Module 6

Risk Assessment Principles

In applying the Risk Assessment principles to issues in local municipalities, you will:

- ✓ *assess the potential for presence of designated weeds and pests in your municipality;*
- ✓ *apply risk assessment of individual weeds and pests to focus weed and pest programming within your municipality*
- ✓ *describe possible extension components for managing designated weeds and pests*
- ✓ *describe an effective enforcement component of a program for managing designated weeds and pests;*

The variety of weeds and pests within your municipality and the variety of risk assessment tools available will influence your development of effective weed and pest control programs that comply with the *Weed Control and Agricultural Pests Acts*. These Acts are enabling legislation that provide authority to municipalities to manage introduced and native species that have the potential to impact agricultural production.

There are many factors that impact the presence of weeds or pests within your municipality and the use of risk assessment tools can assist you in developing appropriate weed and pest control programs.

Weeds in Your Municipality

Weeds may affect the use, economic value and aesthetic aspect of land because of their growth habits. Plants are weeds because they possess certain definable characteristics that set them apart from other plant species. These characteristics include any one or all of the following features:

- Compete with crop plants for essentials of plant growth and development

- Rapid establishment of a population
- Seed easily disseminated by wind, water, animals, and man
- Production of vast numbers of seeds
- Dormancy ability of weed seeds
- Special self-burying appendages (i.e. wild oats)
- Longevity of weed seed viability
- Asexual reproduction (i.e. rhizomes, creeping roots)
- Serve as alternate disease or insect host
- Production of irritants resulting in hay fever or other allergies
- Impact biodiversity and natural habitats
- Poisonous properties to man and/or livestock

Environment

In general, environmental factors that support desirable vegetation including crops also support weeds. However, there are situations where conditions that are poor for supporting crops will support an abundance of a particular weed. The success of a weed is generally based on the inability of a site to support competitive vegetation, and the ability of the weed to survive and reproduce under these conditions. For example, Russian thistle is a weed that is very invasive in dry soils, but is generally not competitive in moist soils. Environmental factors that need to be considered in relation to the potential for weeds to be present within any landbase include climate and physiographic factors.

Climatic factors are considered on a broad scale when determining whether individual weed species will be present within a municipality. Often we think of climatic factors influencing a region rather than an individual municipality. Climatic factors include the following:

- **Light** – intensity, quality, duration. From a practical perspective, this would refer to the day length available during the growing season. Therefore, there may be a difference in the weed spectrum between the Peace Region and the South Region. However, this factor generally does not play a major role in determining the presence of individual weed species within a municipality.
- **Temperature** – minimum, maximum, and optional temperatures. Temperature requirements for germination and growth vary with each weedy species. For example, species such as redroot pigweed and green

foxtail generally require high temperatures (>20 C) before they germinate. Therefore, weed populations of these species will be lower in northern Alberta compared to southern Alberta. The temperature range required by a weedy species will determine the region in which it is capable of growing. The broader the temperature range, the greater the region the weed will invade.

- **Water** – availability. The amount of water available influences the weed spectrum that may be present. Water is often combined with temperature when determining the potential for species to establish. In dry areas, often associated with water temperatures, weed species will be selected based on their ability to best utilize the limited moisture available. For example, in dry areas there will generally be an increase in Russian thistle, foxtail barley, and spreading dogbane. In contrast, in moist areas the species successful in dry conditions will be generally fewer in number and less productive; however, there will be an increase in weed species such as barnyard grass, hempnettle, and tall buttercup.

Other climatic factors include wind (i.e. velocity and duration), and atmosphere (i.e. humidity, acidity), but these are not as influential on the presence of weed species on a local level.

Physiographic factors involving soil and topography are also generally considered on a regional scale when determining whether individual weed species will be present within a municipality. However, small pockets of distinct physiographic features such as soils high in salinity do occur within individual municipalities. Physiographic factors include the following:

- **Edaphic** – soil factors such as pH, fertility, texture, structure, organic matter, and water drainage. Most municipalities experience a range of values for the different edaphic factors. From ½ section to ½ section there may be a difference in soil fertility, pH etc., based on the soil classification, and past and present activities. For example, in areas with high nitrogen there may be an abundance of lamb's quarters, redroot pigweed, and dandelion. In saline areas there will often be an abundance of kochia, and in acidic soils there is generally an increase in the populations of corn spurry. Similar to other environmental factors, the wider the range of edaphic factors that a weed species is capable of growing in, the more common it becomes.
- **Topographic** – altitude, slope, exposure to the sun. Topography is a factor that is generally not widely used to determine potential for the presence of particular weeds within an area. Certain weeds are limited by altitude, but this is more of a regional consideration. Also, certain weeds may be more successful on south facing slopes than north facing, but again this likely does not apply at a municipal level.

