DRAFT

Weed Risk Assessment

Work Instructions

Version 4.1.2

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USDA-APHIS-BRS

Table of Contents

Tables

Figures

1.0 Purpose

This document provides detailed work instructions for risk assessors conducting a Biotechnology Regulatory Services (BRS) Weed Risk Assessment (WRA) to assess whether a genetically engineered (GE) plant poses a weed risk to agricultural plants and agriculturally important natural resources.

2.0 Scope

These work instructions cover the WRA process for both non-GE (baseline) and GE plants. Terms are defined in the WRA Glossary located in Section 12 of this document.

The taxonomic scope of each WRA is limited to plants and progeny within and below the taxonomic level set by the risk assessor, and is described in the answer to the taxonomic scope background question.

The genetic scope of each GE WRA is set on a case-by-case basis by the risk assessor in consultation with their supervisor, and is described in the answers to the GE trait background questions.

The geographic scope of each WRA is the United States and its territories; hence all references to 'United States' or 'U.S.' refer to the United States and its territories, unless otherwise stated.

3.0 Responsibilities

Risk assessors collect and analyze data and information. They provide objective, evidence-based information about the biology of baseline and GE plants and their past, present and potential future impacts to agricultural plants and agriculturally important natural resources.

Risk managers decide whether action is needed to reduce risk to agricultural plants and agriculturally important natural resources, and what actions to take.

4.0 How to conduct WRA

Each WRA consists of answers to 25 Background questions and 25 Weed risk questions. The questions are contained in these work instructions and the answers are entered by risk assessors into the BRS WRA Data Entry Form (a Microsoft InfoPath form) located in the WRA InfoPath Library on the BRS SharePoint site. The number in parentheses before each question in these work instructions (e.g., (1) WRA version number, (B01) Current weed and invasive status) corresponds to the answer field number in the InfoPath form. The answer for each weed risk question is associated with risk and certainty ratings that are assigned on the basis of documented supporting evidence and reasoning.

There are two primary ways to complete a WRA: 1) source-by-source and 2) question-by-question. In the source-by-source approach, focus on one source at a time and answer as many questions as that source can address. In the question-by-question approach, find specific information sources for each question, then identify any data gaps. Each of these methods has advantages and disadvantages. For baseline WRAs, start by gathering major information sources for a taxon and use the source-by-source approach. Once major information sources have been completed, switch to the question-by-question approach to fill in missing information. As you go through the WRA, you may find additional information that applies to questions that were already completed; go back and add any information as needed. If you find a high quality source later in the risk assessment process, you should use it in addition to or instead of a lower quality source found earlier.

Take great care to document your reasoning and certainty for every question and risk rating. Risk managers and reviewers should be able to trace the origins of your reasoning supporting your risk and certainty ratings to specific information highlighted and annotated in the cited source documents. In many cases you may need to synthesize the information you have gathered in order to draw an overall conclusion based on the weight of evidence, or explain how the information led you to assign the given risk rating. Use consistent terminology throughout the document; only introduce new terms if they are included in quotations from information sources. You may use reasonable inference in your answers, as indicated by words such as “could” or “likely” in question descriptions and rating scales. If there is a plausible risk hypothesis, you may form a conclusion based on incomplete information and decrease the Certainty rating appropriately. However, do not increase a risk rating because of uncertainty.

Before you conduct a WRA for a GE plant, there must be a finalized baseline WRA for the taxon to serve as the basis for the comparative assessment of risk between the GE plant and its non-GE taxon. A GE WRA should indicate any changes compared to the baseline, including risks supported by documented evidence or plausible risk hypotheses. All plausible effects of the GE trait should be considered for each question. GE traits could increase or decrease weediness characteristics, effects could be neutral, or some weediness characteristics could be increased while others are decreased. If the GE trait could plausibly affect the plant with respect to a weed risk question, then even if data are not available, change the risk and certainty ratings that were initially decided for the baseline plant, as appropriate, and document your reasoning. If an answer to a weed risk question is already rated as very high (or negligible) in the baseline, but the GE trait could increase (or decrease) the risk even further, document the change and include it in the summary for the risk manager.

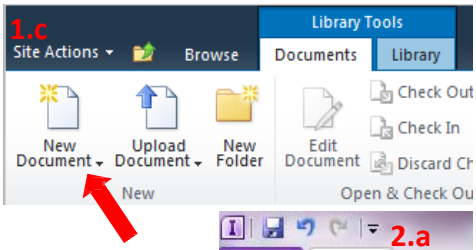
All documentation should use plain writing to the maximum extent possible. All summary fields must use plain writing. Plain writing “is clear, concise, well-organized, and consistent with other best practices appropriate to the subject or field and intended audience. Such writing avoids jargon, redundancy, ambiguity, and obscurity” (Sunstein, 2011).

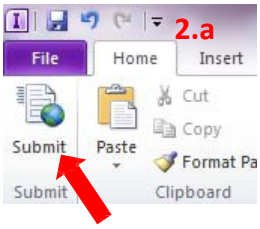
All documentation entered into the WRA InfoPath form should be in 12 point Calibri font. When you paste text from other sources, it may be in a different font or size. If that occurs, be sure to select all of the text in that text entry box and change it to 12 point Calibri font. As you progress through the WRA, if there are any empty text boxes, indicate that there is no information or the question is not applicable by adding “no information available” or N/A, as appropriate.

The next two subsections outline Standard Operating Procedures (SOPs) for conducting WRAs of baseline and GE plants. Although the SOPs provide step-by-step guidance, be sure to read the entire work instructions before conducting a WRA.

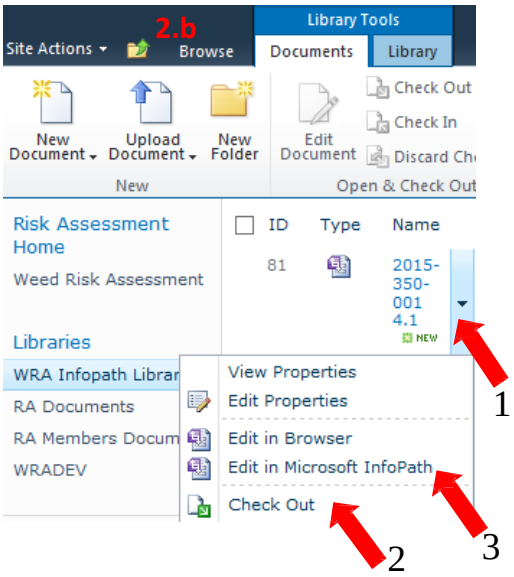
4.1 Baseline WRA SOP

The following steps walk the risk assessor through a baseline WRA. Skip to the GE WRA SOP if you are conducting a GE WRA. Read the entire SOP before conducting a WRA for the first time. Follow the links to additional information on each topic, as needed.





1. **Open a blank form in SharePoint**.
   a. Go to the WRA InfoPath Library.
   b. Click on the Documents tab under Library Tools.
   c. Click on "New document" in upper left corner or use the Add document link at the bottom of the Library.
   d. A blank WRA form will open in InfoPath.
   e. Complete fields (1) WRA version number and (2) WRA number.
2. **Submit the WRA form, Check Out form, Edit form, Check In form**
   a. Save the WRA form in the WRA InfoPath Library by selecting "Submit" in the upper left corner of InfoPath.
      i. The first "Submit" will automatically Check Out the new WRA form, create a new row for the WRA in the Library, and generate the new filename by joining the new (2) WRA number with the (1) WRA version number (e.g., 2015-350-001 4.1 in the Name column).
      ii. Continue editing and frequently selecting "Submit" to save your edits to SharePoint, or if you have to stop and then return to the WRA later, always go back to the WRA form last submitted in SharePoint.



   b. **You *must* Check Out an existing WRA to Edit it. First** hover and click the menu arrow to the right of the hyperlinked Name in the WRA InfoPath Library, **second** select "Check Out" from the drop-down menu, then **third** select "Edit in Microsoft InfoPath".
   c. Alternatively, if you attempt to Edit the WRA by any means without first selecting "Check Out", InfoPath will ask if you want to Check Out the WRA. You must agree to Check Out the WRA in order to enable editing and saving to SharePoint.
   d. **You must "Submit" and "Check In" the WRA when you are finished editing**, to allow others to view the latest version of your WRA and reviewers to open and edit it.
   e. You may save a copy of the WRA file to your computer as a backup.
      i. Click "File", "Save As" in the WRA form.
      ii. Select a folder on your C or H drive.
      iii. A best practice is to use the WRA InfoPath Name and the date and time saved for the filename on your C or H drive, i.e., 2015-350-001 4.1_20151216_1450.xml.
   f. If you wish to occasionally work offline, you can edit your saved WRA version from your C or H drive and later upload it to SharePoint (SP) to serve as the latest authoritative WRA version saved in the WRA InfoPath Library.
      i. "Check Out" the online SP WRA you intend to overwrite with your C or H drive version, but do NOT open the SP WRA and do NOT "Edit in Microsoft InfoPath."

ii. Open the offline WRA saved on your C or H drive and press "Submit".
iii. Receipt of the message that the "Form was submitted successfully" confirms that your previously offline WRA form is now the authoritative version in SP. A quick way to visually confirm this is to, for example, add or delete your middle initial under (7) Preparers in the WRA form, press "Submit", then press F5 or the refresh icon on the WRA InfoPath Library page to immediately see the change in the Preparers column.

3. **Complete Background questions.**
   a. **Complete the Basic information.** Note that the baseline WRA includes only non-GE plants.
   b. **Complete Taxonomy and sexually compatible relatives**. Each baseline WRA must be conducted at the appropriate taxonomic rank.
   c. **Enter N/A for the GE trait questions.**
   d. **Begin Plant context.**
      i. Fill out the plant context questions as much as possible.
      ii. As you go through the WRA, you will likely find additional information that applies to previous questions. Go back and add any information as needed.
4. **Complete the Weed risk questions.**
   a. Consult each question's description and rating scale every time you conduct a WRA.
   b. The task of selecting risk and certainty ratings and providing documentation to support your selections is more of an iterative process than suggested by the linear outline below.
   c. **Identify evidence**.
      i. Gather sources. Three to four high-quality independent sources per question are ideal.
      ii. Directly annotate pdfs of each source document by using Adobe or similar tools to highlight the relevant information and insert sticky notes that indicate which question the information applies to and your reasoning for the risk rating and conclusions you have drawn from the source.
      iii. Cite direct evidence whenever possible and limit inference.
   d. **Select a Weed risk rating**.
      i. For each weed risk question, assign a risk rating from the drop-down list.
      ii. Consider any risks for which there is documented evidence of risk as well as those for which there is a plausible risk hypothesis.
   e. **Document Risk**.
      i. State the risk rating in the first sentence of the risk documentation box.
      ii. Explain both the evidence and your reasoning for the risk rating, referencing your information sources. Specifically discuss any gaps in knowledge.
      iii. State the risk hypothesis, if any.
      iv. Document any characteristics for which the plant may pose a weed risk to agricultural plants and agriculturally important natural resources.
5. **Rate Certainty.**
   a. For each weed risk question, determine which sources are the bases for your risk rating, then assign an overall certainty rating in the drop-down list using the following steps.
   b. **Assess Reliability of sources.**
   c. **Assess Applicability of sources.**
   d. **Assign a Certainty rating**.
      i. Select a certainty rating for each source (see Table 3).
      ii. If there is only one source, decrease the certainty rating by one level.
      iii. If there are multiple sources, you may select the highest rating among the sources if the other sources are consistent with the highest rated source.
      iv. Consider increasing or decreasing certainty depending on agreement or disagreement among the sources (e.g., if all of the independent sources agree, you may increase the

certainty; if your sources do not agree and further searching for sources does not enable consensus, consult with your supervisor).

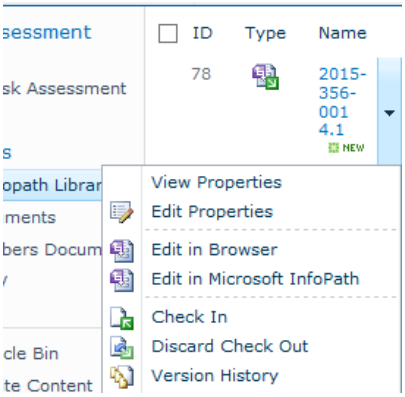
e. **Document Certainty**.
   i. State the overall certainty rating in the first sentence of the certainty documentation box.
   ii. Explain your reasoning for the certainty rating based on the reliability, applicability, amount, and consistency of the evidence. Specifically discuss any gaps in knowledge.
   iii. List the reliability, applicability and certainty rating you gave to each cited source, using the format: Author, Year (reliability rating, applicability rating, certainty rating). For example: USDA-NRCS, 2015 (R: Mod, A: Very high, C: High).

6. **Cite evidence**. List all sources in the Bibliography section at the end of the WRA form.
7. **Summarize weed risk and certainty**. In the summary text box at the end of the Biology and Impact sections, summarize the weed risk and certainty for those sections. Include any major mitigating factors, risks or red flags.

4.2 GE WRA SOP

The following steps walk the risk assessor through a GE WRA which is conducted only after a baseline WRA has been completed for the taxon. Read the entire SOP before conducting a WRA for the first time. Follow the links to additional information on each topic, as needed.

