WASHINGTON NATURAL HERITAGE PROGRAM

The Washington Invasive Ranking System (Version 1.5)

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WASHINGTON STATE DEPARTMENT OF NATURAL RESOURCES

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ON THE COVER: A selection of the ~1200 nonnative plant species established in Washington State: *Typha angustifolia* (Narrowleaf cattail, photo by Thurman Johnson, https://www.inaturalist.org/observations/171511373), *Prunus mahaleb* (Perfumed cherry, photo by Tynan Ramm-Granberg), Bromus tectorum (Cheatgrass, photo by Thurman Johnson, https://www.inaturalist.org/observations/186062175), Utricularia inflata (Swollen bladderwort, photo by Tynan Ramm-Granberg). iNaturalist photos used under creative commons license: https://creativecommons.org/licenses/by-nc/4.0/ .

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Acknowledgements

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We appreciate the support of the Washington Department of Ecology, Washington Noxious Weed Board, and Washington Invasive Species council as this protocol was developed.

Dr. Matt Carlson (Director, Alaska Center for Conservation Science) gave excellent advice and the methods published here borrow heavily from the Invasiveness Ranking System for Non-native Plants of Alaska (Carlson et al., 2008).

We could not have completed this protocol without the contributions of our scientific advisory panel. In particular, Dr. David Giblin (Collections Manager for the University of Washington Burke Herbarium), Dr. Walter Fertig (Collections Manager for the Washington State University Marion Ownbey Herbarium), David Wilderman (Natural Areas Program Ecologist, Washington Department of Natural Resources), and Joe Rocchio (Natural Heritage Program Manager, Washington Department of Natural Resources) provided abundant feedback drawn from decades of experience.

Introduction

The need for a standardized list of invasive plant species for Washington State has long been recognized, particularly since the presence and abundance of invasive plants are some of the most frequently used measures in function and condition assessment tools (Hruby et al., 1999, 2000; Hruby & Stanley, 2000; Rocchio & Crawford, 2013; Hruby, 2014a, 2014b; Magee et al., 2019b, 2019a; Rocchio et al., 2020). Existing state lists of noxious weeds (Washington State Noxious Weed Control Board, 2020) and invasive species (Washington Invasive Species Council, 2020) serve valuable purposes, but incorporate economic impacts and other values that don't always identify the plant species that are most impactful to the ecology of natural ecosystems.

Beginning in 2021, The Washington Natural Heritage Program (WNHP) began work to assemble a consistent, defensible list of invasive plant species of Washington State for carrying out assessment, conservation, and restoration objectives. WNHP ecologists first reviewed existing invasive species ranking methods, including NatureServe's Invasive Species Assessment Protocol (Morse et al., 2004), the Invasiveness Ranking System for Nonnative Plants of Alaska (Carlson et al., 2008), the Plant Risk Evaluation tool (Conser et al., 2015), and many others (Hiebert & Stubbendieck, 1993a; Morse et al., 2004; Cal-IPC, 2006; Carlson et al., 2008; Jordan et al., 2008; Virtue et al., 2008; Magee et al., 2010; Auld & Johnson, 2014; D'hondt et al., 2015; Vanderhoeven et al., 2015; Lieurance & Flory, 2016; Roy et al., 2018; Bartz & Kowarik, 2019; González-Moreno et al., 2019; PPQ, 2019; Verbrugge et al., 2019; Vilà et al., 2019; Ries et al., 2020; Sohrabi et al., 2020; Clarke et al., 2021; Dorjee et al., 2021; Downey et al., 2022; Egawa & Matsuhashi, 2022). Following this review, we decided to adapt a new protocol that borrows largely from Morse et al. (2004) and Carlson et al. (2008).

The Washington Invasive Ranking System is a method for assessing the ecological impact of nonnative plant species in natural ecosystems of Washington State. The primary output of WIRS is an Ecological Impact rank, which indicates the degree of ecological degradation caused by a given plant in the ecosystems in which it is found. WIRS also produces supplementary information related to each plant's management difficulty, biological characteristics, and distribution and abundance.

Results from an initial application of the WIRS protocol to 71 plant taxa are presented in Ramm-Granberg & Wiebush (2024).

Methods

Overview

The Washington Invasive Ranking System produces an Ecological Impact rank and supplementary information through the following process:

- Two-question screening section (Is WIRS the appropriate tool for assessing this plant?)

- Ecological Impact Assessment
- Supplementary Information Sections:
    - Management Difficulty
    - Biological Characteristics
    - Distribution and Abundance
- Data integration workflow for instances when multiple assessments have been completed for a single plant
- Roll-up procedure

Appropriate Uses

The Washington Invasive Ranking System may be used to estimate the ecological impact of a given nonnative plant species in natural ecosystems of Washington State. It does not incorporate economic considerations such as agricultural impacts. Ranks should not be used in isolation to determine management actions. It may be necessary to combine Ecological Impact and with other tools that, for example, look more explicitly at the spatial distribution of infestations and defensible space (M. Carlson, pers comm).

Appropriate Assessors

Assessments are best performed by individuals with relevant professional expertise, particularly when assessing plant taxa for which there may be little formal, quantitative data. The most qualified assessors will have experience in diverse natural ecosystems across the state, though individuals with more localized experience may still contribute significant knowledge, particularly to the Management Difficulty section.

In trial runs of the protocol, WNHP used a crowd-sourced approach that resulted in few outside assessments. In a typical application, Washington Natural Heritage Program (WNHP) staff complete all sections of the assessment and then conduct targeted expert interviews to discuss the most subjective sections: Ecological Impact and Management Difficulty. If the WNHP staff do not have the first-hand expertise to provide initial scores for these sections, they instead walk the consulted expert through those sections and use the expert's ratings. Afterwards, WNHP sends the assessment (or batch of assessments) to a scientific advisory panel for peer-review.

Taxonomic Considerations

Hybrids should be assessed separately from parent species whenever feasible, as they may have different biological characteristics, ecological impacts, etc. In cases where taxonomy is uncertain, however, hybrids and their parent species may be assessed as a single unit. Cultivars should be treated similarly.

Subspecies, varieties, and forms should be assessed at the species level, with the exception of species that contain native and nonnative subtaxa or genotypes. For example, *Poa pratensis* contains both native and nonnative subspecies, so *Poa pratensis* ssp. *pratensis* (nonnative) should be assessed at the subspecies level.

Data Collection

WNHP staff use a custom Survey123 form to complete assessments. Readers interested in adapting these methods to their geography may reach out via Natural_Heritage_Program@dnr.wa.gov for form templates.

Screening Questions

These questions are used to determine if this protocol is appropriate for the nonnative plant under consideration.

1. Is the nonnative plant established in Washington?
    a. "Established" means that the plant has been confirmed to occur within Washington State.
    b. For nativity, refer to the Washington Flora Checklist: https://burkeherbarium.org/waflora/search.php (Weinmann et al., 2002)
    c. If **Yes**, go to question 2. If **No**, this is not the appropriate assessment method.
2. Does the plant occur in natural ecosystems.
    a. We use "natural ecosystems" in the same sense as the EcoVeg approach (Faber-Langendoen et al., 2014) and others (van der Maarel, 2005) to describe vegetation that forms spontaneously and/or is dominated by ecological processes, as opposed to cultural vegetation that is planted and/or dominated by human processes (agricultural fields, lawns, etc.). "Natural ecosystems" include any vegetation type in the natural vegetation hierarchy of the US National Vegetation Classification (Faber-Langendoen et al., 2016; USNVC, 2023), including ruderal (i.e. "semi-natural") vegetation such as abandoned fields that eventually develop the character of natural stands. See Metric 5 in the "Distribution and Abundance" section below for a list of coarse ecosystem examples to consider.
    b. If **Yes**, proceed with the assessment. If **No**, this is not the appropriate assessment method.

NOTE: This method may also be used to assess species that are invasive in adjacent states (or other regions with similar climates, etc.) and likely to occur in WA, but it has only been tested on plants that have already established in Washington. It is a prioritization tool and not a prediction tool.