A combination of the above climatic and physiographic factors required by a particular weed species will help to determine the biological limitations of a weed being able to grow and reproduce within an area. Typically the most common weeds have a broad tolerance to environmental conditions. This in turn is why they are so common. For example, common weeds such as lamb's quarters and chickweed grow in almost any condition, and on all types of soil. Other weeds such as stork's bill and barnyard grass, which were once considered to be only a problem in wet soils, are becoming more adapted to a range of soil moisture conditions.

Local Activities and Traffic

Areas with high traffic volume and a landbase that supports a variety of activities and disturbances generally have a greater potential for the invasion and establishment of weeds. Following establishment, the area will then become a source for weeds and continue the spread or propagation of weeds within and outside the municipality. The following are some examples of situations that would increase the potential for weeds to be present in your municipality.

- Areas with high traffic volumes from vehicles, trains, etc. have an increased probability of receiving and spreading weed species. High traffic corridors often support a very diverse array of weedy species found along roadsides and within the right-of-way. Railway lines are often high priority for weed inspections due to the increased potential for the presence of propagules of weedy species being transported in from other provinces. For example, in 1970, approximately 16 million tons of grain traveled across Canada. Of these 16 million tons of grain, 487,000 tons were wild oat seeds, or the equivalent of 33-train car loads/day for every day of the year (Shuttleworth, 1973.)

- Areas with high volumes of industrial activity, such as oil and gas, support large volumes of traffic into and out of lease sites. Many of these lease sites are located on agricultural land or on crown land where weeds have the opportunity to spread. Activities of the forest industry can also contribute to increased weed populations as a result of increased traffic volumes, increased level of disturbance, and limited methods of weed control. Other areas conducive to introducing or spreading weeds include gravel pits, local county yards, and cemeteries.

- New and ongoing construction of homes, golf courses, roads or other infrastructure increases traffic volumes and levels of disturbance. In addition to actual disturbances, the movement of soil, materials for erosion protection (i.e. straw bales), and equipment greatly contributes to the spread of weeds. Reclamation of these areas also has the potential to

introduce weed species. Remember certified seed does not guarantee weed free!

- Areas with high levels of tourism have a greater chance of receiving exotic weed species from outside their municipality. The opportunity to spread weeds to more remote areas where weeds may be more difficult to control is also a real possibility.
- All forms of agricultural activities present some level of disturbance whether from equipment or livestock. The greater the level of disturbance, or the more often the disturbance, the greater the likelihood of finding weedy species.
- Watercourses have the potential to distribute propagules of weed species, which are often deposited along the length of the watercourse. Therefore, areas with numerous watercourses flowing through the municipality will generally find many weed infestations in and along their riparian landbase.

Public Awareness

Increased public awareness and involvement will generally help to reduce the introduction and spread of weed species. Guidance provided to the general public and landowners on several issues such as species of concern, use of certified seed, purchase of garden/wild plants and seed, and land management practices to reduce the impact of weedy species will heighten their awareness and increase their willingness to participate in the prevention and control of weeds within the municipality. The value of educating the general public and public organizations has already been demonstrated in the purple loosestrife management programs where public assistance has contributed to effective management of this wetland weed. The overall effectiveness of public involvement correlates with the effort expended on public education and the ability of the public to identify with the species or issues at hand.

Risk Assessment/Weed Programming

* Apply risk assessment of individual weeds to focus weed programming within your municipality.

Early intervention is the key to cost effective management of weed problems. Risk assessment of individual weeds is undertaken for the following reasons:

- To allow for planning in the face of uncertainty
- To accommodate for change
- To anticipate the emergence of weed problems
- To factor in risk and uncertainty in decision-making and developing weed control programs

Just as there are a variety of weeds within your municipality, there are also a variety of risk assessment tools available to set priorities within a weed control program. Expectations concerning the degree of control to be achieved from a weed control program are sometimes unrealistic due to a lack of understanding of the weeds and their characteristics, and the availability of effective means of control. To succeed in developing an effective weed control program, the following generalizations should be kept in mind (Ross and Lembi, 1999):