1. **Open the appropriate baseline form in SharePoint**.
   a. Go to the WRA InfoPath Library.
   b. Hover over the hyperlinked Name of the baseline WRA you have been assigned to use to create your GE WRA, select "Check Out" from the drop-down menu, then select "Edit in Microsoft InfoPath".
   c. The completed baseline WRA will open in InfoPath.
2. **Change the (2) WRA number**.
   a. Copy the number in field (2) WRA number and paste it into (4) Baseline WRA number.
   b. Add the *new* (2) WRA number for the GE WRA assigned by your supervisor.
3. **Submit the WRA form, Check Out the form, Edit the form, Check In the form**
   a. Save the GE WRA form in the WRA InfoPath Library by frequently selecting "Submit" in the upper left corner of InfoPath.
      i. The first "Submit" will automatically Check Out the new WRA form, create a new row for the GE WRA in the WRA InfoPath Library, and generate the new filename by joining the new GE (2) WRA number with the (1) WRA version number (e.g., 2015-356-001 4.1).
      ii. However, you will still have the baseline WRA form open, so to avoid confusion, close the baseline WRA form *without* saving changes to it, then open the new GE WRA by selecting "Edit in Microsoft InfoPath". Any edits you make to the checked out GE WRA form are now saved in the new form and will not overwrite the baseline WRA.



   b. If you have to stop and then return to the WRA later, always go back to the form saved in SharePoint.
   c. **You must Check Out an existing GE WRA to Edit**: hover over Name, select "Check Out", then "Edit in Microsoft InfoPath".
   d. **You must "Submit" and "Check In" the GE WRA when you are finished editing**, to allow others to view the latest version of your GE WRA and reviewers to open and edit it.

e. You may save a copy of the GE WRA file to your computer as a backup.
   i. Click "File", then "Save As" in the form.
   ii. Select a folder on your C drive or H drive.
   iii. Use the GE WRA number, date and time in the filename.

4. **Indicate (5) CBI.**
   a. Be sure to add brackets [ ] around any Confidential Business Information (CBI).
5. **Complete the Background questions.**
   a. It is not necessary to completely answer all of the background questions at first. As you go through the GE WRA, you may find additional information and complete your answers.
   b. Add GE-specific information for the background questions as needed.
      i. For each question, add a divider of 5 dashes (i.e., -----) at the top of the text box, then add the GE-related text above the divider. Add headings in bold, "**GE information**" and "**Baseline information**", where appropriate.
      ii. If there is no change, explain why you do not expect the GE trait to have an effect.
   c. **Complete the Basic Information.**
      i. Check that (1) WRA version number from the baseline WRA is the same as the version number on the WRA work instructions you have been assigned to use for the GE WRA. If the version numbers are not identical, the WRA baseline must first be updated to align with the version of the WRA tool you have been assigned to use. Consult with your supervisor.
      ii. Update (3) GE or baseline and (6) Applicant.
      iii. Update (7) Preparers and (8) Reviewers.
   d. **Do not change the Taxonomy and sexually compatible relatives.**
   e. **Complete the GE trait.**
      i. Complete (15) GE phenotype category, (16) GE phenotype, (17) GE phenotype description, and (18) GE genotype description.
   f. **Complete the Plant context section.**
      i. If there are changes due to the GE trait, update (19) Plant history, (20) Plant biology and ecology, (21) Agronomic practices, (22) Management practices, (23) Current U.S. geographic distribution, and (25) Potential U.S. geographic distribution.
6. **Update the Weed risk questions.**
   a. Consult each question's description and rating scale every time you conduct a WRA.
   b. The task of selecting risk and certainty ratings and providing documentation to support your selections is more of an iterative process than suggested by the linear outline below.
   c. **Identify evidence**.
      i. Gather sources. Three to four high-quality independent sources per question are ideal.
      ii. Directly annotate pdfs of each source document by using Adobe or similar tools to highlight the relevant information and insert sticky notes that indicate which question the information applies to and your reasoning for the risk rating and conclusions you have drawn from the source.
      iii. Cite direct evidence whenever possible and limit inference.
   d. **Select a Weed risk rating**.
      i. For each weed risk question, assign a GE risk rating from the drop-down list.
      ii. Consider any risks for which there is documented evidence of risk as well as those for which there is a plausible risk hypothesis.
   e. **Document Risk**.
      i. For each question, add a divider of 5 dashes (i.e., -----) at the top of the Risk documentation text box, then add the GE-related text above the divider. Add headings in bold, "**GE information**" and "**Baseline information**", where appropriate.

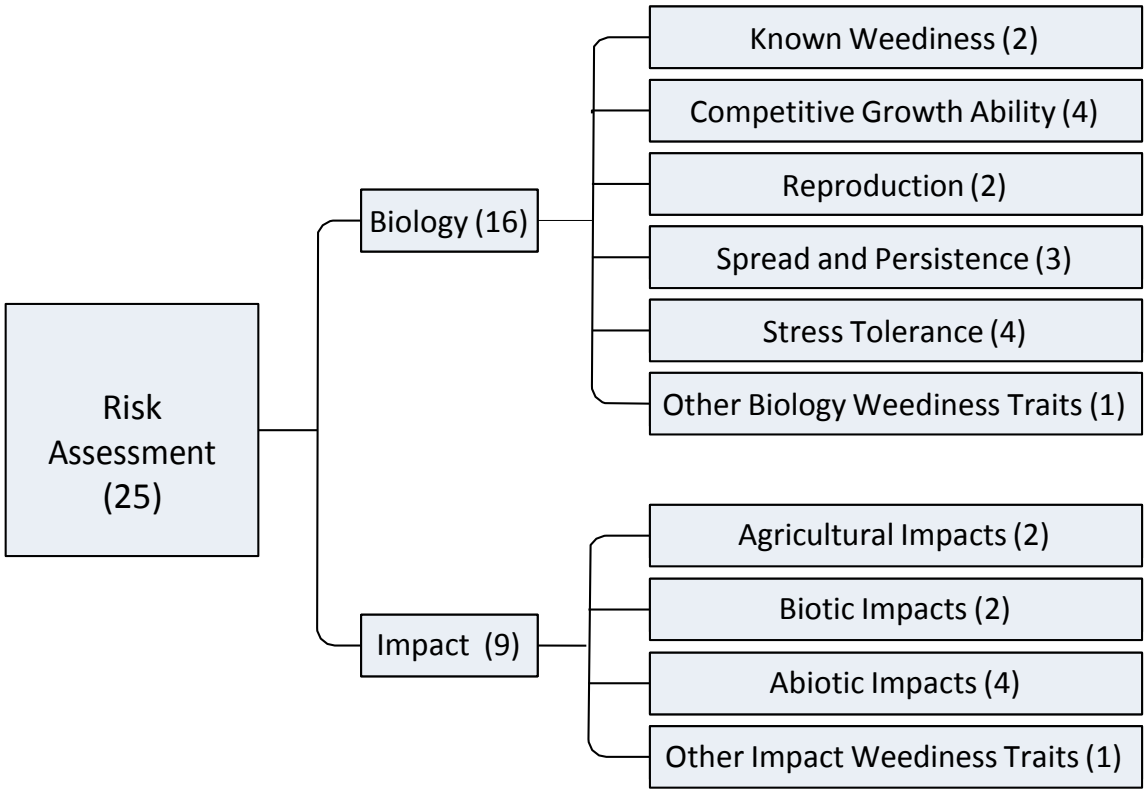
ii. State the GE risk rating in the first sentence of the risk documentation box.
iii. If there is no difference in weed risk between the GE plant and the baseline taxon, then explicitly state that there is no difference in risk, therefore the risk rating remains Low (or Moderate or High or whatever the baseline risk was for the specific weed risk question).
iv. Explain both the evidence and your reasoning for the risk rating, referencing your information sources. Specifically discuss any gaps in knowledge.
v. If there is a difference in risk rating, state the GE risk hypothesis, if any.
vi. Document any characteristics for which the GE plant may pose a weed risk to agricultural plants and agriculturally important natural resources.

7. **Rate Certainty.**
   a. For each weed risk question, add a divider of 5 dashes (i.e., -----) at the top of the Certainty documentation text box, then add the GE-related text above the divider. Add headings in bold, "**GE information**" and "**Baseline information**", where appropriate.
   b. For each weed risk question, determine which sources are the bases for your risk rating, then assign an overall certainty rating in the drop-down list using the following steps.
   c. **Assess Reliability of sources.**
   d. **Assess Applicability of sources.**
   e. **Assign a Certainty rating**. Do not change the baseline rating.
      i. Select a certainty rating for each source (see Table 3).
      ii. If there is only one source, decrease the certainty rating by one level.
      iii. If there are multiple sources, you may select the highest rating among the sources if the other sources are consistent with the highest rated source.
      iv. Consider increasing or decreasing certainty depending on agreement or disagreement among the sources (e.g., if all of the independent sources agree, you may increase the certainty; if your sources do not agree and further searching for sources does not enable consensus, consult with your supervisor).
   f. **Document Certainty rating**.
      i. State the overall certainty rating in the first sentence of the GE section of the Certainty documentation box.
      ii. If the certainty rating for the GE plant remains the same as for the baseline taxon, then explicitly state that the certainty remains … High, Moderate, Low… whatever the baseline certainty was for the question.
      iii. Explain your reasoning for either keeping or changing the certainty rating compared to the baseline, based on the reliability, applicability, amount, and consistency of the evidence. Specifically discuss any gaps in knowledge.
      iv. List the reliability, applicability and certainty rating you gave to each cited source for a weed risk question, using the format: Author, Year (reliability rating, applicability rating, certainty rating). For example: USDA ARS, 2015 (R: Mod, A: Very high, C: High).
8. **Cite evidence.** List all sources in the Bibliography section at the end of the WRA form.
9. **Summarize weed risk and certainty**.
   a. Add a divider of 5 dashes (i.e., -----) at the top of the summary text boxes at the end of the Biology and Impact sections, and summarize the weed risk and certainty for the GE plant for those sections. Add headings in bold, "**GE information**" and "**Baseline information**", where appropriate.
   b. Include any major mitigating factors, risks or red flags.

4.3 Weed risk questions

You will evaluate 25 weed risk questions: 16 biology and 9 impact questions (Figure 1). For each question, you must select a risk rating and a certainty rating from the drop-down lists in the WRA InfoPath form, and provide documentation in the text boxes to support your selections. Each weed risk question has a qualitative scale with explanatory text. Such scales reduce inconsistency between risk assessors (Schrader *et al.*, 2012). The scales have 2, 3, 4, or 5 ratings as needed to allow appropriate separation between ratings; some questions are better suited for a yes/no approach than a gradient.

Figure 1. Categories of risk questions (number of questions) in the BRS Weed Risk Assessment.



4.3.1 Risk documentation

For each weed risk question, state the risk rating in the first sentence of the risk documentation box. This redundancy serves as a backup of the risk rating selected in the drop-down list and facilitates review of your WRA. Document both your evidence and reasoning for selecting the risk ratings. To document evidence, you can use quotes or paraphrased evidence from the literature or other data sources, arranged as bullet points or in text form. Create pdfs of each information source and use Adobe or similar tools to directly annotate each source document. Highlight evidence or relevant information and/or insert electronic sticky note s that indicate which question the information applies to, your reasoning for the conclusion you are drawing from the source, and your reliability, applicability and certainty ratings for

the source-question combination. In addition, synthesize the information you have gathered, drawing an overall conclusion or explaining how the information led you to assign the given risk rating. In general, three to four high-quality independent sources per question are recommended, depending on the quality of sources.

For GE plants, if the risk is not affected by the GE trait, state that no change from the baseline is observed (if there is directly related data) or expected (if there is no directly related data), and explain why. If the GE trait could affect risk, change the rating accordingly in the drop-down list, state the change in rating in the first sentence of the GE section of the risk documentation box, and provide documented evidence or plausible risk hypotheses to support the change in risk. All plausible effects of the GE trait should be considered for each question. If the GE trait could plausibly affect the plant taxon with respect to a weed risk question, then even if data are not available, change the risk and certainty ratings that were initially decided for the baseline plant, as appropriate, and document your reasoning. If an answer to a weed risk question is already rated as very high (or negligible) in the baseline, but the GE trait could increase (or decrease) the risk even further, document the change and include it in the summary for the risk manager.

Use parenthetical documentation to indicate your sources throughout the WRA. List the sources for all supporting evidence in the Bibliography section of the WRA form. Use a consistent citation format, such as the standard BRS citation format (for examples, see the Bibliography of this document). Save PDFs of all of your sources on the I drive in this folder: I:\BRS - Biotechnology Regulatory Services\Document Warehouse\WRA\WRA4.1\References. See the Corn example for baseline and GE reference folders.

4.4 Certainty

This section defines the approach used by risk assessors to evaluate and communicate the degree of certainty in the risk assessment by assigning certainty ratings to each risk rating in the WRA. The primary purpose for identifying and communicating certainty is to provide the decision maker with as complete and objective a view of risk as possible. Careful documentation of certainty also highlights where more or better information may improve a decision.

Certainty is the state of knowing something to be true, especially on the basis of evidence, and it is the binary opposite of uncertainty: not knowing something to be true.

Two major types of uncertainty in analyzing risk are

- Lack of knowledge about or incomplete understanding of the system
- Randomness of the system itself, including natural variability.

Uncertainty due to lack of knowledge may be reduced by further study and data collection. Uncertainty due to variability among individuals is inherent in biological systems. New or additional information will not usually reduce uncertainty arising from variability. Most risk assessments must manage both types of uncertainty, and it is not always possible to distinguish between them. The distinction between uncertainty due to lack of knowledge and due to variability is, however, important when explaining model results to decision makers or the public.