Assessment Metrics

For each metric, users will select a rating (generally either High, Moderate, Low, or Insignificant), specify that there is not enough information to assess the metric (Unknown), OR indicate that they have skipped it (Not Rated). To clarify further, "Unknown" indicates that the user considered the metric, looked for information, and was unable to find sufficient data with which to make an estimate, while "Not Rated" means that the user did not consider the metric. Users will record the source of the information guiding their rating decision, how confident they are in their rating, and any additional notes. No confidence rating is assigned if the metric rating is "Unknown" or "Not Rated".

Each metric is worth a specified number of points (from 1 to 18). Point distributions generally match the NatureServe (Morse et al., 2004) and Alaska (Carlson et al., 2008) methods from which most of the metrics originate. Point distributions in the Ecological Impact Assessment and elsewhere were adjusted to emphasize specific metrics, in consultation with the scientific advisory panel (see Release Notes).

Section 1: Distribution and Abundance

The first portion of the assessment evaluates the current distribution, range trends, and potential for spread of the nonnative plant within Washington. It asks the questions, "How common is this plant? Is it spreading or infilling? Is there any suitable habitat left where it does not occur? Does it occur in many different types of ecosystems?". This section does not contribute to the Ecological Impact rank, but is completed first as an information gathering exercise that sets the stage for the Ecological Impact Assessment. The Distribution and Abundance section consists of five metrics (Table 1).

Table 1. Washington Invasive Ranking System, Section 1: Distribution and Abundance

Q1: Current Range Size in Washington
Q2: Current Trend in Total Range
Q3: Proportion of Potential Range Currently Unoccupied
Q4: Local Range Expansion or Change in Abundance
Q5: Diversity of Ecosystems Invaded

Data Sources for Distribution and Abundance

The Washington State Department of Agriculture (WSDA) is the state repository for invasive species mapping information: https://agr.wa.gov/washington-agriculture/maps/weed-distribution. However, WSDA may not compile data for every plant we wish to rank. Additional sources may be consulted, including:

- Consortium of Pacific Northwest Herbaria -- https://www.pnwherbaria.org/data.php
- Early Detection and Distribution Mapping System (EDDMapS) -- https://www.eddmaps.org/distribution
- iNaturalist – https://www.inaturalist.org
    - The most efficient way to access research grade iNaturalist data is via the Global Biodiversity Information Facility (GBIF) -- https://www.gbif.org
- Washington Department of Ecology Lakes – Environmental Data -- https://apps.ecology.wa.gov/lakes

- Perhaps the most comprehensive and up-to-date distribution data for fully aquatic plants. Observations are updated more frequently than WSDA.

Range data sources used should be cited in the assessment.

Q1. Current Range Size in Washington (15 pts)

The first metric addresses the current geographic distribution of the plant in Washington. This refers to the "generalized" range of the plant. Counties have been the standard geographic unit to date, but future assessors may choose to use ecoregions or other biogeographic systems. This metric is based on the "Current Range Size in Region" and "Proportion of Region's Biogeographic Units Invaded" metrics in the NatureServe method (Morse et al., 2004).

Rating:

- **High**: Widespread in Washington (> 50% of counties or biogeographic units).
- **Moderate**: Range covers a substantial part of Washington (26-50% counties or biogeographic units).
- **Low**: Spotty range in Washington (5-25% of counties or biogeographic units).
- **Insignificant**: Isolated occurrences in Washington (≤ 5% of counties or biogeographic units) or not yet found in the state.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: See Data Sources for Distribution and Abundance (above).

Q2. Current Trend in Total Range (12 pts)

Is the plant spreading only in some areas—which may indicate an ecological constraint—or is it spreading somewhat indiscriminately across the state? This metric evaluates the spread into new counties, watersheds, or ecoregions in the last ~10-20 years. Increases in local abundance (infilling) or spread into new ecosystem types is addressed in subsequent metrics. This metric is based on the "Current Trend in Total Range Within The Region" metric in the NatureServe method (Morse et al., 2004) and "Recent trend in total area infested within state" in the California Invasive Plant Council (Cal-IPC) method (Cal-IPC, 2006).

Rating:

- **High**: Range consistently expanding, and/or spreading in most or all areas.
- **Moderate**: Range increasing in some areas but not most or all.
- **Low**: Range stable, or areas of range contraction balancing areas of expansion.
- **Insignificant**: Range decreasing.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Data availability for range trends is inconsistent across taxa. If you are aware of quantitative data for the plant being assessed, use that information to choose the appropriate rating.

However, clear trends are difficult to derive from collections, citizen science efforts, etc. Otherwise, direct observations/experience/professional judgment may be used.

Q3. Proportion of Potential Range Currently Unoccupied (3 pts)

How much of the potential generalized range in Washington is currently unoccupied? In other words, are there counties in WA where this plant does not yet occur, but are likely to be habitable? This metric assumes current climate and disturbance regimes. This protocol is *not* built to directly assess impacts of projected *future* climates. However, if the plant has the potential to be more/less impactful in specific scenarios, please describe this potential in the metric notes. This metric is directly adapted from the NatureServe method (Morse et al., 2004).

Rating:

- **High**: Less than 10% of potential range currently occupied.
- **Moderate**: 10-30% of potential range currently occupied.
- **Low**: 30-90% of potential range currently occupied.
- **Insignificant**: Greater than 90% of potential range currently occupied.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Consult the mapping resources listed above and incorporate your direct observations/experience/professional judgment to generate an estimate. Some species may have published habitat suitability/potential range models to draw from (e.g., *Tamarix ramosissima*).

Q4. Local Range Expansion or Change in Abundance (12 pts)

Is the plant increasing in abundance (i.e., infilling as measured by cover, density, frequency, etc.) *within* its current range in Washington based on trends of the past 10-20 years? Users may report specific areas of rapid expansion/abundance increase in the notes field. This metric is directly adapted from the NatureServe method (Morse et al., 2004).

Rating:

- **High**: Local range and/or abundance is increasing rapidly (e.g., the area covered within occupied counties has doubled in the last 10 years) and/or abundance is increasing significantly (by >25%) in >75% of the area that it has invaded.
- **Moderate**: Local range and/or abundance is expanding at a moderate rate (e.g., the area covered within occupied counties has increased by >50% in the last 10 years) and/or abundance is increasing significantly (by >25% of current values) in 25%-75% of the area that it has already been invaded.
- **Low**: Local range within occupied counties is expanding slowly and/or abundance is increasing significantly (by >25% of current values) in only a small portion (<25%) of the areas that have already been invaded.
- **Insignificant**: Species abundance and local range is stable within occupied counties OR all potential habitat is already invaded.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Data availability for local abundance trends is inconsistent across taxa. If you are aware of quantitative data for the plant being assessed, use that information to choose the appropriate rating. Otherwise, direct observations/experience/professional judgment may be used.

Q5. Diversity of Ecosystems Invaded (3 pts)

How many of the ecosystem types listed below are known or likely to be invaded by this plant under normal circumstances? Plants that have previously invaded a diverse assortment of ecosystems are more likely to invade new types to which they spread. Ecosystems in which the plant is only sporadically present, or in which the plant is only found along trails/roadsides/etc. should not be counted. USNVC National Vegetation Classification Subbiomes are the standard classification unit. This metric is based on the "Diversity of Habitats or Ecological Systems Invaded in Region" metric in the NatureServe method (Morse et al., 2004) and "Ecological amplitude" in Cal-IPC (2006).