- In most situations growth of the desired species (i.e. crop, lawn, pasture) rather than weed control is the primary goal. Generally, if the desired species is able to provide adequate competition, the weed species will decrease.
- Once a weed has become established, it will be a problem for an extended time even when a good control program is in effect. This is particularly true for perennial weeds.
- A single application of a weed control method (i.e. one cultivation, one herbicide application) will not control all weeds present.
- A weed that is susceptible to a control practice at one stage in its life cycle is not necessarily susceptible at other stages.
- An integrated weed management program consisting of several steps or methods rather than a single treatment is usually the proper approach to solving weed control problems.
- Appropriate weed control practices are limited by the crop management system.
- Some weeds will adapt to any management system.
- Older technology such as prevention, herbicides, tillage and hand removal are among the most effective tools for weed management.

Developing an effective weed control program also depends on knowing the potential risk behind the presence of each weed. The overall goals of a weed control program can be simplified into three categories:

- Eradicate the target weed completely, and everywhere it exists within the municipality.
- Eradicate the target weed only in specific areas.
- Reduce the weed population to a level that does not significantly displace natural vegetation or impact agricultural productivity.

In order to achieve your goal, you must be able to set control and management priorities. This is done by assessing the risk or the level of impact imposed by the

weed, understanding the innate ability of the weed to be a pest, and the feasibility of control.

Canada uses a risk assessment that follows the format and terminology used by the International Plant Protection Convention (IPPC) of the Food and Agriculture Organization (FAO) for pest risk analysis. Pest risk assessment provides the scientific basis for the overall management of risk. It involves identifying hazards and characterizing the risks associated with those hazards by estimating their probability of introduction and establishment as well as the severity of their economic impact.

Similarly, Australia and the United States have developed working templates and scoring systems that can be used as tools to help make standard, informed decisions regarding the development and implementation of weed control programs.

The majority of the remainder of the discussion in this section will be based on CFIA's Weed Risk Assessment followed by some risk assessment discussions in the *Ag Pest Act*.

In initiating a risk assessment for a particular weed it is critical to establish the correct identification of the weed, and to understand its general biology with respect to life cycle, growth habit, means of reproduction and dispersal, preferred habitat and climatic tolerances, and it's current distribution.

Risk Assessment – CFIA

The CFIA Weed Risk Assessment evaluates several factors to determine the potential risk of a particular plant species. This assessment takes into consideration the probability that a species can enter, establish and spread in Canada as well as potential economic and environmental consequences. Each factor is assigned a risk rating as well as an uncertainty rating.

Once the weed risk has been determined for your area, it is important, as part of your weed control program to determine the practicality of eradication vs. continued control. Eradication is the complete elimination of a weed species from an area. Eradication programs must remove living weeds and reproductive structures including vegetative structures (i.e. rhizomes) and seeds. Due to the difficulty in achieving eradication, it is generally confined to recent introductions weeds before they spread. An assessment of the possibility of eradication might result from assessment of the availability and effectiveness of control techniques. Abundance and spatial distribution are also important, as eradication is more feasible for plants covering a smaller area. Should eradication be considered

practical, this would affect prioritization of action against the species, although not strictly affecting risk.

Graded Assignment

Total Question Value = 26 pts
Risk Elements = 20 pts
Overall rating = 2 pts
Interpret = 2 pts

Influence = 2 pts

DUE DATE: April 7, 2017

Assignment 6.1

Using the method for risk assessment devised by CFIA in the appendix, choose a weed that is prohibited noxious, noxious, or not classified and determine the cumulative risk element score and the final risk rating. Interpret your results (i.e. what does it mean to have a low risk rating?). How will the results influence your weed control program?

Ungraded Assignment

Assignment 6.2

1. Having just completed Canada's Weed Risk Assessment, review the United States, Alberta and Australia risk assessment models.
   USDA Plant Protection and Quarantine Weed Risk Assessment
   http://www.aphis.usda.gov/plant_health/plant_pest_info/weeds/downloads/wra.pdf&rct=j&frm=1&q=&esrc=s&sa=U&ei=tcDsVMTfCI_zoATrs4LQDg&ved=0CB0QFjAB&usg=AFQjCNGKmOJH3aKl-YrI6hqklS05hvFLNg
   Alberta Risk Assessment Tool
   http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/prm13262
   Australia Government Weed Risk Assessment System
   http://www.agriculture.gov.au/ba/reviews/weeds/system/weed_risk_assessment

2. Which do you prefer? Give reasons why.

Ungraded Assignment

Assignment 6.3

1. In having completed a Weed Risk Assessment and reviewing what other jurisdictions are doing to complete their assessments. What is the most important factor in assessing weed risk, in your opinion?
   Establishment/Spread Potential
   Impact Potential

Geographic Potential
Entry Potential

2. Explain, in detail, why you chose it as the most important factor.
3. Explain, in detail, what you chose as the least important factor.