Documenting certainty is distinct from documenting risk. You must separate the uncertainty that arises due to lack of knowledge from the ratings of risk. Choose risk ratings based on available evidence; do not increase risk ratings when there is uncertainty due to lack of knowledge or incomplete understanding.

However, when there is uncertainty in the choice of risk ratings due to natural variability in the system, choose the higher risk rating and document the variability.

Assign certainty ratings to each risk rating. First, assign a certainty rating to each information source based on the Reliability of sources used to assess the question and the Applicability of sources in terms of relevance to the question. The certainty rating should be specific to the WRA question; the same information source may have high certainty for one WRA question and low certainty for another. Second, assign an overall certainty rating for the question by considering the certainty ratings of all information sources, as discussed in Section 4.4.3 Certainty ratings.

For personal communications, do not use the reliability and applicability tables. Instead, assign certainty based on the expert's level of expertise with the specific topic. Certainty for personal communications should never be greater than High if from recognized experts or Moderate if from others experienced with the subject matter.

Where a taxon is well known, some information about the taxon may be widely known to be true. In such cases, lack of specific evidence for a given characteristic may indicate lack of the characteristic, since it is likely that evidence for a characteristic would have been reported in the literature. When there is general or common knowledge about the existence or absence of a particular characteristic in a taxon, even though literature to support the risk rating is not available or is limited to reviews or general treatises, certainty may be rated High or Very high.

4.4.1 Reliability of sources

Reliability refers to the degree to which the risk assessor can rely on the data and conclusions of an information source. Sources may provide data that are experimental or observational, and quantitative or qualitative, depending on the information source. Primary information sources are preferred to secondary sources, particularly for controversial of especially important issues, since secondary sources may not represent or interpret primary sources appropriately or may omit data present in primary sources that are applicable to the question. Whenever possible, examine and cite primary sources that are referred to by a secondary source.

Primary data sources include:

- Peer-reviewed journals, including open access journals and archives
- Reputable non-peer reviewed open access journals and archives (excludes "predatory" journals and publishers)
- Reports and databases from governments, scientific societies, universities, and agricultural extension offices
- Meeting and conference papers reporting original research
- Applicant-provided reports of internal research, including original data supplied in petitions
- Theses and book chapters reporting original research
- Flora and herbaria records.

Secondary information sources include:

- Review articles
- Primary sources that cite or include data from other primary sources

- Reports and databases from governments, scientific societies, universities, and agricultural extension offices that compile data or information obtained from primary sources
- High quality science or plant specific books
- News reports
- Gardening guides, horticultural, and nursery web pages.

The Recommended sources section of this document and 'Search Tips' associated with some of the questions may help you find appropriate information. These sources are recommended, not required, and do not represent an exhaustive list. Databases such as Google Scholar and the APHIS Library resources may contain relevant peer-reviewed journal articles. Wikipedia should never be used as a source, though it may help guide you toward higher quality sources. Newer sources are generally preferable to older sources, if they are of the same quality. Use Table 1 as guidance for assigning a reliability rating to each information source.

4.4.2 Applicability of sources

Applicability refers to how relevant the data and conclusions obtained from the information source are to the risk assessment question and how well the evidence supports the risk assessor's risk rating. Ideally, risk ratings should be based on evidence from the taxon of interest (taxon applicability) that enables unambiguous conclusions regarding how the plant behaves in situations that correspond to the criteria specified in each question of the WRA (criterion applicability). Since such evidence is not always available, it may be necessary to extrapolate.

Keep in mind that the agronomy literature and the ecology literature may contain very different perspectives on the potential weediness of crop plants. In general, agronomy literature is about maximizing yields of the desired crop. Because this is a weed risk assessment, the agronomic literature may not provide an appropriate perspective when it comes to crop plant behavior as a weed. When possible, seek out ecology or weed science information, then supplement with agronomy information as needed. Use Table 2 as guidance for assigning an applicability rating to each information source.

4.4.3 Certainty ratings

Each question has a certainty rating (Hammonds *et al.*, 1994; Thompson, 2002; IPPC, 2007; Holt *et al.*, 2014). The certainty ratings are the same for all of the questions: Very high, High, Moderate, Low, and Negligible. For each information source, assess reliability and applicability of the evidence and use Table 3 to determine the certainty rating for the source. Then assign an overall certainty rating for the question. The overall certainty rating should be determined primarily, but not necessarily exclusively, by the certainty ratings of the individual sources. When assigning an overall certainty rating, consider the number of sources, their combined certainties, and the context of the risk rating (including common knowledge, if applicable). If there is only one source, decrease the certainty rating by one level. If there are multiple sources, you may select the highest rating among the sources if the other sources are consistent with the highest rating. Consider increasing or decreasing certainty depending on agreement or disagreement among sources, e.g., if all independent sources agree, you may increase the certainty appropriately; if your sources do not agree and further searching for sources does not enable consensus, see your supervisor). If there is a plausible risk hypothesis even though information is incomplete, decrease the certainty rating appropriately.

A GE WRA should never have greater certainty than a baseline WRA. If it does, the baseline WRA should be reviewed to determine if new information justifies updating the baseline. Once completed, baseline WRAs must not be changed without supervisor approval.

4.4.4 Certainty documentation

Document your reasoning for the certainty rating for each question. Describe the type, amount, quality, consistency, reliability and applicability of the evidence, and document relevant gaps in knowledge. Examples of suitable rationales for each certainty rating:

1. **Very high certainty**
   - Additional or better information is very unlikely to change the risk rating.
   - The risk rating is based on plant or environment specific data that were collected with widely accepted methodology.
2. **High certainty**
   - Additional or better information is unlikely to change the risk rating.
   - The risk rating is based on plant or environment specific data that were collected with sound methodology.
3. **Moderate certainty**
   - Additional or better information probably will not change the risk rating.
   - Available sources have not fully documented their methodology.
4. **Low certainty**
   - Additional or better information may change the risk rating.
   - Some plant or environment specific data are available but most of the data were extrapolated from similar plants or in similar environments.
5. **Negligible certainty**
   - Reliable information is not available.
   - No plant or environmental specific data were available.
   - Available data were collected with poorly documented methodology.
   - Little information about the plant can be found.

At the end of the Certainty text box, list the reliability, applicability and certainty rating you gave to each referenced source, using the format: Author, Year (reliability rating, applicability rating, certainty rating). Risk managers and reviewers should be able to trace the origins of your reasoning supporting your risk and certainty ratings to specific information highlighted and annotated in the cited source documents.

Table 1. Reliability ratings for primary and secondary information sources.

Primary source uses generally accepted and reliable methods that *directly* measure or test characteristics or hypotheses. For experimental studies, the experimental design and statistical methods are well described and rigorous. For observational studies, methods for observing and reporting information are well described or readily apparent.	**Very High**
Primary source uses generally accepted and reliable methods that *indirectly* measure or test characteristics or hypotheses *using derived or surrogate data*, or that *directly* measure or test characteristics or hypotheses *but have small sample sizes*. For experimental studies, the experimental design and statistical methods are well described and rigorous. For observational studies, methods for observing and reporting information are well described or readily apparent.	**High**

OR Secondary source cites multiple, independent, primary sources supporting high consensus conclusions (practically no contradictory evidence) within a well-accepted conceptual framework.	
Primary source uses methods that are clearly specified and described and are determined acceptable by risk assessor but may be less rigorous, not generally used, or of a preliminary nature with unknown reliability. OR Secondary source cites multiple, independent, primary sources supporting general consensus conclusions (may include some contradictory evidence) within a well-accepted conceptual framework.	**Moderate**
Primary source uses methods that are clearly specified and described and generally accepted, but are of limited reliability due to factors such as known high false positive or false negative rates, high limits of detection, or other factors described by the risk assessor. OR Secondary source cites a single primary source, multiple but non-independent sources, or multiple sources that present substantial contradictory evidence, or draws conclusions based on a preliminary conceptual framework. OR Secondary source contains uncited or anecdotal information that supports conclusions based on an accepted conceptual framework.	**Low**
Primary source has poor experimental design or observational practice, or methods not clearly described. OR Secondary source draws conclusions based largely or exclusively on speculation.	**Negligible**

Table 2. Applicability ratings for taxon-specific data in an information source.

Criterion Applicability / Taxon Applicability	Data indirectly related to criterion and provide ambiguous support.	Data indirectly related to criterion but provide unambiguous support OR directly related but provide ambiguous support.	Most data directly related to criterion and provide largely unambiguous support.	All data directly related to criterion and provide unambiguous support.
Data collected entirely from the taxon of interest.	**Low**	**Moderate**	**High**	**Very High**
Some data collected from the taxon of interest and some data are collected from closely related taxa that are known to behave similarly to the plant of interest.	**Negligible**	**Low**	**Moderate**	**High**
Taxon specific data limited; most data collected from related taxa that are not necessarily known to behave similarly to the plant of interest.	**Negligible**	**Negligible**	**Low**	**Moderate**
Data collected from taxa that are not closely related to the plant of interest.	**Negligible**	**Negligible**	**Negligible**	**Low**

Table 3. Certainty rating assignment matrix.

		Reliability Rating				
		Negligible	Low	Moderate	High	Very high
Applicability Rating	Very high	**Low**	**Moderate**	**High**	**High**	**Very high**
	High	**Low**	**Low**	**Moderate**	**High**	**High**
	Moderate	**Negligible**	**Low**	**Moderate**	**Moderate**	**Moderate**
	Low	**Negligible**	**Low**	**Low**	**Low**	**Low**
	Negligible	**Negligible**	**Negligible**	**Negligible**	**Negligible**	**Negligible**

4.5 Summarize weed risk and certainty

The weed risk questions are separated into two sections: biology and impact. Once you have reviewed the biology questions, create a short summary to identify and discuss any biological characteristics that make an important contribution to or mitigate weed risk, and create a short summary of any sources of substantial uncertainty. Similarly, create a summary of the risk and certainty for the impact section when you have completed your review of those questions. For each GE plant, the summaries should indicate the influence of the induced genetic changes on weed risk and certainty. For GE plants, the summary fields should include both the GE and the baseline summaries, clearly labeled and separated.

At the end of the WRA, there is a section for an overall assessment of weed risk. First state your overall assessment of whether the plant poses a weed risk and, for a GE plant, an increased weed risk relative to the baseline plant. Also, discuss any relevant risks or concerns (e.g., effects on management practices) that have not been addressed previously in the biology or impact summaries.

The summaries will help risk managers address their attention where it is most needed. Use plain language when writing the summaries, and write with awareness that the overall summary will precede the biology and risk summaries in the document that is provided to the risk manager. All issues addressed in the summaries should have been addressed in at least one of the Weed Risk Questions.

5.0 Background questions

The purpose of the 25 background questions is to provide administrative, technical and biological context in preparation for answering the 25 weed risk assessment questions.

5.1 Basic information

5.1.1 (1) WRA version number

- If conducting a baseline WRA, enter the version number of the WRA work instructions (found on the title page and header of this document) used to assess the questions.
- If a new WRA version becomes available, and you update a WRA to match the new version, change this version number accordingly.
- If conducting a GE WRA, there must be a finalized baseline WRA for the taxon. Check that the WRA version number from the baseline WRA is the same as the version number on the WRA work instructions you have been assigned to use for the GE WRA. If the version numbers are not identical, the WRA baseline must be updated to align with the assigned version of the WRA tool. Consult with your supervisor.

5.1.2 (2) WRA number

- Enter the assigned WRA number approved by your supervisor.
- This is a unique identifier for each combination of plant and trait(s).
- Each WRA number may pertain to multiple notifications, permits, or petitions, if they have the same plant and trait(s).
- The WRA number is the four digit year, the day of the year (sometimes called the Julian date), and a three digit number issued in the order in which the WRA was assigned. For example, 2015-001-001 is the first WRA assigned on January 1, 2015.

5.1.3 (3) GE or baseline

- If this WRA is for a GE plant, select "GE".
- If this WRA is for the baseline plant, select "baseline".

5.1.4 (4) Baseline WRA number

- If this WRA is for a GE plant, enter the (2) WRA number from the completed baseline WRA.
- If this is a baseline WRA, enter N/A.

5.1.5 (5) CBI

- If the document contains confidential business information (CBI), then select yes.
- If not, select no.
- Add brackets [ ] around any CBI present in the document.
- Baseline WRA generally should not contain CBI.

5.1.6 (6) Applicant

- If this WRA is for a GE plant, enter the full name of the applicant's institution (e.g., the particular company or university) that developed the GE plant.
- If this is a baseline WRA, enter N/A.

5.1.7 (7) Preparers

- Enter the names of the preparers of this WRA (last name, first name) separated by semi-colons.

5.1.8 (8) Reviewers

- Enter the names of the reviewers of this WRA (last name, first name) separated by semi-colons.

5.2 Taxonomy and sexually compatible relatives

5.2.1 (9) Common name

- Enter the primary common name of the species.
- If a lower taxon is the subject of the risk assessment, also enter the common name of the subspecies, variety, cultivar, or ecotype.
- Whenever possible, use the primary common and scientific names as documented in a well-respected database.

5.2.2 (10) Scientific name

- Enter the primary scientific or Latin name of the species or lower taxon according to the Integrated Taxonomic Information System (ITIS), including the taxon author.

5.2.3 (11) Other common names

- Enter any other common names for the plant, separated with commas and citing sources.
- Briefly explain differences in use of common names, only if needed to clarify or avoid confusion.
- If you are unable to find other common names, state "none".