Ecosystems (USNVC Subbiomes):

Uplands

- Forest & Woodland
- Grassland & Shrubland
- Semi-desert (Shrub-steppe + Semi-desert grasslands)
- Alpine & Tundra
- Marine Coastal Shore (Shrublands & Grasslands)
- Open Rock

Wetlands

- Emergent Open Wetland (Freshwater Marsh, Wet Meadow & Shrub Wetlands + Inland Salt Marshes)
- Coastal Brackish Tidal Wetland (Salt Marsh)
- Bog & Fen
- Forested Wetland
- Marine Seagrass & Kelp Bed
- Shallow Water Wetland (Aquatic Vegetation)

Rating:

- **High**: Many (4+) distinct ecosystems invaded.
- **Moderate**: Moderate number (3) of distinct ecosystems invaded OR both wetland and upland ecosystems are invaded.
- **Low**: Small number (1-2) of ecosystems.
- **Insignificant**: Only ruderal/semi-natural ecosystems (e.g., old fields) are invaded.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Some plants may have detailed literature descriptions of the range of habitats in which they are found, but habitat descriptions are generally not comprehensive (e.g., descriptions of *Bromus tectorum* may mention invasion of shrub-steppe, but not dry grasslands and woodlands). Be sure to supplement any sources with your personal experience/observations/professional judgement. Collection records and other observations may also be consulted, although it may be difficult to determine whether the plant is only incidentally present and/or which USNVC Subbiome is represented.

Section 2: Biological Characteristics

This section evaluates traits that may allow the plant to disperse into, establish, and spread in natural areas. Such traits are commonly associated with "invasiveness" (Carlson et al., 2008). This section also contributes to the Ecological Impact rank when the confidence rank for that section is Low. In such cases, the biological characteristics of the plant help supplement the determination of likely ecological impact. See the "Calculating the Ecological Impact Rank" below. As with Distribution & Abundance, this section an information gathering exercise that sets the stage for the Ecological Impact Assessment. The Biological Characteristics section consists of 12 metrics (Table 2).

Table 2. Washington Invasive Ranking System, Section 2: Biological Characteristics.

Q6: Aggressive Mode of Reproduction
Q7: Innate Potential for Long-Distance Dispersal
Q8: Potential to be Spread by Human Activities
Q9: Allelopathy
Q10: Competitive for Limiting Abiotic Factors
Q11: Growth Form
Q12: Germination Requirements
Q13: Invasiveness of Other Plants in Genus
Q14: Shade Tolerance
Q15: Disturbance Tolerance
Q16: Propagule Persistence
Q17: Palatability

Data Sources for Biological Characteristics

There are many species abstract repositories that may be useful. A subset includes:

- The Fire Effects Information System -- https://www.feis-crs.org/feis/faces/index.xhtml
- The Alaska Center for Conservation Science (ACCS) Non-Native Plant Species List -- https://accs.uaa.alaska.edu/invasive-species/non-native-plant-species-list
- The Cal-IPC Inventory -- https://www.cal-ipc.org/plants/inventory/

Data sources used should be cited as part of each relevant metric in the assessment.

Q6. Aggressive Mode of Reproduction (3 pts)

Does the plant spread rapidly via vegetative reproduction, produce many seeds, or otherwise have any combination of traits listed below? This metric is based on the "Mode of reproduction" metric in the Alaska method (Carlson et al., 2008) and the Southwest Exotic Plants system (Hiebert & Stubbendieck, 1993b), "Reproductive Characteristics" from the NatureServe method (Morse et al., 2004), "Innate reproductive potential" from Cal-IPC (2006), and several propagule/reproduction-related metrics in the Australian Weed Risk Assessment model (WRA) (Pheloung et al., 1999a) and California's Plant Risk Evaluation tool (PRE) (Conser et al., 2015). Additional background from Pysek (1997). The following reproductive characteristics are typical of invasive plants:

- Produces over 1,000 seeds or spores per plant annually.
- Reproduces more than once per year.
- Grows more rapidly to reproductive maturity than most plants of its lifeform.
- Reproduces readily both vegetatively and by seed or spores.
- Has quickly spreading rhizomes or stolons that may root at nodes.
- Resprouts readily when broken, cut, grazed, or burned.
- Fragments easily, with fragments capable of dispersing and establishing.
- Has other comparable reproductive factors suggesting potential aggressiveness

Rating:

- **Yes**
- **No**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgement.

Q7. Innate Potential for Long-Distance Dispersal (3 pts)

Does the plant have an innate potential for long-distance dispersal, regardless of human intervention? Examples of innate long-distance dispersal mechanisms include fleshy fruits that promote bird dispersal, barbs or other mechanisms that stick to animal hair, buoyant seeds that facilitate water dispersal, awns that facilitate wind dispersal, etc. This metric is based on the "Innate potential for long-distance dispersal" metric in the Alaska method (Carlson et al., 2008), "Long-Distance Dispersal Potential Within Region" from the NatureServe method (Morse et al., 2004), and several dispersal related metrics in WRA (Pheloung et al., 1999a). Additional background from Rejmánek & Richardson (1996).

Rating:

- **Yes**
- **No**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgement.

Q8. Potential to be Spread by Human Activities (3 pts)

Is the plant likely to be spread either directly or indirectly by human activities? Possible mechanisms include commercial sales, use as forage, revegetation projects, spread along highways, transport via agricultural activities or contaminated boats, etc. This metric is based on the "Potential to be spread by human activities" metric in the Alaska method (Carlson et al., 2008), "Potential for human-caused dispersal" from Cal-IPC (2006), and "Propagules dispersed intentionally by people" in WRA (Pheloung et al., 1999a). Additional background from: (Mack, 2000; Kolar & Lodge, 2001; Rejmánek, 2001; Mack & Erneberg, 2002).

Rating:

- **Yes**
- **No**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgement.

Q9. Allelopathy (1 pt)

Is the plant known to be allelopathic, providing a competitive advantage and making it more likely to cause long term ecosystem alterations? The term "allelopathic" is used here in a broad sense to refer to any plant that adds harmful chemical agents to the environment. If the plant produces compounds that are thought to be allelopathic, but allelopathy has yet to be demonstrated for this taxon, select "Yes" and "Low Confidence". This metric is adapted from the Alaska method (Carlson et al., 2008), WRA (Pheloung et al., 1999a), and PPQ (2019). It is also similar to "Excretes salts or toxins" in the US Environmental Protection Agency's Index of Alien Impact (Magee et al., 2010).

Rating:

- **Yes**
- **No**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review (unlikely to be reliably determined by direct experience/observations).

Q10. Competitive for Limiting Abiotic Factors (4 pts)

Is the plant competitive for limited water or nutrients in its environment (abiotic factors). Competitive advantages may be gained through efficient use of limited abiotic factors, accessing water or nutrients that are inaccessible to other plants (e.g., deep tap root), timing (e.g., winter annuals or evergreens taking advantage of moist conditions when other species may remain dormant), or other means. If the plant is a nitrogen fixer, select "Yes". Competition for sunlight is addressed in the following metric. This metric is based on the "Competitive ability" metric in the

Alaska method (Carlson et al., 2008) and the Southwest Exotic Plants system (Hiebert & Stubbendieck, 1993b). Additional background from Pheloung et al. (1999b).

Rating:

- **Yes**
- **No**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgement.

Q11. Growth Form (2 pts)

Does the plant form dense thickets, have a climbing or smothering growth habit, or otherwise outcompete native vegetation for sunlight for extended periods of time? Some exotic plant populations establish as a dense flush, but are relatively quickly replaced by other species, such plants are not considered to have an invasive growth form in this assessment and should be rated as "No". This metric is based on the "Forms dense thickets, climbing or smothering growth habit, or otherwise taller than the surrounding vegetation" metric in the Alaska method (Carlson et al., 2008), "Does this plant overtop and/or smother surrounding vegetation?" and "Does the plant produce impenetrable thickets, blocking or slowing movement?" in PRE (Conser et al., 2015), and "Climbing or smothering growth habit" in WRA (Pheloung et al., 1999a) and PPQ (2019). Additional background from: (Rejmanek & Richardson, 1996; Goodwin et al., 1999).

Rating:

- **Yes**
- **No**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgement.

Q12. Germination Requirements (3 pts)

Is this plant able to germinate without natural or anthropogenic disturbance providing open soil? Select "Yes" if this species may germinate in natural ecosystems in a variety of conditions. Select No if this species only germinates amid other vegetation in a narrow range of conditions. This metric is based on the "Germination requirements" metric in the Alaska method (Carlson et al., 2008) and the Southwest Exotic Plants system (Hiebert & Stubbendieck, 1993b) and "Ability to establish without anthropogenic or natural disturbance" in Cal-IPC (2006).