Summary of Key Areas to Consider

Regardless of the method you use to assess the potential risk of an individual weed, there are always several key areas that need to be understood and should be addressed:

Weed Biology

The biology of the weed dictates the weed's ability to invade a particular habitat range, the aggressiveness or rapid growth and attainment of maturity, the ability to be self-compatible, high reproductive capacity both sexual and asexual with good dispersal ability, life history strategy and other aspects of competitive abilities.

Ecological Effects

The growth habit of the weed and its ability to cause changes in species composition and habitat structure, potential to form monoculture stands or infestations, change nutrient status (N-fixing) and influence soil water regime impact the ecology of the surrounding area.

Control Methods

Assuming that a method of control is available, it is also necessary to consider effectiveness of control. Is there a need for repeated treatments? Other factors that need to be considered include, non-target or residual effects of the treatment and any environmental impact of the control method.

Cost

Although absolute costs may be difficult to calculate, the distribution, abundance and conspicuousness should permit assessment of relative costs for different species. What is the cost of not controlling the weed? Weeds interfere with cropping operations in a variety of ways, which can influence the costs of production.

- Cultivation – has the potential to enhance the spread of weeds by vegetative structures
- Harvesting – may be delayed due to green weeds which can interfere with the operation of equipment, increased cost of desiccants, seed

contamination which can result in dockage and reduction of seed grade, increased cost to clean contaminated seed

- Crop use – weeds can reduce quality, incur spoilage, and limit rotations

A 1991 survey estimated that Canada lost an average of $984 million in one single year. Eastern Canada accounted for $372 million, while Western Canada accounted for the remaining $612 million (Swanton et. al., 1993). The economic impact of weeds on the United States during this same year was estimated to be $20 billion (USDA, 1991). Although these numbers are dated, it still provides a clear perspective on the impact of weeds in agriculture in both Canada and the United States.

Social Factors

Potential conflict of values exists between people who use the different land bases. Social factors can sometimes assist in weed control planning. Public support will be much easier to obtain for a plant seen as a threat by the public, because it invades farmland, is poisonous, causes allergies, impacts property value, causes structural damage, is hazardous, interferes with water flow etc., rather than for something which only affects natural habitats. This could influence the selection of priorities for control and eradication campaigns.

Pests in Your Municipality

It is also important to be aware of the various pests that may exist within your municipality. The ability to develop an inspection and control program is dependent on being aware of several factors that could promote the establishment and spread of these species within your municipality. Pest species listed under the Act consist of a variety of organisms. The organisms include the following categories:

7 insects	2 mammals
2 bacteria	1 virus
10 fungi 1 protista	3 nematodes

Each type of pest will have different requirements that will need to be considered when developing inspection and control programs. The potential for a species declared to be a pest or nuisance under the Agricultural Pests Act to exist within your municipality is influenced by many factors. Natural factors, which you have different levels of control over, include environmental conditions, availability of hosts or shelter, food and water supplies, presence of natural enemies, presence of natural barriers and source. Organisms such as bacteria, fungi, protists, virus and nematodes require more specific conditions than that of insects and mammals.

Environmental Conditions

Depending on the organisms, weather conditions, such as temperature, day length and humidity, affect general pest activity and the ability to reproduce. Pests may be killed or suppressed by rain, freezing temperatures, drought, or other adverse weather conditions. Environmental conditions can also indirectly affect pest populations by influencing the growth and development of vegetation as a host or as a suitable habitat.

Host, Shelter, Food and Water Supply

Once introduced, pest populations can thrive for as long as their food and water supply lasts. If the food source is eliminated or is exhausted, the pest may die, become inactive or relocate. The life cycle of many pests depends on the availability of water. The availability of shelter can also affect pest populations. Overwintering sites, and the ability to hide from predators and raise their offspring is also important in the success of pests from generation to generation.

Natural enemies

Again depending on the organism, the presence of natural enemies has the potential to reduce pest populations. Birds, reptiles, amphibians, fish, and mammals are considered natural enemies to a wide variety of the declared pests and nuisances. Insects and pathogens are also capable of suppressing pest populations through predatory or parasitic activities.