5.2.4 (12) Scientific name synonyms

- Enter any scientific name synonyms for the taxon, separated with commas and citing sources.
- Specifically include the scientific name(s) at the USDA PLANTS Database, if different from ITIS; see Section 9.0 for other taxonomic information sources.
- If you are unable to find synonyms, state "none".

5.2.5 (13) Taxonomic scope

- Clearly describe the taxonomic level for the WRA and your reasoning for including or excluding taxa from the scope. For example, if there are closely related plants, state whether the scope of the WRA includes the related plants or only the cultivated variety, and why. You may need to consult with your supervisor to determine the appropriate taxonomic scope.
- Use the species level unless the biology of the taxon indicates otherwise. For example, assess the subspecies in cases where the species includes a cultivated subspecies and wild subspecies.
- Once you determine the appropriate taxonomic level, the WRA scope is limited to plants and progeny within the same taxonomic level and below.
- The use of data collected from a taxonomic level above (e.g., genus) or below (e.g., subspecies) the species level should be supported by scientifically sound rationale (IPPC, 2013).
- If taxon-specific data are not available, use data from closely related taxa that have similar biology, but decrease the level of Certainty and document the source of the information.
- Information from closely related species (i.e., congeners) is more useful for more simple characteristics that are well conserved within taxonomic groups. Such evidence is less useful for complex characteristics that are not well conserved. See the Applicability of sources section for more information.
- Older sources may have a different genus or species name for the same plant.

5.2.6 (14) Sexually compatible relatives

- Sexually compatible relatives (SCR) are wild or cultivated taxa that can produce fertile offspring with the taxon being examined in this WRA without any intentional human assistance beyond hand pollination.
- Using a separate line for each known SCR, provide the following information:
    - Scientific name (common name if one exists)
    - Degree of compatibility (natural hybrids known, hybrids formed in field crosses, hybrids formed in laboratory crosses at a high rate, hybrids formed in laboratory crosses at a low rate, etc.); include whether compatibility is greater from pollen donor than the other; include percentage data if available
    - Whether the SCR is present in the U.S.
    - Whether the SCR is considered weedy or invasive, including the context in which it is considered a weed or invasive (e.g., corn field, rangeland, natural area, etc.) and whether it is on a Federal or State Noxious Weed List

  - Whether hybrids are more weedy or invasive than either parent
  - Information sources supporting the above findings.
- You may find it useful to research SCR at the same time you research (B02) Weedy and invasive relatives.
- When there is uncertainty due to dated or poor quality information sources, contact recognized experts (ideally greater than one) to get up-to-date knowledge.
- If an SCR exists in the U.S., a separate WRA for the SCR baseline and any applicable GE traits must be conducted.
- If there are many SCR for the taxon under evaluation, WRAs may be conducted for a sub-set of those SCRs and additional maps created to determine overlapping range or potential range.
- If you are unable to find any SCR, write "no SCR found".

5.3 GE trait

If this WRA is for a GE plant, you must understand the GE trait to identify any potential changes in weediness. Familiarize yourself with components of the GE trait: genotype, gene function, intended phenotype, and other (unintended) phenotypes. Consult with your supervisor to determine the appropriate genetic scope of the GE WRA (i.e., which gene components and their variations are inside or outside the scope).

Before you conduct a WRA for a GE plant, there must be a finalized baseline WRA for the taxon based on the identical version number of the WRA work instructions.

A GE WRA should indicate any changes compared to the baseline, including risks supported by documented evidence and plausible risk hypotheses. All plausible effects of the GE trait should be considered for each question. GE traits could increase or decrease weediness characteristics, effects could be neutral, or some weediness characteristics could be increased while others are decreased. If the GE trait could plausibly affect the taxon with respect to a weed risk question, then even if data are not available, change the risk and certainty ratings that were initially decided for the baseline taxon, as appropriate, and document your reasoning. If an answer to a weed risk question is already rated as very high (or negligible) in the baseline, but the GE trait could increase (or decrease) the risk even further, document the change and include it in the summary for the risk manager.

5.3.1 (15) GE phenotype category

If this WRA is for a GE plant, select the two-letter designation for one or more categories of the intended phenotype(s). If this is a baseline WRA, enter N/A.

- **AP**. Agronomic property (e.g., tolerance to specific environmental stresses, enhanced nitrogen use, male sterility)
- **BR**. Bacteria resistance
- **FR**. Fungal resistance
- **HR**. Herbicide resistance
- **IR**. Insect resistance
- **NR**. Nematode resistance
- **PQ**. Product quality (e.g., delayed ripening of fruit, altered amino acid profile, modified seed storage proteins, enhanced floral characteristics)
- **VR**. Virus resistance

- **MG**. Marker gene
- **OO**. Other modifications that do not clearly fall into one of the other categories (e.g., control lines transformed with empty vectors).

5.3.2 (16) GE phenotype

- If this WRA is for a GE plant, enter the GE phenotype intended by the genetic modification (e.g., increased biomass, Phytophthora resistance, increased oleic oil content, etc.).
- If this is a baseline WRA, enter N/A.

5.3.3 (17) GE phenotype description

- If this WRA is for a GE plant, enter a description of the GE phenotype intended by the genetic modification. In addition, describe other phenotypes that may be caused by the genetic modification. Include the mechanism of action by which the phenotype is conferred, if applicable. If important to a specific aspect of the phenotype, note details such as levels and tissue locations of gene expression.
- Document if any varieties of the taxon being evaluated have had similar phenotypes developed through breeding. Some GE traits may directly affect a plant trait (e.g., increased drought tolerance). For such traits, assume the highest risk rating for that question unless data are available that show otherwise.
- If this is a baseline WRA, enter N/A.

5.3.4 (18) GE genotype description

- If this WRA is for a GE plant, summarize relevant details of the introduced genetic material, i.e., the construct.
- Provide the abbreviation and full name of any introduced coding sequence (gene) and the organism from which it is derived. Provide similar information for associated regulatory elements (e.g., promoter, enhancer, terminator) if they are important to a specific aspect of the phenotype. For example, a tissue-specific promoter may be important for a specific aspect of the phenotype, whereas a constitutive promoter generally is not.
- Ensure that you are using proper gene nomenclature. This can be complicated and guidelines may change for different species or disciplines. The Plant Cell has guidance for genes from some plant species (Plant Cell, 2013); and The Society for the Study of Reproduction has guidance for genes from some animal species (Maltais, 2014).
- If applicable, include the unique identifier for the construct that was provided by the applicant, and include the source document number (e.g., notification, permit, or petition number) where more information about the GE plant can be found.
- If this is a baseline WRA, enter N/A.

5.4 Plant context

5.4.1 General guidance

- The taxonomy, geography, and biology sources in Section 9.0 may provide useful sources of information to answer these questions.

5.4.2 (19) Plant history

- Document the following information about the taxon, if applicable: center of origin, when the taxon was domesticated, when it was introduced to the United States, the primary uses of the plant (e.g., human food, animal feed, oil, biofuel feedstock) and the parts of the plant so used (e.g., grain, tubers, leaves), and the major cultivated types (including how much of the cultivated crop is GE).

5.4.3 (20) Plant biology and ecology

- Document the following information about the taxon, if applicable: annual or perennial, growth habit (e.g., grass, herb, shrub), whether plants typically reproduce from seed or vegetatively, seed germination requirements and characteristics, flowering and pollination characteristics, disease and pest susceptibilities, habitat types (see Table 5), and any other notable biological characteristics.

5.4.4 (21) Agronomic practices

- Document basic agronomic information, including whether plants of the taxon are commercially grown from seed or vegetatively propagated; whether plants are grown using tillage, reduced till, or no till; whether fertilizers, herbicides, pesticides or irrigation are used to maximize production; and how much of the crop is cultivated using organic practices.

5.4.5 (22) Management practices

- Is the taxon a known weed or does it act as a problematic volunteer? If yes, document the management practices used to control plants for each land use or habitat type (see Table 5) in which it occurs and the difficulty of managing the plant.
- Management practices used to control plants may differ depending on the land use, crop grown, soil, and climate. Management practices include:
    1. **Preventive methods**. Clean seed source, equipment cleaning, screening irrigation water.
    2. **Cultural methods**. Seedbed preparation, planting procedures, seed variety traits, crop rotation, stale seedbed, cover crops, soil maintenance, preventing overgrazing.
    3. **Mechanical methods**. Tillage before or after planting, hoeing, hand pulling and digging, mowing (note that mechanical methods may be counterproductive for plants with vegetative propagules or perennial roots that can resprout).
    4. **Chemical methods**. Pre-emergence, post-emergence, and autumn application of herbicides. Note that herbicide use may be affected by the developmental stage of the crop and by crop rotation, which may limit (plantback restrictions) or promote (herbicides that can prevent the establishment or reduce the size of the propagule bank in a subsequent crop) the use of certain herbicides. Be specific; identify the predominant types of herbicides used.

5.4.6 (23) Current U.S. geographic distribution

If this WRA is for a baseline plant, document the current geographic distribution of the taxon within the United States and territories. The current geographic distribution includes both where the plant is

cultivated and where the plant is established without intentional human assistance (e.g., as a native in its U.S. range or as a naturalized, weedy, or invasive plant).

- First, identify where the taxon is cultivated (this information can usually be obtained from the Census of Agriculture or NASS) and/or if native to the U.S., identify its native U. S. range (this information can usually be found in the PLANTS Database or BONAP).
- Next, identify where the taxon is reported as naturalized, weedy, or invasive in the U.S. Include where the taxon is reported as escaped if all reports of escapes are recent (within approximately ten years) or the ultimate fate of the escapes (i.e., whether they form self-perpetuating populations) is uncertain (e.g., conflicting reports in the literature). However, keep in mind that ALL reports of escapes will be required for (B01) Current weed and invasive status.
- For each primary source that provides convincing evidence that plants of the taxon are growing without intentional human assistance, determine the plant hardiness zone and the precipitation zone at the location where plants are reported to grow and document the source in the appropriate section of (24) Plant hardiness and precipitation zones. Do not include reports of cultivation in field (24).
- Prepare a short written summary of the current cultivated range, current native range, and/or the range where it occurs as a naturalized, weedy, or invasive plant in the U.S., if applicable.
- Attach maps from the Census of Agriculture, NASS, PLANTS, BONAP or other source to illustrate these ranges. Cultivation maps generated in ArcGIS using NASS data are acceptable and may be superior to cultivation maps from other sources. Maps indicating where the taxon is naturalized, weedy, or invasive may not be easily available, although can be generated in ArcGIS using point source or other data from the literature. However, discuss with your supervisor before attempting to construct such a map.
- This information on current U.S. distribution may be useful for (B01) Current weed and invasive status.

If this WRA is for a GE plant which has a history of cultivation in the U.S., document where the GE plant is cultivated and for how long. Attach a map if available.

5.4.7 (24) Plant hardiness and precipitation zones

If this WRA is for a baseline plant, document the plant hardiness zones and precipitation zones where the taxon grows without intentional human assistance, both inside and outside the U.S.

- First, identify where the taxon is reported as native, naturalized, weedy, or invasive **outside the U.S.** Include where the plant is reported as escaped if all reports of escapes are recent (within approximately ten years) or the ultimate fate of the escapes (i.e., whether they form self-perpetuating populations) is uncertain (e.g., conflicting reports in the literature). However, keep in mind that ALL reports of escapes will be required for (B01) Current weed and invasive status.
- For each primary source that provides convincing evidence that plants of the taxon are growing without intentional human assistance, determine the plant hardiness zone and precipitation zone at the location where plants are reported to grow and document the source in the appropriate section of this field.
- Document only primary sources that provide convincing evidence that the plant is growing without intentional human assistance. Do not include reports of cultivation.

5.4.8 (25) Potential U.S. geographic distribution

If this WRA is for a baseline plant, determine where the plant has the potential to establish in the U.S. without intentional human assistance. Do not consider cultivation when determining potential distribution.

- Based on information documented in (24) Plant hardiness and precipitation zones, identify matching climates in the U.S.
- Prepare a short written summary of the information on matching climates and attach a map displaying the potential geographic distribution, based on temperature and precipitation range.
- If the plant has been cultivated in the U.S in the climate-matched area, document if and how long it has been cultivated without escape or naturalization.
- This information may be useful for (B01) Current weed and invasive status.

If this WRA is for a GE plant, determine if/how the geographic distribution might change due to the GE trait.

6.0 Weed risk questions – Biology

This section addresses biological characteristics associated with weediness and invasiveness as measured by Known weediness, Competitive growth ability, Reproduction, Spread and persistence, and Stress tolerance.

6.1 Known weediness

The questions in this category assess the previously established weediness of the taxon and its relatives, as measured by (B01) Current weed and invasive status and (B02) Weedy and invasive relatives. No changes are expected to the baseline risk rating for B01 and B02 due to GE traits.

6.1.1 (B01) Current weed and invasive status

- Use information from (23) Current U.S. geographic distribution to assess whether the taxon has escaped, naturalized, or demonstrated weediness or invasiveness in the U.S.
- Use information from (24) Plant hardiness and precipitation zones and (25) Potential U.S. geographic distribution to assess whether the taxon has escaped, naturalized, or demonstrated weediness or invasiveness outside the U.S. in areas that match climates in the U.S. Consider all reports of casual or escapes, not just the limited set required for the geographic background questions. Known weediness of a species in one location can predict weediness in a new location (Richardson *et al.*, 2000; Reichard, 2001; Warner *et al.*, 2003; Morse *et al.*, 2004; Caley and Kuhnert, 2006; Ellstrand *et al.*, 2010; Koop *et al.*, 2012). The risk rating for a taxon may vary among areas of the U.S. Select the highest risk rating and document the area of the U.S. to which it applies. Document any lower risk ratings for other areas.
- Plants that are native in the U.S. automatically receive a Negligible risk rating unless a) they are considered weedy in the U.S. within their native range or b) they are considered casual/escaped, naturalized, or are weedy or invasive in areas of the U.S. outside their native range, in which case they receive an appropriate higher risk rating.