Rating:

- **Yes**
- **No**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgement.

Q13. Invasiveness of Other Plants in Genus (3 pts)

Are there other nonnative plants in this genus that are invasive in Washington or other non-native regions where they are found? You may also consider whether there are plants in this genus that are *native* to Washington, but invasive in other locales. Similarly, consider other plants in this genus that act as native increasers (i.e., "native invasives", aggressive natives, successful competitors) (Richardson et al., 2000). If other plants in this genus have been rated using this protocol, consider an Ecological Impact rank of Moderate or higher to be "invasive" for the purposes of this metric. If the plant is a monotypic species (i.e., the only species in the genus) select "Not Rated". This metric is based on the "Other species in the genus invasive in Alaska or elsewhere" metric in the Alaska method (Carlson et al., 2008) and "Are other species of the same genus invasive in other areas with a similar climate?" in PRE (Conser et al., 2015). Additional background from Rejmánek (1999).

Rating:

- **Yes**
- **No**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgement. Assessments of other species in the genus using this protocol.

Q14. Shade Tolerance (2 pts)

Is the plant able to persist under closed overstory canopies? This metric is based on the "Is a shade tolerant plant at some stage of its life cycle" metric in WRA (Pheloung et al., 1999a), "Wide light regime" in the EPA Index of Alien Impact (Magee et al., 2010), and "Shade tolerant at some stage of life cycle" in PPQ (2019).

Rating:

- **High**: Shade tolerant and persists under closed overstory canopies.
- **Moderate**: Tolerates partial shade.
- **Low/Insignificant**: Shade intolerant and does not persist under closed overstory canopies.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgement.

Q15. Disturbance Tolerance (2 pts)

Is the plant's response to disturbance markedly different than other plants in the same ecosystem? Does that response provide a competitive advantage? For example, does this plant resprout readily following fires, while native plants in the ecosystem do not? This metric is based on the "Tolerates or benefits from mutilation, cultivation or fire" metric in WRA (Pheloung et al., 1999a) and "Is

the plant noted as being highly flammable and/or promotes fire and/or changes fire regimes?" in PRE (Conser et al., 2015).

Rating:

- **Yes**
- **No**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgement.

Q16. Propagule Persistence (3 pts)

How long do seeds (or other reproductive structures such as vegetative propagules) of this plant persist? This metric is based on the "Seed banks" and "Vegetative regeneration" metrics in the Alaska method (Carlson et al., 2008), "Evidence that a persistent ([1 year) propagule bank (seed bank) is formed" in PPQ (2019), "Dispersal over time" in the EPA Index of Alien Impact (Magee et al., 2010), and "Evidence that a persistent propagule bank is formed" in WRA (Pheloung et al., 1999a). Additional background from Auld & Johnson (2014).

Rating:

- **>20 years**
- **>10 years**
- **>5 years**
- **<5 years**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Most likely from a literature review, but potentially observable via direct experience.

Q17. Palatability (1 pt)

Is this plant unpalatable to most grazing/browsing animals for all or part of its lifespan? Plants with low palatability are likely to increase under grazing pressure. Unpalatability may be due to coarseness, poison, thorns, etc. Select "Yes" if the plant is only eaten under extreme circumstances, such as targeted invasive species treatments with goats. Management implications of palatability are considered in the Management Difficulty metrics below. This metric is based on the "Grazing tolerant or increaser" metric in the EPA Index of Alien Impact (Magee et al., 2010) and "Unpalatable to grazing animals" in WRA (Pheloung et al., 1999a).

Rating:

- **Yes, the plant is unpalatable.**
- **No, the plant is palatable.**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review (range management documents are often useful) and direct experience/observations/professional judgement.

Section 3: Ecological Impact Assessment

This section evaluates the impact of the plant on ecosystem structure, composition, abiotic processes, and individual species, as well as the observed ability of the plant to invade natural ecosystems. Because the Washington Invasive Ranking System focuses on the observed impact of nonnative species on biodiversity and ecosystem condition, this section is the core of the assessment. For plants that receive a Low confidence rank in Ecological Impact, the Biological Characteristics section is also factored in. See "Calculating the Ecological Impact Rank" (below) for more information. The Ecological Impact section consists of six metrics (Table 3).

Table 3. Washington Invasive Ranking System, Section 3: Ecological Impact.

Q18: Impact on Ecosystem Abiotic Processes
Q19: Impact on Ecosystem Structure
Q20: Impact on Ecosystem Composition
Q21: Impact on Particular Native Species
Q22: Observed Ability to Invade Undisturbed Ecosystems
Q23: Observed Ability to Invade Naturally Disturbed Ecosystems

Data Sources for Ecological Impact

This section relies heavily on the user's "best professional judgment", but journal articles, grey literature, and species abstracts like those found on the Fire Effects Information System (https://www.feis-crs.org/feis/faces/index.xhtml) may be useful for drawing ecological connections. Other sources noted in the Biological Characteristics section may also be useful.

Data sources used should be cited as part of each relevant metric in the assessment.

Q18. Impact on Ecosystem Abiotic Processes (9 pts)

What is the impact of the plant on abiotic processes and attributes in the ecosystem? Some nonnative plants can alter the natural range and variability of ecosystem processes and attributes in ways that impact the survival and reproduction of native species. This metric is based on the "Impact on Ecosystem Processes and System-Wide Parameters" metric from the NatureServe method (Morse et al., 2004), "Impact on abiotic ecosystem processes (e.g. hydrology, fire, nutrient cycling)" in Cal-IPC (2006), "Change ecosystem processes and parameters that affect other species" in PPQ (2019), "Effect on natural processes and character" in the Southwest Exotic Plants system (Hiebert & Stubbendieck, 1993b), and "Impact on Natural Ecosystem Processes" in the Alaska method (Carlson et al., 2008).

Examples of abiotic ecosystem processes and attributes include:

- Fire – Does the plant alter the occurrence, frequency, and/or intensity of fire?
- Geomorphology – Does the plant alter erosion or sedimentation rates, as in stabilization of mobile dunes by *Ammophila arenaria*?
- Hydrology – Does the plant impact the hydrologic regime/water table, e.g., lowering water levels in wetland systems through rapid transpiration.
- Nutrient Dynamics – Does the plant impact nutrient cycling in the ecosystem? For example, nonnative nitrogen-fixing plants that invade ecosystems with few native nitrogen fixers can increase soil nitrogen to the benefit of other nonnative invaders.
- Light Availability – Does invasion by this plant produce a stand-wide reduction in light availability? For example, some aquatic plants may cover entire bodies of water that may otherwise be open. Invasive trees may alter the light availability in the understory.
- Chemistry – Does invasion by the plant change soil or water pH or electroconductivity?

Rating:

- **High**: The plant causes major, potentially irreversible, alteration or disruption of abiotic ecosystem processes and attributes.
- **Moderate**: Moderate impacts to abiotic ecosystem processes and attributes.
- **Low**: Perceivable, but minor impacts to abiotic ecosystem processes and attributes.
- **Insignificant**: No measurable impact on abiotic ecosystem processes and attributes.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgment.

Q19. Impact on Ecosystem Structure (12 pts)

What is the impact of the plant on ecosystem structure? This metric is directly adapted from the NatureServe method (Morse et al., 2004). Additional background from: (Cal-IPC, 2006; Carlson et al., 2008; PPQ, 2019).

Examples of structural changes include:

- Conversion of grasslands to shrublands, shrublands to forests, aquatic vegetation to emergent marshes, etc. See the list of USNVC Subbiomes in Q5.
- Changes in canopy structure that alter or eliminate understory vegetation.
- Creation of a new vegetation layer or elimination of an existing layer.
- Changes in density or total cover.

Rating:

- **High**: The plant causes major alterations to ecosystem structure, such as conversion to a different USNVC Subbiome.
- **Moderate**: Moderate structural alterations, such as conversion from bunchgrass-dominated to rhizomatous grassland or development of an additional vegetation layer/subcanopy.
- **Low**: Minor structural impacts, such as changes in density or total cover with a given vegetation layer.
- **Insignificant**: No impact. The plant establishes within existing vegetation layers without altering structure.
- **Unknown**: Not enough information.

- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgment.

Q20. Impact on Ecosystem Composition (9 pts)

What is the impact of the plant on the species composition of the ecosystem? Some nonnative plants impact the relative abundance and diversity of native species or alter successional patterns. This metric is directly adapted from the NatureServe method (Morse et al., 2004). Additional background from: (Cal-IPC, 2006; Carlson et al., 2008; Conser et al., 2015).

Examples of compositional changes include:

- Reduction or extirpation of native plant, animal, fungal, or other species through increased shade, competition, allelopathy, or other means.
- Elimination or reduction in cover of diagnostic dominant plant species.
- Reduced native species diversity.
- Increased proportion of other nonnative plants in the ecosystem.
- Suppression of successional/climax species.

Rating:

- **High**: The plant has major impacts on ecosystem composition, such as elimination of diagnostic dominant plant species or significant reduction in native species diversity.
- **Moderate**: Moderate compositional impacts, such as reduction in the cover of diagnostic dominant species or moderate reduction in native species diversity.
- **Low**: Observable but minor compositional impacts, such as reduced recruitment of one or more diagnostic dominant species, likely resulting in reduction in long-term abundance of that species, or minor reduction in native species diversity.
- **Insignificant**: No impact. No known alterations to species composition, cover, diversity, etc.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgment.

Q21. Impact on Particular Native Species (3 pts)

Does the plant disproportionately negatively impact particular native plant, animal, fungal, or other species (at least at some sites)? Such impacts may occur even if alterations to broader ecosystem structure or composition are minimal. Note that this metric focuses on unusual, disproportionate impacts on individual native species, and should not be used to catalog long lists of species that are more generally impacted in rough proportion to the local abundance of the nonnative plant. For many plants, individual impacts will be "Unknown". This metric is based on the "Impact on Individual Native Plant or Animal Species" metric from the NatureServe method (Morse et al., 2004), and several separate metrics in the Harmonia+ method (D'hondt et al., 2015).

Examples of disproportionate individual impacts to one or more native species include:

- Strong competition with a particular native species.
- Hybridization with a particular native species.

- Parasitism upon a particular native species.
- Poisoning of a particular native species.
- Serving as a host for nonnative diseases that impact a particular native species.
- Distraction of pollinators that would otherwise interact with a particular native species.

Rating:
- **High**: The plant has major, disproportionate negative impacts on one or more particular native species.
- **Moderate**: Moderate negative impacts on one or more particular native species.
- **Low**: Occasional negative impacts on one or more particular native species. Some native species may experience positive impacts.
- **Insignificant**: Rare or no negative impacts on particular native species (or impacts are generally positive).
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Most likely from a literature review, but potentially observable via direct experience.

Q22. Observed Ability to Invade Undisturbed Ecosystems (15 pts)

Has the plant been observed to invade relatively undisturbed, mature natural vegetation with intact substrates? Plants rated highly in this metric typically have a "competitive" evolutionary strategy (Grime, 1977). This metric is related to other metrics such as "Germination Requirements", but is less theoretical—the focus here is on observed invasion of relatively intact ecosystems. This metric is based on the "Inherent Ability to Invade Conservation Areas and Other Native Species Habitats" metric from the NatureServe method (Morse et al., 2004) and "Invades in absence of human disturbance" from the EPA Index of Alien Impact (Magee et al., 2010).

Rating:
- **High**: The plant regularly establishes and persists in undisturbed, otherwise healthy, late-successional or mature native vegetation with intact substates.
- **Moderate**: Occasionally establishes and persists in mid-successional native vegetation, but may establish in late-successional or mature vegetation following minor one-time or recurrent disturbances such as tree fall, social trails, or streambank erosion. The plant rarely establishes in undisturbed portions of intact, mature native vegetation.
- **Low**: Occasionally establishes and persists in areas where major natural or human-caused disturbance has occurred in the previous 20 years (e.g., fires, clearcuts, major windthrow, landslides, utility corridors, heavy grazing), but seldom if ever in undisturbed areas or areas with only minor disturbance.
- **Insignificant**: Not known to spread to and persist in conservation areas or other native ecosystems on its own.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgment. Potentially supplemented by precise mapping data (see Section 1), collections, or citizen science observations.

Q23. Observed Ability to Invade Naturally Disturbed Ecosystems (3 pts)

Has the plant been observed to invade ecosystems that are naturally maintained by regular disturbance? Many ecosystems in Washington experience regular disturbance when operating within their natural range of variability. Natural disturbances may include fire (e.g., grasslands), flooding (e.g., riparian systems), landslides (e.g., cliff vegetation and landslide forests), avalanches (e.g., subalpine shrublands), shifting sand (e.g., coastal dune vegetation), and others. Nonnative plants that invade and persist under such disturbance regimes typically have a "ruderal" evolutionary strategy (Grime, 1977). Invasion of anthropogenically disturbed ecosystems is *not* considered here. This metric is very similar to the previous one, but the focus here is on observed invasion of ecosystems operating within naturally frequent disturbance regimes.

Rating:

- **Yes**
- **No**
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Literature review and direct experience/observations/professional judgment. Potentially supplemented by precise mapping data (see Section 1), collections, or citizen science observations.

Section 4: Management Difficulty

Unlike similar protocols, management difficulty is separated from ecological impact in this protocol and reported as a separate rank. The assessment of management difficulty consists of five metrics (Table 4).

Table 4. Washington Invasive Ranking System, Section 4: Management Difficulty

Q24: General Management Difficulty
Q25: Minimum Time Commitment
Q26: Impacts of Management on Native Species
Q27: Accessibility of Invaded Areas
Q28: Sociopolitical Implications of Management

Data Sources for Management Difficulty

As with the Ecological Impact section, the Management Difficulty section relies heavily on the user's "best professional judgment", but the Fire Effects Information System (https://www.feis-crs.org/feis/faces/index.xhtml) often has valuable information about control methods and difficulty. Other resources such as the Washington Noxious Weed Control Board's species abstracts (https://www.nwcb.wa.gov/) and the Pacific Northwest Weed Management Handbook (https://pnwhandbooks.org/weed) may also be useful.

Data sources used should be cited as part of each relevant metric in the assessment.

Q24. General Management Difficulty (18 pts)

How difficult is it to control an established stand of this plant with the management methods and tools that are currently available? Consider both the difficulty of control and the state of knowledge regarding the management of the plant. Potential unavailability of some methods/tools for social or other reasons is addressed in the "Sociopolitical Implications of Management" metric below. This metric is directly adapted from the NatureServe method (Morse et al., 2004). Additional background from: (Hiebert & Stubbendieck, 1993a; Pheloung et al., 1999a; Carlson et al., 2008).

Rating:

- **High**: Control of this plant typically requires a major, long-term investment of human and/or financial resources OR is not possible with available technology and knowledge.
- **Moderate**: Control requires a major, short-term investment of human and/or financial resources, or a moderate long-term investment.
- **Low**: Control is relatively easy and inexpensive, requiring only a minor investment of human and/or financial resources.
- **Insignificant**: Active management/control is unnecessary. For example, it does not persist in the absence of ongoing human disturbance.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Direct experience/observations/professional judgment and literature review.

Q25. Minimum Time Commitment (15 pts)

What is the minimum time commitment needed to control this plant? For this exercise, assume a 1-hectare (~2.5 acre) site in which it is abundant or well-established. Include time for the initial survey, follow-up treatments, focused monitoring, and ecosystem restoration. For this metric, "control" is defined as a reduction to acceptable levels that can be maintained with little effort beyond ambient monitoring (i.e., the native ecosystem is on a stable restoration trajectory). With some exceptions, the minimum time commitment typically cannot be shorter than the length of time that the plant's propagules remain viable (see Q16). This metric is directly adapted from the NatureServe method (Morse et al., 2004). Additional background from: (Pheloung et al., 1999a; Carlson et al., 2008).