Natural barriers

Geographic features such as mountains and large bodies of water restrict the spread of many pests.

Source

The pest must be able to move into your area and establish. In order to do this the source of the pest must be reproductively viable. The pest may move in by a variety of methods such as wind, water, carried on other organisms during their normal movement patterns, or they may be transported by humans. Pests may also move to fulfill their needs for an adequate host, or availability of shelter, food and water supply.

Understanding the biology of an organism is important in determining whether your area is suitable for the establishment of a pest or nuisance. The following are examples that illustrate this point.

Example 1: Potato Wart Disease (pest)
Potato wart disease is caused by a soil-borne fungus that affects cultivated potatoes and other species within the *Solanaceae* family. Spores produced by the fungus can remain viable for at least 30 years. The main method of spread for this disease is through the use of infected seed potatoes. The spores can also be carried in contaminated soil through the movement of equipment. Spores are also known to survive passage through the digestive track of animals and can therefore be spread in manure. The disease is more predominant under cool, wet conditions.

Example 2: Thirteen-lined Ground Squirrel (nuisance)
The 13-lined ground squirrel is a member of the squirrel family, which also includes chipmunks, prairie dogs, ground and tree squirrels. This squirrel prefers open areas with closely mowed vegetation and generally avoids tall vegetation. As this is a burrowing animal, the soil should be suitable to allow for this activity. The squirrels hibernate in their burrows to avoid winter weather. Their preferred diet consists of seeds, garden vegetables, flowers and insects. Natural predators include badgers, coyotes, hawks, weasels and snakes.

Test your knowledge

Learning Exercise 6.1

Based on the biology provided above for potato wart disease and 13-lined ground squirrel, determine whether it is possible for these two species to become established in your area. If they are already in your area identify which conditions you have that are conducive to supporting these organisms.

Ungraded Assignment

Assignment 6.4

Select a pest from the Pest and Nuisance Control Regulation of the *Agricultural Pests Act* that has not become established in your area. Collect information on the biology of that pest and **describe the potential for the pest to invade your area** based on environmental conditions, availability of host or shelter, food and water supplies, presence of natural enemies, presence of natural barriers and source.

References

Ag Pest Act 2000
http://www.qp.alberta.ca/1266.cfm?page=a08.cfm&leg_type=Acts&isbncln=9780779782642

Alberta Weed Control Act 2010.
http://www.qp.alberta.ca/574.cfm?page=W05P1.cfm&leg_type=Acts&isbncln=9780779737420

Alberta Weed Control Regulation 2010.
http://www.qp.alberta.ca/574.cfm?page=2010_019.cfm&leg_type=Regs&isbncln=9780779748150

Risk Assessment Tool (RAT).
http://www.agric.gov.ab.ca/app19/calc/risk/riskcalculator.jsp

Ross, M.A. and C.A. Lembi. 1999. Applied Weed Science, 2nd ed. Prentice-Hall Inc., New Jersey.

Shuttleworth, C.L. 1973. The case for reducing wild oats in commercial grain. *In* Let's Clean Up on Wild Oats, Proceedings, Action Proposals and Programs. Agriculture Canada and United Grain Growers Limited Special Seminar.

Swanton, C.J., K.N. Harker and R.L. Anderson. 1993. Crop Losses Due to Weeds in Canada. Weed Technology. Vol. 7:537-542.

Pheloung, P. 2002. Weed Risk Assessment System –2002. Western Australian Department of Agriculture. . Australia.

USDA and APHIS. 2012. Background Information on the PPQ Weed Risk Assessment Process and Products. Version 1, Raleigh, NC.

Appendix 6.1

CFIA Weed Risk Assessment

Introduction

The purpose of this weed risk assessment (WRA) is to evaluate the plant health risk associated with Scientific name (common name).

The WRA summarizes the available information on Scientific name and evaluates the probability of entry, establishment, and spread in the pest risk analysis (PRA) area, and the potential economic and environmental consequences. The factors considered in each of these sections, along with the guidelines used to assign risk and uncertainty ratings, are shown. Overall risk and uncertainty is summarized in terms of probability and consequences. This WRA will help risk managers within the Plant Biosecurity and Forestry Division develop an appropriate action plan regarding Scientific name.

Background

Identification of the PRA Area: The PRA area is (all of Canada or part of Canada).

Available Fact Sheets / Pest Alerts, etc: (List related materials in Canada and other countries if relevant).