- Decrease the certainty rating if the information used to support the risk rating is from outside of the U.S. A risk rating based on such data cannot receive any higher than Moderate certainty.
- The risk rating scale below is also presented as a risk rating matrix in Table 4.

Rating scale

- **Very high**. Plant is weedy or invasive anywhere in the U.S.; or the plant has been cultivated in an area of the U.S. for less than 50 years or never cultivated in the U.S *and* it is weedy or invasive in a climate-matched region elsewhere.
- **High**. Plant is naturalized anywhere in the U.S.; or the plant has been cultivated in an area of the U.S. for less than 50 years or never cultivated in the U.S. *and* it is naturalized in a climate-matched region elsewhere, or it is weedy or invasive in a non-climate-matched region elsewhere.
- **Moderate**. Plant is casual or escaped anywhere in the U.S.; or the plant has been cultivated in an area of the U.S. for less than 50 years or never cultivated in the U.S. *and* it is casual or escaped in a climate-matched region elsewhere, or it is naturalized in a non-climate-matched region elsewhere. If the casual or escaped plants are from a plant that is highly domesticated, reduce the risk rating one level. If reports of casual or escaped plants in the U.S. are over 50 years old, reduce the rating one level. Note that if both of these conditions are true, the risk rating will be lowered two levels.
- **Low**. Plant has been cultivated in an area of the U.S. for less than 50 years or never cultivated in the U.S. and is not invasive, weedy, naturalized, casual or escaped in the U.S. or is casual or escaped in a non-climate-matched region elsewhere.
- **Negligible**. Plant is not invasive, weedy, naturalized, casual or escaped anywhere in the U.S. where it has been cultivated for more than 50 years, *or* the plant has been cultivated in an area of the U.S. for less than 50 years or never cultivated in the U.S. *and* it is not invasive, weedy, naturalized, casual or escaped in any climate-matched region elsewhere.

Table 4. Risk rating matrix for (B01) Current weed and invasive status.

Highest reported stage of invasion for taxa being assessed	**Cultivated in U.S. > 50 years**	**Cultivated in U.S. < 50 years or never**
Weedy/Invasive in U.S.	Very High	Very High
Weedy/Invasive in Climate-Matched Region Elsewhere (CMRE)	N/A	Very High
Weedy/Invasive in non-CMRE	N/A	High
Naturalized in U.S.	High	High
Naturalized in CMRE	N/A	High
Naturalized in non-CMRE	N/A	Moderate
Casual/Escape in U.S.	Moderate[ab]	Moderate[a]
Casual/Escape in CMRE	N/A	Moderate[a]
Casual/Escape in non-CMRE	N/A	Low[a]
Not weedy/invasive/naturalized/ casual/escaped in U.S.	Negligible	Low
Not weedy/invasive/naturalized/ casual/escaped in CMRE	N/A	Negligible

[a] If casual/escaped plants are from a taxon that is highly domesticated, reduce risk rating one level.
[b] If reports of casual/escaped plants in the U.S. are over 50 years old, reduce risk rating one level.

6.1.2 (B02) Weedy and invasive relatives

- Assess whether the plant has relatives that are weedy or invasive in the United States or elsewhere.
- Plants with relatives that are weedy or invasive may have an increased propensity for weediness or invasiveness. Plants that produce weedy or invasive hybrids pose increased weed risk (Pheloung *et al.*, 1999; Morse *et al.*, 2004; Ellstrand *et al.*, 2010; Koop *et al.*, 2012).

Rating scale

- **Very high**. Conspecific plant is weedy or invasive.
- **Moderate**. Congeneric plant is weedy or invasive.
- **Negligible**. No weedy or invasive congeners, conspecifics or plant is highly domesticated. Highly domesticated plants are plants that have been intentionally selected by humans over many generations for traits that have likely reduced their weediness. Supporting evidence must be documented in order to assign a Negligible risk rating due to domestication of the plant.

6.2 Competitive growth ability

The questions in this section assess the taxon and GE variety's competitive growth ability, as measured by (B03) Ability to establish, (B04) Dense thickets or monospecific stands, (B05) Shade tolerance, and (B06) Life form and growth habit.

6.2.1 (B03) Ability to establish

- Assess whether seedlings and dispersed vegetative propagules could establish in existing vegetation (e.g., crops, pastures, grasslands, wetlands, shrublands, forest, native and naturalized vegetation) (Morse *et al.*, 2004; Pyšek and Richardson, 2007; Barney and DiTomaso, 2008; Virtue, 2008; VIC DPI, 2009; Keese *et al.*, 2013).
- This question addresses the ability of individual plants to establish, not the ability of the plant to establish a self-perpetuating population. However, in the absence of other evidence, the establishment of a self-perpetuating population can be an indirect indicator of the ability of individual plants to establish. Consider establishment ability within the type of land uses and habitats in which the plant occurs (see Table 5). Where the plant occurs in more than one land use, select the highest risk rating among all land use categories.

Search tips

- Volunteer information from various climates can inform this rating.
- You can find information on seedling vigor in the Conservation Plant Characteristics documents in the USDA PLANTS Database or in the literature.

Rating scale

- **Very high**. Seedlings readily establish in dense or well-established vegetation with intense competition from other plant taxa (e.g., healthy, mature native plant communities and well-established naturalized vegetation).
- **High**. Seedlings establish in less dense, relatively intact vegetation with high competition from other plant taxa (e.g., vigorously growing crops with closed canopies; well-managed and regularly overseeded pastures; established native and naturalized vegetation with only minor disturbance or sparse distribution of small gaps and openings).
- **Moderate**. Seedlings mainly establish in open or moderately disturbed vegetation with moderate competition from other plant taxa (e.g., developing crops with open canopies; moderately grazed pastures and rangelands; regenerating native or naturalized vegetation with a moderate distribution of gaps and openings; some wildlife corridors).
- **Low**. Seedlings mainly establish in very open or highly disturbed vegetation with little competition from other plant taxa (e.g., recently planted ground, very young or poorly growing crops, heavily grazed pastures or rangelands, highly degraded or disturbed native or naturalized vegetation, roadsides, utility right-of-ways, areas impacted by humans such as tourist areas or campsites).
- **Negligible**. Seedlings require mainly bare ground to establish, including removal of stubble/leaf litter, with little or no competition from other plant taxa (e.g., cultivation, overgrazing, hot fires, herbicide burndown, long-term floods or droughts); or seedlings require intentional human assistance to establish, such as the deliberate addition of specific nutrients or water.

6.2.2 (B04) Dense thickets or monospecific stands

- Assess whether the plant could grow in dense thickets or monospecific stands without intentional human assistance (Tye, 2001; Brunel *et al.*, 2012; Koop *et al.*, 2012).
- Dense thickets are plants that grow close together such that they exclude most other organisms.
- Monospecific stands are areas of plant growth that are dominated by a single type of plant.
- Plants that grow in dense thickets or in monospecific stands may be able to outcompete crops and wild plants for water, light, nutrients, and space.

Rating scale

- **Very high**. Plant can grow in dense thickets or monospecific stands without intentional human assistance.
- **Negligible**. Plant cannot grow in dense thickets or monospecific stands, or only grow in dense thickets or monospecific stands with intentional human assistance.

6.2.3 (B05) Shade tolerance

- Assess whether the plant can tolerate low light levels with no direct light at some stage of its life cycle. Consideration of the taxon's ecological niche may help address this question. (Koop et al., 2012; Pheloung et al., 1999).
- Consideration of the effects of shade on propagule production may also help address this question. However, low propagule production or fecundity is a plant feature associated with increased shade tolerance (Valladares and Niinemets, 2008), so consider relative propagule production, rather than absolute, if you can find data comparing responses to light gradients.

Rating scale

- **Very high**. Plant can grow in full shade at any stage in the life cycle; or exposure to low light levels causes only a small to moderate reduction in propagule production.
- **Negligible**. Plant requires full or partial sun; or exposure to low light levels causes a major reduction in propagule production.

6.2.4 (B06) Life form and growth habit

- Assess if the plant is a grass, aquatic, or N-fixing woody plant, or has a climbing or rosetting growth habit.

Rating scale

- **Very high**. The plant is a grass, aquatic, or N-fixing woody plant, or has a climbing or rosetting growth habit.
- **Negligible**. The plant is not a grass, aquatic, or N-fixing woody plant, or does not have a climbing or rosetting growth habit.

6.3 Reproduction

The questions in this section assess the reproductive ability of the taxon and GE variety without intentional human assistance, as measured by (B07) Time to reproductive maturity and (B08) Reproductive potential.

6.3.1 (B07) Time to reproductive maturity

- Assess the plant's time to reproductive maturity without intentional human assistance (Warner *et al.*, 2003; Morse *et al.*, 2004; Skurka Darin *et al.*, 2011; Koop *et al.*, 2012; Keese *et al.*, 2013). Time to reproductive maturity is the time needed from germination or rooting of a new plant to production of seed, vegetative propagules or clones capable of independent growth.
- Do not assume that a plant cannot reproduce in its first year just because it is a biennial or perennial.
- Do not consider multiple reproductive cycles that result only from replanting by humans.
- Only consider asynchronous seed production if it results in multiple generations per year.

Search tips

- If the databases are not helpful, search for the plant name and years flower, years seed, annual, or perennial.

Rating scale

- **Very high**. Multiple generations per year are possible. This is uncommon for plants reproducing by seed, but some vegetatively reproducing plants may produce multiple generations in a year.

- **High**. Plants reach reproductive maturity within one year and have only one generation per year. Include plants that germinate, grow, and reproduce quickly, but have perennating parts or seeds that remain dormant for the rest of the year.
- **Moderate**. Plants reach reproductive maturity in two to three years.
- **Low**. Plants require more than three years to reach reproductive maturity.
- **Negligible**. Plants require human assistance to reach reproductive maturity.

6.3.2 (B08) Reproductive potential

- Assess the sexual and vegetative reproductive potential of the plant without intentional human assistance, as measured by propagules per square meter (Koop *et al.*, 2012; Keese *et al.*, 2013).
- Reproductive potential applies only to viable seeds and distinct individuals that could grow apart from the parent plant.
- Vegetative reproduction potential may include new plants that develop from rhizomes, stolons, roots, or stems that root at the nodes, as well as new plants sprouting from fragments of an adult plant, and other means of vegetative reproduction.
- Do not consider vegetative reproduction caused by humans.

Search tips

- Use quantitative information from three or more sources when available, because single sources can vary greatly on this question.
- Search for the plant name and the term seed production.
- There are multiple ways to determine propagules per square meter. Examples: a) the literature provides the number directly; b) calculate from data on propagules/plant and plants/unit area; c) calculate from data on propagules/plant and crown area/plant; d) calculate from weight of propagules/unit area and individual propagule weight.
- Data from highly controlled artificial conditions should not be used for this question (e.g., incubator, greenhouse), but data from managed agricultural fields may be used with lower certainty. Data from studies of the effect of weed competition on crop yield may be especially useful as an indirect measure of the potential yield of some cultivated taxa when growing without intentional human assistance.

Rating scale

- **Very high**. Plants produce more than 1,000 viable seeds or more than 10 plants vegetatively per square meter per year.
- **Moderate**. Plants produce 10 to 1,000 viable seeds or 2 to 10 plants vegetatively per square meter per year.
- **Negligible**. Plants produce 9 or fewer viable seeds, 1 or fewer new plants vegetatively per square meter per year, or require intentional human assistance to reproduce.

6.4 Spread and persistence

The questions in this section assess whether the taxon and GE variety could spread over large areas and persist over time without intentional human assistance, as measured by (B09) Propagule dispersal, (B10) Dormancy, and (B11) Regeneration.

6.4.1 (B09) Propagule dispersal

- Assess the plant's potential to spread viable propagules without intentional human assistance (van der Pijl, 1982; Forcella, 1985; Willson, 1993; Higgins and Richardson, 1999; Pheloung *et al.*, 1999; Warner *et al.*, 2003; Morse *et al.*, 2004; Brunel *et al.*, 2012; Koop *et al.*, 2012; Keese *et al.*, 2013).
- Pollen is not a propagule.
- Consider natural dispersal mechanisms that can spread propagules (water, wind, birds, mammals, etc.), and unintentional human-mediated dispersal (clothing, agricultural machinery, tires, etc.).
- Do not consider intentional human-mediated movement of propagules.
- You can use morphological adaptations for dispersal in the absence of direct evidence for dispersal, but with a lower certainty rating. Morphological adaptations for seed dispersal include, but are not limited to: water dispersal with waterproof outer structures or structures that increase buoyancy; wind dispersal with very light seeds, hairs, wings, or a pappus; dispersal by birds and mammals with fleshy fruits or arils; barbs, spines or other structures that adhere to fur, feathers, or clothing.

Search tips

- The PLANTS Database information on seed spread rate may help inform your answer.