Rating:

- **High**: Control of this plant requires at least 10 years OR is only possible with constant management (this may be due to persistence or near-constant reintroduction) OR is not possible with available technology and knowledge.
- **Moderate**: Control requires 5-10 years.
- **Low**: Control requires 2-5 years.
- **Insignificant**: Control can usually be accomplished within 2 years OR active management/control is unnecessary.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Direct experience/observations/professional judgment and literature review.

Q26. Impacts of Management on Native Species (15 pts)

What is the degree of collateral damage (i.e., non-target damage) to native species when implementing effective management of this plant? This metric is directly adapted from the NatureServe method (Morse et al., 2004).

Rating:

- **High**: Collateral damage from management is often severe. The only effective methods for controlling this plant cause significant and persistent reductions in the abundance of native species >75% of the time.
- **Moderate**: Collateral damage from management is usually moderate. Effective control causes significant and persistent reductions in the abundance of native species 25-75% of the time.
- **Low**: Collateral damage from management is usually minor. Effective control causes significant and persistent reductions in the abundance of native species <25% of the time.
- **Insignificant**: Collateral damage from effective management is insignificant and/or rare OR causes only ephemeral reductions in the abundance of native species (lasting <2 years).
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Direct experience/observations/professional judgment and literature review.

Q27. Inaccessibility of Invaded Areas (3 pts)

How difficult is it to access invaded areas? Inaccessibility may be due to terrain (e.g., coastal bluffs), remoteness (e.g., roadless areas), deep water, or any other factors that make it difficult to initiate management. This metric does *not* address access difficulty caused by private property or other jurisdictional issues. This metric is directly adapted from the NatureServe method (Morse et al., 2004). Additional background from: (Hiebert & Stubbendieck, 1993a; Pheloung et al., 1999a).

Rating:

- **High**: Accessibility problems are significant. Many invaded areas (hundreds of thousands of acres, or >30% of the infested area) are not accessible for treatment.
- **Moderate**: Accessibility problems are moderate. A substantial percentage of the area invaded by this plant is inaccessible (tens of thousands of acres, or 5-30% of the infested area).
- **Low**: Accessibility problems are minor. Only a small percentage of the area invaded by this plant is inaccessible (thousands of acres or <5% of the infested area).
- **Insignificant**: Accessibility is not a problem. Little or none of the infested area is inaccessible.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Direct experience/observations/professional judgment and literature review, supplemented by data sources from the Distribution and Abundance section.

Q28. Sociopolitical Implications of Management (6 pts)

Are there social, political, cultural, economic, or other non-ecological complications that impact one's ability to implement management of this plant? For example, land managers may receive pushback from the public when managing ornamental or fruit-bearing plants, or plants that are

useful for forage/grazing. Similarly, there may be public objection to intensive herbicide treatment of highly visible populations (more common with foliar application than with other methods such as cut-stump). This metric addresses public opposition to management—the human impact on spread and cultivation of the plant is considered in the "Potential to be Spread by Humans" metric.

Rating:

- **High**: Management is very difficult to initiate or maintain due to public opposition. Treatment is opposed in most areas and is not restricted to specific locales or highly visible populations.
- **Moderate/Low**: There is some public opposition to management, but it may be limited to specific locales (e.g., public lands with grazing leases) or highly visible populations (e.g., an escaped ornamental in a public park). Treatment may still be initiated with sufficient public engagement and remains possible in other areas without engagement.
- **Insignificant**: There is little or no public opposition to treatment.
- **Unknown**: Not enough information.
- **Not Rated**: Did not consider this metric.

Data Sources: Direct experience/observations/professional judgment and literature review.

Outputs

Ecological Impact Rank

The Washington Invasive Ranking System (WIRS) assesses nonnative plants relative to their impact on biodiversity and ecosystem condition. The primary output of WIRS is an Ecological Impact rank, which indicates the degree of ecological degradation caused by a given plant in the ecosystems in which it is found.

Calculating the Ecological Impact Rank

Each metric has a maximum possible score (1 to 18), with each potential rating a proportionate amount of that maximum. For example, the potential ratings for a hypothetical metric worth 15 points may be "high" (15 points), "moderate" (10 points), "low" (5 points), and "insignificant" (0 points). Points for each metric rating are summed and divided by the points possible in that section (Unknown and Not Rated metrics are excluded) to determine the overall score.

Assessors also assign a confidence rating to each metric (Metric Unknown or Not Rated = 0 pts, Low = 0 pts, Moderate = 1 pt, High = 2 pts). Points for each confidence rating are summed and divided by the points possible for that section. Unknown and Not Rated metrics are included for the calculation of confidence because they represent uncertainty about the plant. Additionally, if Q22 is "unknown" or "not rated" or if Q18, Q19, AND Q20 are Unknown or Not Rated, then the Ecological Impact confidence rank is automatically set to Low.

Calculation of the Ecological Impact score/rank depends on the confidence in the Ecological Impact metric ratings. If the overall confidence in the Ecological Impact metric ratings is Moderate to High, then the calculation is simply the total points from rated metrics divided by the total points possible (Unknown and Not Rated metrics are excluded) (Table 5, Figure 1). If the confidence

rating for the Ecological Impact metric ratings is Low, we average that calculation with the overall score from the Biological Characteristics section.

Table 5. Overview of Ecological Impact score calculation. Calculation varies depending on confidence ratings and the number of unrated metrics in the Ecological Impact Assessment. Scores are then converted to ranks: ≤ 30% = Insignificant Impact, 31-50% = Low Impact, 51-70% = Moderate Impact, >70% = High Impact.

Calculating the Ecological Impact Rank	
Ecological Impact Metric	**Points Possible**
Q18: Impact on Ecosystem Abiotic Processes	9
Q19: Impact on Ecosystem Structure	12
Q20: Impact on Ecosystem Composition	9
Q21: Impact on Particular Native Species	3
Q22: Observed Ability to Invade Undisturbed Ecosystems	15
Q23: Observed Ability to Invade Naturally Disturbed Ecosystems	3
Ecological Impact Calculation (Option 1)	
Is Q18, Q19, OR Q20 rated? **Is Q22 rated?** **Is overall confidence for Q18:23 Medium or High?**	
Yes to all of the above	**No to one or all of the above**
Sum of Q18:Q23 Ratings / Sum of Q18:23 Points Possible [Rated Metrics Only]	Complete Biological Characteristics section and recalculate below
Biological Characteristics Metric	**Points Possible**
Q6: Aggressive Mode of Reproduction	3
Q7: Innate Potential for Long-Distance Dispersal	3
Q8: Potential to be Spread by Human Activities	3
Q9: Allelopathy	1
Q10: Competitive for Limiting Abiotic Factors	3
Q11: Growth Form	2
Q12: Germination Requirements	3
Q13: Invasiveness of Other Plants in Genus	3
Q14: Shade Tolerance	2
Q15: Disturbance Tolerance	2
Q16: Propagule Persistence	3
Q17: Palatability	1
Ecological Impact Calculation (Option 2)	
Q18, Q19, and Q20 NOT rated **Q22 NOT rated** **Overall confidence for Q18:23 is Low**	
Sum of Q18:Q23 Ratings / Sum of Q18:23 Points Possible [Rated Metrics Only] * 0.5 + Sum of Q6:Q17 Ratings / Sum of Q6:17 Points Possible [Rated Metrics Only] * 0.5	

