous population at the garden that captures order of magnitude
Area inhabited by spontaneous population	An estimate of the land area occupied by the spontaneous population at the garden that captures order of magnitude
Setting where spontaneous population observed*	Short description of where spontaneous population is observed (e.g., adjacent garden beds, turf, compost area, forested natural area, etc.)
Management at location where spontaneous population observed	Short description of how the site where spontaneous population is observed is routinely managed (e.g., mowing, hand-weeding, deadheading, herbicide treatments, etc.)
Distance of spontaneous population from nearest accession of same taxon*	An estimate of the distance between the spontaneous population and potentially contributing plants of the same taxon in the garden's collections or display areas that captures order of magnitude
Age of spontaneous population	Age class(es) represented in the spontaneous population (e.g., seedlings, juvenile, mature)
Health/vigor of spontaneous population	Describe if the plants in the spontaneous population appear to be distressed or thriving
Evidence of reproduction	Indicate if there is any evidence that the spontaneous population is self-replicating
Hybridization potential	Describe any known potential of the taxon to hybridize with other taxa

Table 3: Recommended data parameters for a Public Garden Sentinel List that provide characterization of the listed taxon status within the garden’s collections or displays

Parameter	Description
Accession date	Date the taxon was first accessioned
Cultivar name	Name of accession cultivar thought to be contributing to spontaneous population

Table 4: Recommended data parameters for a Public Garden Sentinel List that provide characterization of management and policy decisions

Parameter	Description
Spontaneous population management	List methods that have been used to remove or control the spontaneous population at the garden
Degree of resistance to management	Describe the level of difficulty in managing the spontaneous population relative to other spontaneously occurring taxa (e.g., easy to manage with single treatment, moderately difficult to manage with repeat treatment, or difficult to manage with limited success after repeat treatments)
Deaccession dates	Date range over which the taxon was removed from the garden collections