Rating scale

- **Very high**. Documented evidence for regular (versus sporadic) long-distance (>1 km) dispersal by any means that results in reproductive offspring.
- **High**. Dispersal by three or more classes of natural vectors (i.e., wind, birds, other highly mobile animals, or flowing water), without documented evidence for regular long-distance dispersal.
- **Moderate**. Dispersal by one or two classes of natural vectors (i.e., wind, birds, other highly mobile animals, or flowing water), without documented evidence for regular long-distance dispersal.
- **Low**. Dispersal by animals with small ranges (e.g., ants, mice), unintentional movement by humans nearby (e.g., agricultural equipment), short distance dispersal by water, or by explosive dispersal by plants (e.g., *Euphorbia*); without documented evidence for regular long-distance dispersal.
- **Negligible**. Propagules mainly spread by gravity or require intentional human assistance to disperse.

6.4.2 (B10) Dormancy

- Assess whether propagules could remain dormant in the soil or canopy (i.e., forming a seed bank, long-lived bulbs or rhizomes) for greater than 12 months without intentional human assistance (Thompson *et al.*, 1997; Baskin and Baskin, 1998b; 1998a; Koop *et al.*, 2012).
- Dormancy is a mechanism to prevent germination during unsuitable ecological conditions or to allow plants to extend germination over a period of years, and may have physical, physiological, and morphological aspects.
- Long-term propagule viability in the environment may increase weedy or invasive potential because the plant can escape unfavorable conditions.

- If propagules have variability in dormancy in different environments, select the environment with the highest rating scale and describe the variability in your response.

Search tips

- Search for the plant name and dormancy, storage, bank, recalcitrant germination, or viability years.
- Do not use data from highly controlled artificial conditions (e.g., seed stored in liquid nitrogen can remain viable indefinitely).
- Literature consensus that propagules lack dormancy can support a negligible rating in the absence of specific data.

Rating Scale

- **Very high**. More than 1% of propagules remain dormant and viable without intentional human assistance for greater than 12 months, or propagules require dormancy-breaking treatment in order to germinate.
- **Negligible**. Less than 1% of propagules are viable after 12 months.

6.4.3 (B11) Regeneration

- Assess whether the plant is able to regenerate without intentional human assistance after removal of most of its biomass by mutilation, cultivation, herbivory, or fire (Warner *et al.*, 2003; Morse *et al.*, 2004; Koop *et al.*, 2012). This includes resprouting, coppicing, and suckering.
- Do not consider seasonal changes (e.g., winter dieback) or growing from seeds or bulbs.

Search tips

- Search for the plant name and regeneration, resprout, coppicing, suckering, or ratoon.

Rating scale

- **Very high**. Plants are able to regenerate without intentional human assistance when broken, cut, grazed, or burned. Plants adapted to biomass loss through grazing, browsing, or fire pressure should receive a high risk rating.
- **Negligible**. Plants are not able to regenerate without intentional human assistance when broken, cut, grazed, or burned.

6.5 Stress tolerance

The questions in this section assess whether the taxon and GE variety could survive to reproduction without intentional human assistance despite various stressors, as measured by (B12) Flood or drought tolerance, (B13) Tolerance to poor soils, (B14) Cold tolerance, and (B15) Biotic stress tolerance.

Because stress tolerance can be a complex trait, the certainty rating should be lower than Very high unless there is strong documented evidence supporting a Very high rating. If tolerance to a specific stress is the intended GE trait, select the highest risk rating unless evidence has been provided otherwise. Consider

tolerance found in the non-GE plant as well as due to the GE trait. For perennials, reproduction need not occur in the same year the stress was encountered.

6.5.1 (B12) Flood or drought tolerance

- Assess the plant's ability to survive to reproduction in flood or drought conditions without intentional human assistance (Kartesz, 2013; Koovers, 2015).
- Plants use a variety of mechanisms to achieve drought tolerance. Desiccation tolerance is an extreme degree of drought tolerance.
- Because stress tolerance can be a complex trait, the certainty rating should be lower than Very high unless there is strong documented evidence supporting a Very high rating.
- If tolerance to a specific stress is the intended GE trait, select the highest risk rating unless evidence has been provided otherwise.
- Consider tolerance found in the non-GE plant as well as due to the GE trait.
- For perennials, reproduction need not occur in the same year the stress was encountered.

Search tips

- Precipitation bands (National Atlas of the U.S., 2005) and global and domestic distribution in the absence of irrigation may inform the rating of this question, when compared with the known range of the species.
- Volunteer information from various locations can inform this rating.

Rating scale

- **Very high**. Plant could survive to reproduction with only minor, if any, reductions in propagule production in prolonged periods of drought or flood, or has low water demand or high water use efficiency.
- **Moderate**. Plant could survive to reproduction with moderate reductions in propagule production in intermittent periods of drought or flood.
- **Negligible**. Plant cannot survive to reproduction in drought or flood conditions, or requires intentional human assistance to survive to reproduction in drought or flood conditions.

6.5.2 (B13) Tolerance to poor soils

- Assess the plant's soil requirements and ability to survive to reproduction in poor soils without intentional human assistance such as addition of fertilizers (Standards Australia and Standards New Zealand, 2006; Stone *et al.*, 2008; Kartesz, 2013).
- Good soils have characteristics such as high organic matter content; good texture with large pore spaces for adequate air infiltration and water movement; can hold a reasonable supply of water and nutrients; ease of tillage; and low impedance to seedling emergence and root penetration (Whiting *et al.*, 2011). Poor soils have characteristics such as low organic matter; inadequate nutrients; poor texture (e.g., particles too large or too small) or structure (e.g., soil is compacted or waterlogged) (Swanson); or contamination with harmful compounds (e.g., salt, arsenic).
- Because stress tolerance can be a complex trait, the certainty rating should be lower than Very high unless there is strong documented evidence supporting a Very high rating.
- If tolerance to a specific stress is the intended GE trait, select the highest risk rating unless evidence has been provided otherwise.

- Consider tolerance found in the non-GE plant as well as due to the GE trait.
- For perennials, reproduction need not occur in the same year the stress was encountered.

Search tips

- Maps of global soil regions may inform the rating of this question, when compared with the known range of the plant.
- Volunteer information from various locations can inform this rating.

Rating scale

- **Very high**. Plant could survive to reproduction with only minor, if any, reductions in propagule production in low nutrient or otherwise poor soils; or the plant could produce ample propagules in a wide range of soil types.
- **Moderate**. Plant could survive to reproduction with moderate reductions in propagule production in low nutrient or otherwise poor soils.
- **Negligible**. Plant cannot survive to reproduction without intentional human assistance (e.g., specific additions of nutrients to soils), or require a specific type of soil, or nutrient-rich soils that are low in harmful compounds.

6.5.3 (B14) Cold tolerance

- Assess the plant's ability to survive to reproduction or over winter in cold temperatures without intentional human assistance (Goodwin *et al.*, 1999; Magarey *et al.*, 2008; Koop *et al.*, 2012; Kartesz, 2013). Do not consider dormancy of propagules as cold tolerance.
- Cold tolerant plants can have a wide geographic survival range, long growing season, or reduced impact of cold temperatures on plant germination or growth.
- Cold tolerance can be due to adaptations that allow survival through short periods of cold temperatures, acclimation (hardening) to longer periods of cold temperatures, growth throughout cold temperatures, or postponement of growth until temperatures become amenable for growth. For annuals to be considered cold-tolerant, they must be able to withstand cold temperatures before senescence.
- Because stress tolerance can be a complex trait, the certainty rating should be lower than Very high unless there is strong documented evidence supporting a Very high rating.
- If tolerance to a specific stress is the intended GE trait, select the highest risk rating unless evidence has been provided otherwise.
- Consider tolerance found in the non-GE plant as well as due to the GE trait.
- For perennials, reproduction need not occur in the same year the stress was encountered.

Search tips

- Global and domestic distribution may be helpful in determining cold tolerance.
- For trees, shrubs, perennials, and biennials, USDA Plant Hardiness Zones (USDA-ARS, 2012) may also be helpful, when compared with the known range of the plant.
- Volunteer information from various locations can inform this rating.

Rating scale

- **Very high**. Plant could survive to reproduction with only minor, if any, reductions in propagule production in heavy frosts or temperatures severely below freezing (<28°F).
- **Moderate**. Plant could survive to reproduction with moderate reductions in propagule production in light frosts or temperatures at or moderately below freezing (28° to 33°F).
- **Negligible**. Plant cannot survive to reproduction in frosts or freezing temperatures (<33°F) without intentional human assistance.

6.5.4 (B15) Biotic stress tolerance

- Assess the plant's ability to survive to reproduction under the pressures of herbivory or pathogens without intentional human assistance (Raghu *et al.*, 2006; Ellstrand *et al.*, 2010; Davis *et al.*, 2011; Keese *et al.*, 2013; Richardson, 2013).
- Because stress tolerance can be a complex trait, the certainty rating should be lower than Very high unless there is strong documented evidence supporting a Very high rating.
- If tolerance to a specific stress is the intended GE trait, select the highest risk rating unless evidence has been provided otherwise.
- Consider tolerance found in the non-GE plant as well as due to the GE trait.
- For perennials, reproduction need not occur in the same year the stress was encountered.

Rating scale

- **Very high**. Herbivores or pathogens could not reduce the plant's ability to survive to reproduction, causing only minor, if any, reduction in propagule production. This rating may apply to exotic plants in the absence of their native herbivores and pathogens.
- **Moderate**. Herbivores or pathogens could reduce the plant's ability to survive to reproduction or cause a moderate reduction in propagule production.
- **Negligible**. Herbivores or pathogens could prevent the plant from surviving to reproduction without intentional human assistance.

6.6 Other weediness traits

Over time, as more WRAs are conducted, additional weediness characteristics may be identified and additional questions may be added. This question is designed to capture any potential additional weediness characteristics.

6.6.1 (B16) Other biology weediness traits

- Assess any other characteristics (baseline or GE) that could increase the taxon or GE variety's ability to establish, persist, and spread without intentional human assistance that have not been accounted for in the questions above.
- Documentation is required for any response other than negligible risk and high or very high certainty.
- Be sure that any information provided here is not better suited for another question.

Rating scale

- **Very high**. Plant has other characteristics that could highly increase its ability to establish, persist, and spread.
- **Moderate**. Plant has other characteristics that could moderately increase its ability to establish, persist, and spread.
- **Low**. Plant has other characteristics that could slightly increase its ability to establish, persist, and spread.
- **Negligible**. Plant is not known to have any other characteristics that could increase its ability to establish, persist, and spread.

7.0 Weed risk questions - Impact

The questions in this section assess whether the taxon or GE variety could have an impact on agricultural plants or agriculturally important natural resources, as measured by Agricultural impacts, Biotic impacts, and Abiotic impacts.

7.1 Agricultural impacts

The questions in this section assess whether the taxon or GE variety could have an impact on agricultural plants, as measured by (I01) Agriculture yield, and (I02) Agriculture quality. Consider the potential for agricultural impacts in the context of the land uses and habitat types (see Table 5) in which the plant does or could establish, unless noted otherwise.

7.1.1 (I01) Agriculture yield

- Assess the plant's ability to reduce yields of other agricultural plants (not including the plant being assessed) (Koop *et al.*, 2012; Keese *et al.*, 2013).
- Consider potential impacts to agriculture yield only in ecosystems where the plant could establish without intentional human assistance.
- Yield is the amount of desired vegetation produced by the land; it can include crop plants, plants grown in pasture, and other plants in various forms of agriculture.
- Do not consider volunteers in the season after a plant is intentionally grown.
- Do consider persistent growth of unintended plants in subsequent years and escaped plants that infiltrate a field from other areas.

Search tips

- Yield could be decreased through a variety of mechanisms, including: competition for nutrients, light, and water resources; direct damage to plants through parasitism or allelopathy; and increase in difficulty of harvesting.
- In the absence of quantitative data on yield loss, evidence of control may be evidence for yield loss.

Rating scale

- **Very high**. Plants could reduce yields by more than 10%.

- **Moderate**. Plants could reduce yields by 1 to 10%.
- **Negligible**. Plants could reduce yields by less than 1% or are unlikely to establish without intentional human assistance.

7.1.2 (I02) Agriculture quality

- Assess the plant's ability to reduce the quality of plant products obtained from the land (not including products from the plant being assessed), including pasture and grazing quality (Koop *et al.*, 2012; Keese *et al.*, 2013).
- Consider potential impacts to agriculture quality only in ecosystems where the plant could establish without intentional human assistance or in situations when co-mingled seed or other parts of plants being assessed have a property that could cause biological or physical damage to agricultural plants or plant products (e.g., corn expressing amylase).
- Do not consider volunteers in the season after a plant is intentionally grown.
- Do consider persistent growth of unintended plants in subsequent years and escaped plants that infiltrate a field from other areas.

Rating scale

- **Very high**. Plants could severely reduce agriculture quality such that plants or products cannot be used.
- **Moderate**. Plants could reduce agriculture quality such that plants or products cannot be used for their intended purpose (e.g., as may occur in some cases of grain contaminated with weed seeds that cannot be removed).
- **Low**. Plants could reduce agriculture quality, but the plants or products can still be used for their intended purpose (e.g., edible but less palatable plants reduce quality of grazing land).
- **Negligible**. Plants are not expected to affect agriculture quality.

7.2 Biotic impacts

The questions in this section assess the potential biotic impacts of the taxon or GE variety on agriculturally important natural resources as measured by (I03) Harm to agriculturally important organisms and (I04) Competition with plants. Consider the potential for biotic impacts in the context of the land uses and habitat types (see Table 5) in which the plant does or could establish, unless noted otherwise.

These biotic impacts may result in changes in community composition or ecosystem services that could have a negative impact on agricultural plants and agriculturally important natural resources.