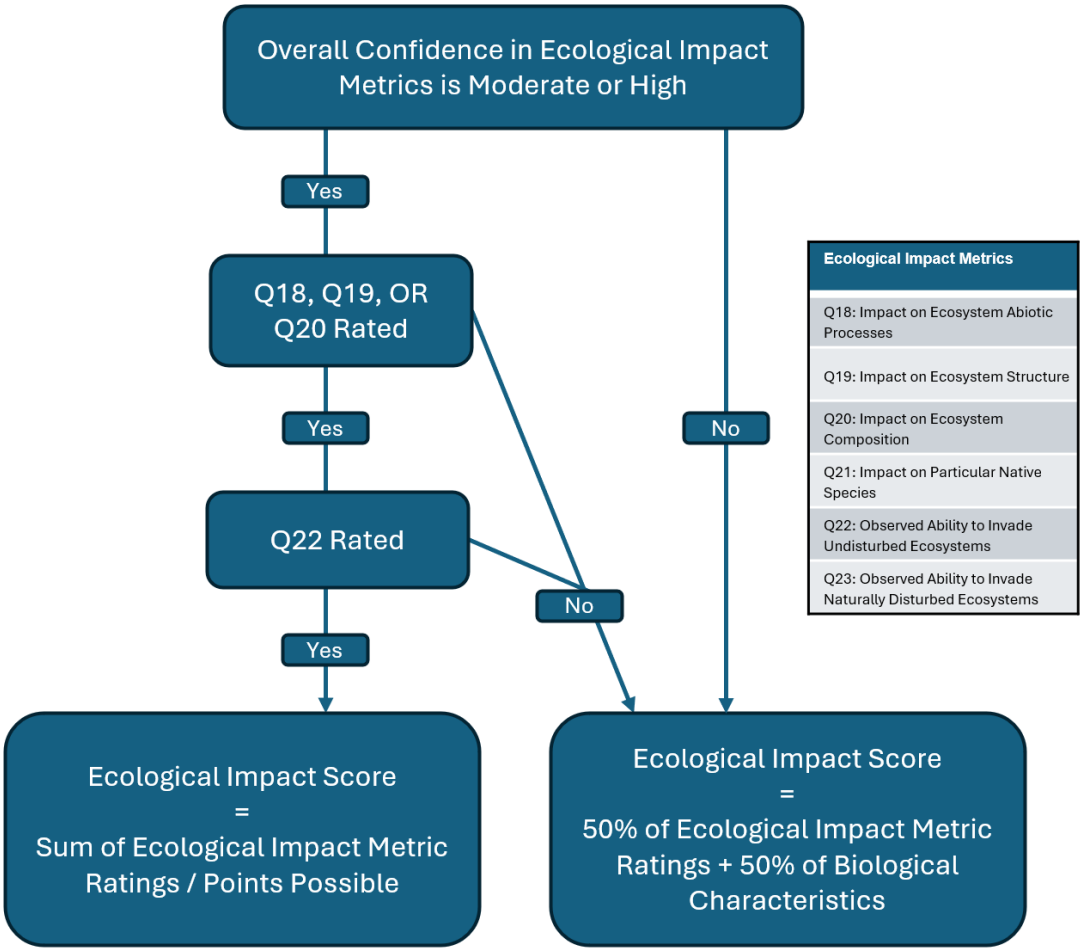


Figure 1. Flow chart demonstrating calculation of Ecological Impact rank. Scores are then converted to ranks: ≤ 30% = Insignificant Impact, 31-50% = Low Impact, 51-70% = Moderate Impact, >70% = High Impact.

Scores are converted to the following Ecological Impact ranks (rounded to the nearest whole percentage point):

- ≤ 30 = Insignificant Impact
- 31-50 = Low Impact
- 51-70 = Moderate Impact
- >70 = High Impact

Confidence scores are converted to the following confidence ranks (rounded to the nearest .01%):

- 0-33.33 = Low
- 33.34-66.66 = Moderate
- >66.66 = High

Note that the divisions between these ranks (modified slightly from Morse et al. (2004)) are largely arbitrary. The conversion to ranks, however, may help ameliorate the false sense of precision provided by numerical scores derived from largely qualitative data.

Supplementary Information

WIRS also produces supplementary information related to each plant's management difficulty, biological characteristics, and distribution and abundance.

Management Difficulty Rank

Some plants may cause significant ecological impacts if left unchecked, but are relatively easy to control, while others require major investments of time and resources to control—or may be impractical to control at all. The assessment of management difficulty provides another means of prioritizing action among exotic plants that may have the same ecological impact. For example, land managers with limited resources may choose to target a plant species with a high ecological impact but a low management difficulty. On the other hand, managers may choose to target plant species with high management difficulty while populations are small, to avoid costly and/or impractical interventions down the line.

Biological Characteristics of Invasiveness

This result synthesizes the number of traits a plant has that may allow it to disperse into, establish, and spread in natural ecosystems. It may be appropriate to maintain vigilance for plants that have high Biological Characteristics of Invasiveness but are not yet well-established in the region. This section contributes to the overall Ecological Impact rank only when the confidence in Ecological Impact is Low.

Concern Related to Distribution and Abundance

As noted above, this result basically synthesizes "How common is this plant? Is it spreading or infilling? Is there suitable habitat left where it does not occur? Does it occur in many different types of ecosystems?". While it does not contribute to the Ecological Impact rank, information provided here may prove useful in prioritizing between similarly impactful plants at a statewide level. For example, a land management agency may choose to focus management on a plant with a High Ecological Impact rank but for which there is Low Concern Related to Distribution and Abundance, as there will be comparatively few acres to treat.

Quality Control & Integration of Multiple Assessments

When submissions from outside parties are accepted, assessments are first screened to remove duplicate or repeat submissions from individual users. WNHP then reads through all submissions and removes those from users who appear to have misunderstood the protocol. This protocol provides flexibility to incorporate assessments from multiple individuals into a single aggregate assessment. When multiple assessments are integrated, there is an additional QA/QC step. If the spread in a section score for the different users is 20+ percentage points:

- Check that disagreement is due to diverging scores and not simply from a disproportionate number of "unknown" or "not rated" ratings on the part of one or more users.

- If disagreement remains, contact the assessors directly and discuss their scores to see if they still agree with their initial assessment.

- If disagreement remains, contact one or more additional experts—these can be from a scientific advisory panel, or other individuals—and walk them through that section of the protocol, essentially treating their ratings as an additional assessment/tie-breaker.

Following QA/QC, integration happens at the level of individual metrics, permitting the use of incomplete assessments. There is no change in the remainder of the roll-up procedure. Integration varies based on the type of metric:

Subjective Metrics

For metrics that involve substantial "professional judgement" or experience, we take the modal rating (when possible), unless one user clearly has more expertise. If there are fewer than three assessments, or if no rating has a majority, the median rating is used (again, unless one user clearly has more expertise). "Unknown" or "not rated" ratings are not included in these calculations (but do count against Confidence scores).

To calculate overall confidence for subjective metrics, we simply take the median confidence of the modal ratings. For example, consider a situation in which there are three ratings for a metric: "High" with High confidence, "High" with Low confidence, and "Insignificant" with High confidence. The modal rating is "High" and the confidence is then "Moderate" (median confidence of the modal ratings). When there is no modal rating, the median of all confidence values is used. Confidence scores calculated in this manner are rounded to the nearest whole number.