7.2.1 (I03) Harm to agriculturally important organisms

- Assess the plant's ability to produce harmful substances (e.g., a known toxin) or structures (e.g., spines, barbs) that harm agriculturally important organisms (Pheloung *et al.*, 1999; Burrows and Tyrl, 2001; Qasem and Foy, 2001; Power, 2010; Koop *et al.*, 2012; Keese *et al.*, 2013).
- Consider substances and structures produced by the taxon or GE variety, but do not consider substances that are applied externally during farming such as pesticides or fertilizers.

- Consider harms that could result from any substances produced by the plant, including proteins, RNA, anti-nutrients, and metabolites.
- For GE plants, consider whether the GE phenotype could have impacts on organisms that are important to agricultural plants and agriculturally important natural resources, (e.g., male sterility or flower color impacts on pollinators), including secondary effects (e.g., if the GE plant kills aphids which may reduce the food source for ladybird beetles).
- If a substance produced by the plant could be harmful to agriculturally important organisms, provide information on toxicity or other effects and the potential for exposure. Include where the substance is expressed in the plant, the amount, and the potential impacts on non-target organisms from each potential route of exposure.

Rating scale

- **Very high**. Plants could cause death, major illness, or a large decrease in abundance of one or more agriculturally important organisms.
- **Moderate**. Plants could cause slight injuries or minor illness, or a reduction in the palatability, quantity, or nutritional quality of a food source for one or more agriculturally important organisms, with no lasting effects.
- **Negligible**. Plants are not known to harm agriculturally important organisms.

7.2.2 (I04) Competition with plants

- Assess the plant's ability to outcompete or displace other plants during or after the establishment phase in a way that could have a negative impact on agriculturally important natural resources (Zavaleta, 2000; Power, 2010; Eviner *et al.*, 2012).
- Consider competition with non-crop plants only in ecosystems where the plant being assessed could establish without intentional human assistance.
- Examples include: shading, climbing or smothering growth habit, allelopathy, and parasitism.
- Competition with crop plants is addressed in (I01) Agriculture yield, and biology characteristics that affect a plant's ability to establish are addressed in (B03) Ability to establish.

Rating scale

- **Very high**. Plants could cause elimination or major reduction in abundance of one or more local plant populations.
- **Moderate**. Plants could cause a minor reduction in abundance of one or more local plant populations, which may result in a decrease in long-term abundance.
- **Negligible**. Plants are not expected to cause perceivable negative changes in local plant populations, or are unlikely to establish without intentional human assistance.

7.3 Abiotic impacts

The questions in this section assess the potential abiotic impacts of the taxon or GE variety on agriculturally important natural resources when growing without intentional human assistance, as measured by (I05) Hydrology, (I06) Soil quality, (I07) Fire regime, and (I08) Physical obstructions. Consider the potential for abiotic impacts in the context of the land uses and habitat types (see Table 5) in which the plant does or could establish.

7.3.1 (I05) Hydrology

- Assess the plant's ability to cause a detrimental change in hydrology (Morse *et al.*, 2004; Pejchar and Mooney, 2009; Koop *et al.*, 2012) only in ecosystems where the plant could establish without intentional human assistance.
- Detrimental effects on hydrology include: lowering or raising the water table; draining water from wetland systems through rapid transpiration, making these systems unable to support native wetland plants and animals; rendering wetlands unable to perform purification services important for agriculture; reducing the availability of water for irrigation; increasing the likelihood of flooding; increasing sedimentation rates along coastlines; or reducing open water areas.
- Evidence that plants could change the flow of water includes: deeper roots, higher evapotranspiration rates, or greater biomass compared to other plants.

Search tips

- The PLANTS Database Conservation Plant Characteristic "Moisture use" may inform this rating.

Rating scale

- **Very high**. Plants could cause a major detrimental change in hydrology (e.g., by using water excessively or greatly reducing water availability for other organisms in the ecosystem).
- **Moderate**. Plants could cause some detrimental change in hydrology.
- **Negligible**. Plants are unlikely to cause a detrimental change in hydrology, or are unlikely to establish without intentional human assistance.

7.3.2 (I06) Soil quality

- Assess the plant's ability to negatively affect soil quality (Morse *et al.*, 2004; Koop *et al.*, 2012) only in ecosystems where the plant could establish without intentional human assistance.
- Soil quality includes high organic matter content; good texture with large pore spaces for adequate air infiltration and water movement; can hold a reasonable supply of water and nutrients; ease of tillage; and low impedance to seedling emergence and root penetration (Whiting *et al.*, 2011).
- Soil quality could be influenced by many factors, including the ratio of carbon and nitrogen in the plant, erosion (e.g., shallow root systems may promote erosion), and altered decomposition (e.g., increased lignin reduces speed of decomposition).

Rating scale

- **Very high**. Plants could cause a major detrimental change in soil quality. Examples include plants that promote erosion, alter decomposition, or cause a detrimental change in soil nutrient availability.
- **Moderate**. Plants could cause a minor detrimental change in soil quality.
- **Negligible**. Plants are unlikely to cause a detrimental change in soil quality, or are unlikely to establish without intentional human assistance.

7.3.3 (I07) Fire regime

- Assess the plant's ability to cause a change in the frequency or intensity of fires (Morse *et al.*, 2004; Zouhar *et al.*, 2008; Koop *et al.*, 2012) only in ecosystems where the plant could establish without intentional human assistance.
- Examples include: plants that could promote fire in habitats that otherwise rarely support fires, or plants that could cause a decrease or increase in fires in a habitat that naturally supports fires.

Rating scale

- **Very high**. Plants could cause a change in the frequency or intensity of fires. Examples include major changes in the amount of dry matter or oil content of plant matter, which could increase the fuel load.
- **Negligible**. Plants are unlikely to cause a change in the frequency or intensity of fires, or are unlikely to establish without intentional human assistance.

7.3.4 (I08) Physical obstructions

- Assess the plant's ability to restrict the physical movement of people, livestock, wildlife, vehicles, machinery, or water (Koop *et al.*, 2012; Keese *et al.*, 2013) only in ecosystems where the plant could establish without intentional human assistance.
- Examples include: dense growing aquatic or land plants that restrict physical movement, vines on power lines, and plants that can damage natural or man-made structures.

Rating scale

- **Very high**. Plants could be impenetrable, preventing physical movement.
- **Moderate**. Plants could slow physical movement or provide a minor obstruction, but would never be impenetrable.
- **Negligible**. Plants are not expected to affect physical movement, or are unlikely to establish without intentional human assistance.

7.4 Other weediness traits

Over time, as more WRAs are conducted, additional weediness characteristics may be identified and additional questions may be added. This question is designed to capture any potential additional weediness characteristics.

7.4.1 (I09) Other impact weediness traits

- Assess any other characteristics (baseline or GE) that could increase the taxon or GE variety's impact on agricultural plants or agriculturally important natural resources that have not been accounted for in the questions above.
- Consider impacts only in ecosystems where the plant could establish without intentional human assistance (e.g., without addition of fertilizers, physical modifications of the land, etc.).
- If the plant is a known weed or acts as a problematic volunteer in a subsequent crop, describe any changes due to the GE trait that could impact agricultural plants or agriculturally important

natural resources. Include whether there are cost-effective alternatives (consider the relative cost and efficacy of the management practice and the alternatives).
- Documentation is required for any response other than negligible risk and high or very high certainty.
- Be sure that any information provided here is not better suited for another question.

Rating scale

- **Very high**. Plants have other characteristics that could highly impact agricultural plants or agriculturally important natural resources.
- **Moderate**. Plants have other characteristics that could moderately impact agricultural plants or agriculturally important natural resources.
- **Low**. Plants have other characteristics that could slightly impact agricultural plants or agriculturally important natural resources.
- **Negligible**. Plants are not known to have any other characteristics that could impact agricultural plants or agriculturally important natural resources.

8.0 Supplementary tables

Table 5. Habitat types.

This list of habitats is based on Anderson *et al.* (1976), NLCD (2006), IUCN (2012), Kueffer et al (2013), Keese et al (2014), and Barney (2014).

1.1	Cropping land – dryland
1.2	Cropping land – irrigated
1.3	Orchards, vineyards, and other horticulture – dryland
1.4	Orchards, vineyards, and other horticulture – irrigated
1.5	Abandoned crop and horticultural land
1.6	Crop and horticultural field margins
1.7	Pasture
2.1	Rangeland (grassland and shrubland)
2.2	Undisturbed and conservation grassland and shrubland – temperate (Prairie)
2.3	Undisturbed and conservation grassland and shrubland – desert and xeric
2.4	Undisturbed and conservation grassland and shrubland – Mediterranean type
3.1	Plantation forestry
3.2	Abandoned plantation forestry
3.3	Forest – tropical and sub-tropical broadleaf (including rainforest, dry)
3.4	Forest – temperate broadleaf and mixed
3.5	Forest – temperate coniferous
3.6	Forest – Mediterranean type
3.7	Forest margins
4.1	Urban
4.2	Roadsides and railways
4.3	Industrial, mining, and waste sites
5.1	Lakes and ponds
5.2	Riparian (river, stream, and channel margins; floodplains)
5.3	Marshes, bogs, swamps, and other wetlands (fresh water, salt water)
6.1	Beach

Table 6. Cold hardiness zones (average annual minimum temperature).

Zone	Temperature
Zone 1	-60 to -50 F
Zone 2	-50 to -40 F
Zone 3	-40 to -30 F
Zone 4	-30 to -20 F
Zone 5	-20 to -10 F
Zone 6	-10 to 0 F
Zone 7	0 to 10 F
Zone 8	10 to 20 F
Zone 9	20 to 30 F
Zone 10	30 to 40 F
Zone 11	40 to 50 F
Zone 12	50 to 60 F
Zone 13	60 to 70 F

Table 7. Precipitation zones.

Zone	Precipitation
Zone 1	0-10 inches
Zone 2	10-20 inches
Zone 3	20-30 inches
Zone 4	30-40 inches
Zone 5	40-50 inches
Zone 6	50-60 inches
Zone 7	60-70 inches
Zone 8	70-80 inches
Zone 9	80-90 inches
Zone 10	90-100 inches
Zone 11	100+ inches

9.0 Recommended sources

The following recommended resources may help you find information about baseline plants. More resources may be added to future versions of the work instructions. Use these resources in addition to plant-specific sources you may find in the scientific literature or elsewhere. Use these resources with care as there may be changes over time. Each resource should be verified by checking the primary literature whenever possible.

- Geography
  - Census of Agriculture (current and historical cultivation)
  - NASS Quick Stats Data Search Tool (current cultivation)
  - Other historical documents, herbaria collections, other databases, and the scientific literature; for herbaria and other collections, ensure that the collection location for each specimen is reported, not just the location where the specimen is housed.
- Taxonomy and geography
  - NASS Quick Stats Data Search Tool (current cultivation)
  - Integrated Taxonomic Information System (ITIS)
  - Germplasm Resources Information Network (GRIN)
  - Randall 2012
  - USDA PLANTS Database Some plants have additional Characteristics documents that can be found in the "General Information" section of the PLANTS Database listing for the plant.
  - Taxonomic Name Resolution Service
  - BONAP Taxonomic Data Center
  - Biota of North America Program (BONAP)
  - CABI Crop Protection Compendium
  - CABI Forestry Compendium
  - CABI Invasive Species Compendium
  - EDDMapS
  - Global Biodiversity Information Facility (GBIF) compiles geographic information on species distribution from herbaria, may be a useful source for some plants. The database plots geo-referenced datapoints on a global map. Country and state/province occurrence data are also available if a spreadsheet of the records is downloaded (Explore occurrences → Download spreadsheet of results). Be mindful of isolated occurrences as these may represent herbarium samples taken from plants grown under artificial conditions. In addition, if the plant is generally cultivated, most or all of the occurrences listed may be for cultivated plants and should not be considered when determining potential range. Whenever possible, confirm the listing by reviewing primary information sources.
  - ISSG Global Invasive Species Database
- GE Databases
  - USDA-APHIS-BRS Petitions for Determination on Nonregulated Status
  - ISAAA GM Approval Database
  - Virginia Tech Information Systems for Biotechnology
- WRA Databases. Use these resources with care and only after you have completed your WRA, as they can introduce bias from previous, non-APHIS-BRS assessors.
  - Weed Risk Assessments for Hawaii and Pacific Islands
  - Pacific Islands Ecosystems at Risk (PIER)
  - Victoria's Noxious Weeds Review
  - PPQ Weed Risk Assessments

  - NatureServe Explorer contains U.S. Invasive Species Impact Ranks
- Plant biology resources (often include some discussion of sexually compatible relatives)
  - OECD Consensus Documents on Plant Biology
  - Australian Plant Biology Documents
  - CABI Crop Protection Compendium
  - APHIS-BRS Plant Brief Profiles (these cannot be cited but can be used to find other sources)
  - Gressel, J. 2005. Crop Ferality and Volunteerism. Taylor & Francis.
  - Andersson, MS and de Vicente, MC. 2010. Gene Flow between Crops and their Wild Relatives. Baltimore: Johns Hopkins.
- Weed biology resources
  - Introduced, Invasive, and Noxious Weeds on USDA PLANTS
  - NatureServe Explorer
  - CABI Crop Protection Compendium
  - CABI Invasive Species Compendium
  - Flora of North America
  - Global Compendium of Weeds, see updated Randall 2011
  - ISSG Global Invasive Species Database
  - Bridges, D. C. (ed.). 1992. Crop Losses Due to Weeds in Canada and The United States - 1992. Weed Science Society of America, Champaign, IL, U.S.A. 403 pp.
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  - Weber, E. 2003. Invasive Plant Species of the World: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK. 548 pp.
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- (B03) Ability to establish and (B04) Dense thickets or monospecific stands
  - CABI Forestry Compendium has information for woody plants.
  - Garden guides may also be a source of information, but decrease certainty accordingly. e.g., http://davesgarden.com/
  - Cornell Cooperative Extension: nine out of 14 of the worst forest invasives in NY State are described as forming dense thickets or monospecific stands
- (B07) Time to reproductive maturity and (B08) Reproductive potential
  - Kew Seed Information Database
  - Horticultural sources
- (B09) Propagule dispersal
  - Willson, M. F. 1993. Mammals as Seed-Dispersal Mutualists in North America. Oikos 67(1):159-176.
  - PLANTS Database seed spread rate (not vegetative spread rate)
- (B10) Dormancy

- Seeds, Ecology, Biogeography and Evolution of Dormancy and Germination (in BRS library)
- The Soil Seed Bank of NorthWest Europe: Methodology, Density and Longevity (in BRS library)
- Baskin, C. C., and J. M. Baskin. 1998. Seeds, Ecology, Biogeography and Evolution of Dormancy and Germination. Academic Press, San Diego, CA, U.S.A.
- Thompson, K., J. P. Bakker, and R. M. Bekker. 1997. The Soil Seed Bank of NorthWest Europe: Methodology, Density and Longevity. Cambridge University Press, Cambridge.