Relatively Objective Metrics

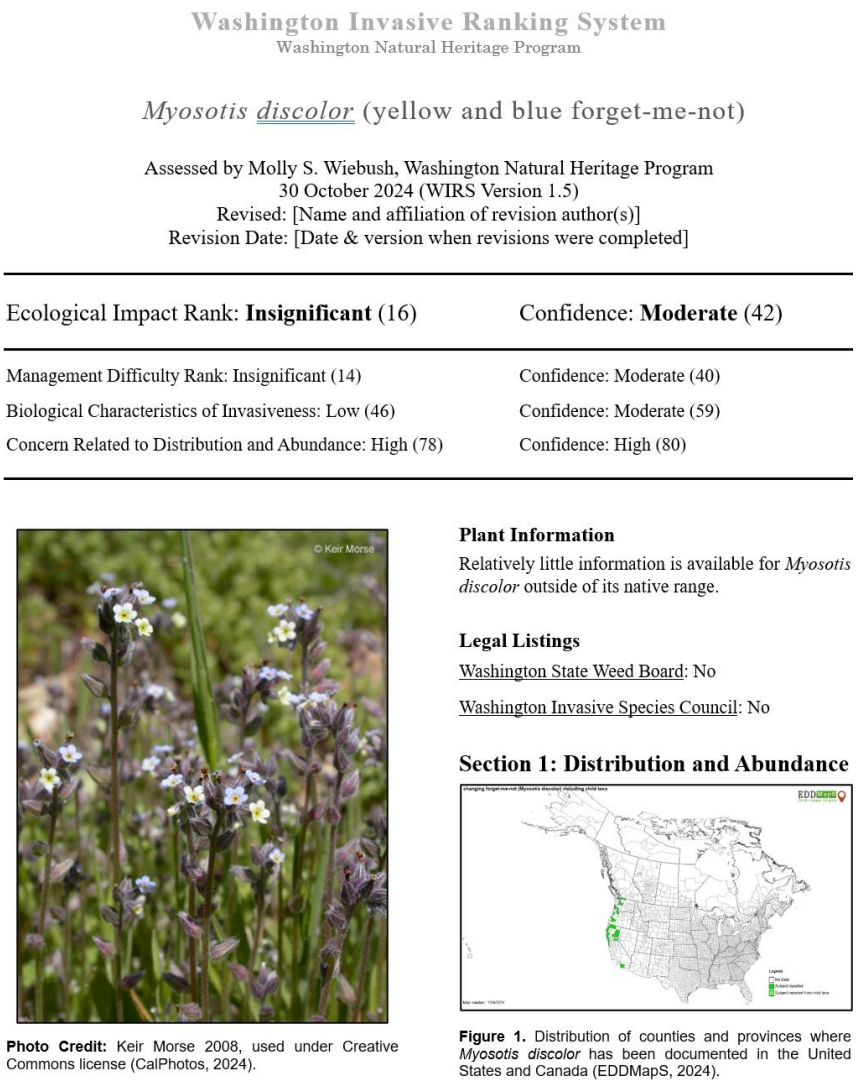
Some metrics—particularly in Section 2 (Biological Characteristics)—are relatively quantifiable and/or can be rated with a yes/no with some degree of certainty. For example, it's relatively straightforward to determine the longevity of plant propagules (Q16). When reviewing these metrics, we do not want to dilute the ratings of individuals who may have more information than the other assessors (e.g., they may be aware of recent research that shows greater longevity for the propagules of a given plant). We review all relatively objective metrics with disagreeing ratings and choose the one with the most supporting evidence. Overall confidence is calculated as the median of the confidence values associated with the chosen rating. Table 6 shows which metrics are considered subjective vs. objective in this context.

Table 6. Subjective v. Relatively Objective Metrics. This distinction impacts how ratings are integrated only when multiple users assess the same plant.

Metric	Type
Q1: Current Range Size in Washington	Relatively Objective
Q2: Current Trend in Total Range	Relatively Objective
Q3: Proportion of Potential Range Currently Unoccupied	Subjective
Q4: Local Range Expansion or Change in Abundance	Subjective
Q5: Diversity of Ecosystems Invaded	Relatively Objective
Q6: Aggressive Mode of Reproduction	Relatively Objective
Q7: Innate Potential for Long-Distance Dispersal	Relatively Objective
Q8: Potential to be Spread by Human Activities	Relatively Objective
Q9: Allelopathy	Relatively Objective
Q10: Competitive for Limiting Abiotic Factors	Subjective
Q11: Growth Form	Relatively Objective
Q12: Germination Requirements	Relatively Objective
Q13: Invasiveness of Other Plants in Genus	Relatively Objective
Q14: Shade Tolerance	Relatively Objective
Q15: Disturbance Tolerance	Relatively Objective
Q16: Propagule Persistence	Relatively Objective
Q17: Palatability	Relatively Objective
Q18: Impact on Ecosystem Abiotic Processes	Subjective
Q19: Impact on Ecosystem Structure	Subjective
Q20: Impact on Ecosystem Composition	Subjective
Q21: Impact on Particular Native Species	Relatively Objective
Q22: Observed Ability to Invade Undisturbed Ecosystems	Subjective
Q23: Observed Ability to Invade Naturally Disturbed Ecosystems	Subjective
Q24: General Management Difficulty	Subjective
Q25: Minimum Time Commitment	Relatively Objective
Q26: Impacts of Management on Native Species	Subjective
Q27: Accessibility of Invaded Areas	Relatively Objective
Q28: Sociopolitical Implications of Management	Subjective

Data Storage

The Washington Natural Heritage Program is responsible for maintaining a database of assessments that will be accessible online in early 2025 (https://www.dnr.wa.gov/natural-heritage-program). **Importantly, ranks are not static—they may change as new information is incorporated**. Each species will be labeled with its assessment date and date of any revisions. Revised species will be highlighted in the "What's New?" section of the WNHP website: https://www.dnr.wa.gov/natural-heritage-program. A page specific to the database will be live in early 2025. Besides the database, WNHP will also host Species Assessment Summaries for each plant assessed to date (Figure 2).



Washington Invasive Ranking System
Washington Natural Heritage Program

Myosotis discolor (yellow and blue forget-me-not)

Assessed by Molly S. Wiebush, Washington Natural Heritage Program
30 October 2024 (WIRS Version 1.5)
Revised: [Name and affiliation of revision author(s)]
Revision Date: [Date & version when revisions were completed]

Ecological Impact Rank: **Insignificant** (16)	Confidence: **Moderate** (42)
Management Difficulty Rank: Insignificant (14)	Confidence: Moderate (40)
Biological Characteristics of Invasiveness: Low (46)	Confidence: Moderate (59)
Concern Related to Distribution and Abundance: High (78)	Confidence: High (80)

Photo Credit: Keir Morse 2008, used under Creative Commons license (CalPhotos, 2024).

Plant Information

Relatively little information is available for *Myosotis discolor* outside of its native range.

Legal Listings

Washington State Weed Board: No

Washington Invasive Species Council: No

Section 1: Distribution and Abundance

Figure 1. Distribution of counties and provinces where *Myosotis discolor* has been documented in the United States and Canada (EDDMapS, 2024).

Figure 2. Species Assessment Summary screenshot.

Release Notes

Version 1.3.1 (November 27, 2023)

- Added Washington Department of Ecology's lakes environmental database as a potential resource for distribution data for aquatic plants
- Added Table of Contents and page numbers.

Version 1.4 (November 7, 2024)

- Minor citation corrections
- Following recent changes to the US National Vegetation Classification, this protocol now uses USNVC Subbiomes as the standard classification unit (See Q5).

Version 1.5 (December 31, 2024)

- Metric weighting changes [All reported Q #'s are current as of publication of Version 1.5]:
  - Q19 points possible increased from 9 to 12
  - Q21 points possible reduced from 9 to 3
  - Q22 points possible increased from 9 to 15
  - Q23 points possible reduced from 6 to 3
- Finalized integration methods for multiple assessments of the same plant
- Ecology section (Section 3) renamed "Ecological Impact". Ecological Impact rank no longer integrates Sections 1-3. Only integrates Section 2 when Section 3 confidence rank is Low.
- Ecology section (Section 3) confidence rank capped at Low if Q22 or Q18, Q19, AND Q20 are "unknown" or "not rated".
- Finalized QA/QC procedure for plants with large spread (20+ percentage points) in section ranks.
- "Unknown" and "not rated" metrics are now included in confidence calculations (both count as "low" confidence).
- Codified WNHP's roll in future assessments (WNHP staff will conduct majority of assessment and then conduct expert interviews, followed by a "gut check" style peer-review).
- Clarified that public objection to herbicide treatment may be considered in Q28.

- Former Q18 “Evergreen” merged into current Q10 “Competitive for Limiting Abiotic Factors”. Q10 points possible increased from 3 points to 4 points. All other Q#’s reduced by 1 relative to Version 1.4 and total number of metrics reduced from 29 to 28.

- Name of Q3 “Proportion of Potential Range Currently Occupied” changed to “Proportion of Potential Range Currently **Unoccupied**” to align with rating criteria and reduce user confusion.

- Name of Q27 “Accessibility of Invaded Areas” changed to “**Inaccessibility** of Invaded Areas” to align with rating criteria and reduce user confusion.

- Switched terminology from “Questions” to “Metrics”.

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Appendix A. WIRS Database

See accompanying Excel Workbook. Results (including individual Species Assessment Summaries) will also be posted online in early 2025 at: https://www.dnr.wa.gov/natural-heritage-program.