- (B11) Regeneration
  - USDA PLANTS Database Some plants have additional Characteristics documents that can be found in the "General Information" section of the PLANTS Database listing for the plant. See the characteristics "coppice potential" for trees and shrubs, "resprout ability" for woody perennials, and "hedge tolerance" for woody perennials.
- (B12) Flood or drought tolerance
  - National Atlas of the United States precipitation band designations with maps
  - NCSU APHIS Plant Pest Forecasting System (NAPPFAST)
  - PRISM Climate maps
- (B13) Tolerance to poor soils
  - Natural Resources Conservation Service Global soil region designations with maps.
  - USDA PLANTS Database Some plants have additional Characteristics documents that can be found in the "General Information" section of the PLANTS Database listing for the plant. See the characteristics "fertility requirement" and "salinity tolerance".
- (B14) Cold tolerance
  - USDA-ARS Plant Hardiness Zones
  - NAPPFAST Global Plant Hardiness Zones
  - PRISM Climate maps
- (B15) Biotic stress tolerance
- (I01) Agriculture yield
- (I02) Agriculture quality
- (I03) Harm to agriculturally important organisms
  - Cornell University toxicity database
- (I04) Competition with plants
  - USDA PLANTS Database Some plants have additional Characteristics documents that can be found in the "General Information" section of the PLANTS Database listing for the plant. See the characteristic "foliage porosity".
- (I05) Hydrology
  - USDA PLANTS Database Some plants have additional Characteristics documents that can be found in the "General Information" section of the PLANTS Database listing for the plant. See the characteristic "moisture use".
- (I06) Soil quality
  - USDA PLANTS Database Some plants have additional Characteristics documents that can be found in the "General Information" section of the PLANTS Database listing for the plant. See the characteristic "N fixation".
- (I07) Fire regime
  - Zouhar, K., J.K. Smith, S. Sutherland, and M.L. Brooks. 2008. Wildland Fire in Ecosystems: Fire and Nonnative Invasive Plants. General Technical Report RMRS-GTR-42-volume 6.

10.0 WRA review checklist

The WRA review checklist is for internal reviewers of draft WRAs, as well as for risk assessors when completing WRAs in advance of or in response to internal review, to identify errors and guard against bias; ensure solid judgment, reasoning and interpretation; improve consistency and clarity; and ensure clear communication of key issues in the WRA to risk managers.

Content checklist: This part of the review focuses on the question-specific content of the WRA.

- Is the question answered completely and appropriately?
  - Are all aspects of the question discussed in the work instructions addressed?
  - Is conspecific or congeneric information used only when appropriate (e.g., when information is lacking about the subject of the risk assessment), and is the use of conspecific/congeneric information made clear?
  - Is all information relevant/no extraneous information included?
  - Has the risk assessor correctly understood the question, as indicated by the narrative response as a whole?
- Is the answer correctly documented and sufficiently justified?
  - Documentation
    - Is each statement or group of related statements supported by a reference?
    - Does each reference support the specific statement for which it was cited?
    - Is each reference annotated in a question-specific manner to highlight essential evidence and the assessor's reliability, applicability, and certainty ratings?
  - Justification
    - Has the evidence been synthesized and the reasoning documented?
    - Are any assumptions and risk hypotheses clearly identified, explained, and justified?
    - Does the weight of evidence justify the conclusion or risk rating, including when there is conflicting or indirect evidence?
- Has the risk assessor evaluated certainty in accordance with the work instructions?
  - Is the certainty rating correctly assigned for each reference used to support the response to the question?
  - Is the overall certainty rating for the response consistent with the quality and weight of evidence?
  - Does the certainty narrative justify the certainty rating?

Presentation checklist: This part of the review focuses on plain writing, terminology, and formatting issues used in the presentation of the WRA.

- Are the narrative responses clear and concise?
  - Do the narratives maintain consistent terminology and order of discussion throughout the document, e.g., if there are two traits or two issues (A and B) being discussed, does the narrative always discuss them in the same order in each field (always A then B)?
  - Does the WRA clearly identify which information is GE and which information is baseline?
- Are the summaries written in plain writing and do they include discussion of any key factors that contribute to and mitigate risk?
- Do the narratives:

  - Use gender neutral language?
  - Avoid language that is too definitive, too vague, or could be perceived as intemperate or as evidence of bias?
    - "Common sense"
    - "The plant is a weed" or "the plant is a troublesome/problematic weed" (instead use "reported as a weed" or "low (high) weed risk")
    - "No reason to believe" (instead use "no evidence," "lack of evidence," or "preponderance of evidence" if experimental or observational evidence exists; or "no change expected based on gene and mechanism of action," "no plausible risk hypothesis based on gene and mechanism of action" or "insufficient information to evaluate").

Overarching checklist

- Are all questions answered and all relevant information fields completed?
- Does some information provided in the narrative response to one question more appropriately belong in the narrative response to a different question?
- Does the overall conclusion "make sense" in light of the body of evidence collected?
  - Is the final outcome the expected result?
  - Is the final outcome consistent with the amount evidence, level of certainty, and conflicting data?

11.0 Glossary

Term	WRA Definition
Agriculturally important natural resources	Natural resources that have some function in or provide services to agriculture, e.g., flowing streams that provide water for agriculture, threatened and endangered species because their extinction or reduction in abundance could affect ecosystem function.
Agriculturally important organism	Include domesticated and non-domesticated animals, plants, insects, fungi, and microbes. Do not include humans. Specific organisms include beneficial organisms such as pollinators, earthworms, symbionts, and predators and parasites of plant pests.
Agricultural plant	Plants that have a function in agriculture, including crops, trees, pasture, and others.
Agricultural lands	Lands that have a function in agriculture, including row crops, pastures, grazed rangelands, orchards, vineyards, nurseries, plantation forestry, and similar types of land uses.
Allopatric	Occurring in separate, non-overlapping, geographic areas.
Baseline	A WRA conducted for a non-genetically engineered (GE) plant.
Casual	A plant that grows and may occasionally reproduce outside of its native range or the specific location where it is cultivated, but that does not form a self-perpetuating population, instead relying on repeated introductions for population persistence.
Congeneric	Belonging to the same genus as the plant being assessed.
Conspecific	Belonging to the same species as the plant being assessed. This is typically a subspecies, variety, or ecotype.
Construct	An artificially constructed segment of nucleic acid inserted into an organism to cause expression of a specific phenotype(s). Construct components (e.g., promoter sequence to signal expression of the gene of interest in the GE organism, gene sequence encoding or suppressing a protein of interest, termination sequence signaling cessation of gene transcription) are named and described.
Crop	Any plant intentionally grown or cultivated for the purposes of agriculture.
Escaped	A cultivated plant that grows outside the specific location where it is cultivated but that does not form a self-perpetuating population; subset of casual.
Established	When used for populations, see Naturalized. For individuals, “establish" and "establishment" refers to the ability of an individual plant or plant seedling to survive and grow.
Feral	A previously domesticated plant that has reverted to the wild state and formed a self-perpetuating population. Endoferal plants are directly descended from a crop while exoferal plants are descended from hybrids between a crop and another, usually wild, taxon.
Gene	A discrete region(s) of DNA (deoxyribonucleic acid) that encodes a coding or non-coding functional RNA (ribonucleic acid) or protein and is the molecular unit of heredity.
Gene function	Molecular function of genetic material or the RNA or protein it encodes.
Genetic engineering	See Biotechnology.

Term	WRA Definition
Genotype	The genetic makeup of an organism – referring either to the entire genome or, more commonly, to a certain gene or set of genes. In current BRS notifications and permits, the GE genotype is the introduced or altered genetic sequence(s) that is expected to cause an intended phenotype.
Herbicide resistance	The inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type. In a plant, resistance may be naturally occurring or induced by such techniques as genetic engineering or selection of variants produced by tissue culture or mutagenesis.
Herbicide tolerance	The inherent ability of a species to survive and reproduce after herbicide treatment. This implies there was no selection or genetic manipulation to make the plant tolerant; it is naturally tolerant.
Highly domesticated plant	Plant taxa that have a broad range of human-selected traits (such as non-shattering, absence of seed dormancy, lack of photoperiod requirement, bigger seed size, etc.) expressed at a high level, such that the plants and taxa are highly dissimilar from their wild relatives/progenitors in such traits and are highly or completely dependent in human assistance for survival
Hybrid	Offspring resulting from crosses between individuals of two populations, or groups of populations, which are distinguishable on the basis of one or more heritable characters. This process thus includes cases involving crosses between individuals considered to be conspecific or congeneric, but not crosses between individuals from the same gene pool that possess alternate states of a polymorphic character.
Introduction	Movement into or through the U.S., movement interstate, or release into the environment. In ecology, movement of a plant (including any propagule that might survive and subsequently reproduce) outside of its native range (past or present) by human activity, intentional or accidental.
Invasive plant (invasiveness)	A non-native plant whose introduction does or is likely to cause economic or environmental harm or harm to human, animal, or plant health. Invasiveness may be demonstrated by the uncontrolled or unintended spread of a plant over a considerable area outside its native range.
Native	A plant occurring within the area in which it evolved or in which it arrived through range expansion without intentional or accidental human assistance. (Synonym: indigenous)
Natural resources	Land, biota, air, water, and other such resources of the U.S.
Naturalized	Locally non-native plants that have formed self-perpetuating populations. Since invasive plants also reproduce and spread without human help once introduced, they also are naturalized
Noxious weed	Any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the U.S., the public health, or the environment. Plants may be listed as noxious by the U.S. federal government or by a state. USDA Plants hosts a list of federal noxious weeds, state noxious weeds, and a combined list.
Phenotype	The observable characteristic(s) of an organism resulting from the combined influence of the genotype and the environment. In GE plants, the term phenotype refers to both the "intended" phenotype and to unintended

Term	WRA Definition
	characteristics that result from the intended genetic change or intended phenotype.
Plant	Any plant (including any plant part) for or capable of propagation, including a tree, a tissue culture, a plantlet culture, pollen, a shrub, a vine, a cutting, a graft, a scion, a bud, a bulb, a root, and a seed.
Plant product	Any flower, fruit, vegetable, root, bulb, seed or other plant part that is not included in the definition of plant; or any manufactured or processed plant or plant part.
Propagule	A sexual or asexual unit of reproduction, including a seed, plant fragment, tuber, bulb, or any other plant part able to regenerate a plant.
Risk assessor	An individual who performs the technical components of the weed risk assessment, based on objective, evidence-based information collected from the scientific and technical literature and other subject matter experts about the nature of weed risk.
Risk manager	An individual who has the authority and responsibility to determine BRS' weed risk decision for GE plants.
Sexually compatible relative	Sexually compatible relatives (SCR) are wild or cultivated taxa that can produce fertile offspring with the taxon being examined in the WRA without any intentional human assistance beyond hand pollination.
Sympatric	Occurring within the same geographic area; overlapping in distribution.
Taxon	Any group or rank in a biological classification into which related organisms are classified; can include any level, from kingdom to genus and species to ecotype, cultivar, or variety. A taxonomic group includes all taxa of lower rank.
Volunteer	Self-set crop plant that grows in or immediately adjacent to the cultivated field following cultivation. Volunteers may arise from a seedbank formed from seed that either shattered from the original crop prior to or as a result of harvesting operations or from originally sown seed that did not germinate immediately after sowing. Volunteers rarely persist for more than a season or two.
Weed (weedy, weediness)	A plant considered to be undesirable, unattractive, or troublesome, especially one growing where it is not wanted. Weeds may be native or non-native. A plant may be known as a weed by its presence on a weed list hosted by a U.S. state, other country, non-governmental or other organizations, or a plant may be documented as a weed in agricultural production systems or natural ecosystems. For the purposes of this Weed Risk Assessment, the term "weed" does not include volunteers.
Weed risk	The potential for a plant to act as or become a weed, described by its biological characteristics and its potential impact on agricultural plants and agriculturally important natural resources.
Yield	The amount of desired vegetative or reproductive product. Yield may include any plant part from any type of plant in any type of agriculture, including crops, pasture, and forestry.

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