Identity of Organism

Name: Scientific name Author (Family) (use USDA- ARS (GRIN) wherever possible)

Synonyms:

English common names:

Description of organism: Brief description including morphology and human use if relevant. Include seed size & shape, weight, texture etc.

Presence/Absence in the PRA Area

Scientific name is not reported to occur in Canada?

Describe U.S. distribution if relevant.

Scientifc name is (/is not) grown as an ornamental plant. Discuss evidence, e.g., No evidence was found that it is cultivated in Canada Based on this information, for the PRA area, Scientific name is considered absent with no pest records.

Current Regulatory Status

Give the regulatory status in Canada followed by - Scientific name is (/is not) regulated as a Federal Noxious weed in the U.S. and is also regulated in the following states: XXX.

Probability of Entry

This rating reflects the probability that the weed will enter the PRA area. The probability of entry of a pest depends on the pathways from the exporting country to the destination, and the frequency and quantity of pests associated with them. The higher the number of pathways, the greater the probability of the pest entering the PRA area. Note that the ratings are designed to reflect the risk of entry through unintentional pathways of introduction. If the primary pathway of introduction is the intentional importation of plants for planting, a rating of "HIGH" is automatically assigned, and the assessment continues with probability of establishment (below).

Probability of Entry Rating Scores

Rating = **negligible (numerical score is 0):** The probability of entry is extremely low given the combination of factors including the distribution of the weed at source, management practices applied, low commodity volume, low probability of weed survival in transit, low probability of transfer to a suitable habitat, or low probability of distribution in the PRA area given the intended use of the commodity.

Rating **= low (1):** The probability of entry is low but clearly possible given the expected combination of factors necessary for entry described above.

Rating = **medium (2):** Weed entry is likely given the combination of factors necessary for entry described above.

Rating = **high (3):** Weed entry is very likely or certain given the combination of factors necessary for entry described above.

Risk ratings are subjective, and based on interpretation of available information. Therefore, risk assessors are not always completely confident of the ratings assigned to risk elements. Uncertainty ratings are designed to give the reader an indication of the level of confidence associated with a particular risk rating. The level of confidence depends largely on the quality or nature of the evidence available. In general, quantitative data, multiple independent sources or expert information will lower uncertainty. By contrast, low-quality sources, conflicting information or a lack of evidence will raise uncertainty. In cases where evidence is lacking for a species and information about congeners(organisms within the same genus) is used to support risk ratings, uncertainty will also be higher.

Uncertainty Rating Scores

Uncertainty	Interpretation / Meaning
Negligible	There is very little doubt about the risk rating. Additional or better information is very unlikely to change the risk rating.

Low	There is little doubt about the risk rating. Additional or better information will probably not change the risk rating.
Medium	There is some doubt about the risk rating. Additional or better information may change the risk rating.
High	There is considerable doubt about the risk rating. Reliable information is lacking. Additional information could significantly change the rating.

Type of Potential Introduction	Specific Pathways	Description – *consider italicized notes below in this column*	Pathway rating	Uncertainty
Natural Means of Dispersal (*in general these will usually score negligible to possibly low) (refers to propagules of the species under discussion)*	Wind			
	Water	*Eg. drainage basins, streams and oceans*		
	Bird			
	Wild animal (external or internal)			
Intentional Introduction Pathways *(refers to the deliberate introduction of the species under discussion)*	Plants for planting (excluding seed)	*Refers to importation of parts of the target species for planting (eg. bulbs, corms, rhizomes, stems, cuttings, etc.) Check internet sales*		
	Seed	*Refers to importation of seed of the target species intended for planting as opposed to food, feed or processing. Check internet sales*		
	Field crops not intended for propagation	*Refers to importation of parts of the target species for food, feed, medicine, compost, bedding, construction, mulch, packing material or processing (eg. oilseeds, biofuels)*		
	Decorative arrangements and branches	*Refers to importation of parts of the target species for decorative use*		
Unintentional Introduction Pathways *(refers to the species under discussion as a*	Field crops not intended for propagation	*Refers to propagules of the species under discussion present as contaminants in other plant commodities being imported for food, feed, medicine or processing (eg. oilseeds, biofuels) Give commodity specific information*		

contaminant in other commodities)		*here - The specific commodities requested by IP would include corn, soybeans, dry beans, sorghum/millet, cereal grains, canola and sunflowers - outline likely associations (in-field and in-harvested crop, seed size/shape, etc)*		
	Seed	*Refers to seeds of the species under discussion present as contaminants in seed of other plant species intended for planting. "Seed" in this context includes bulbs, corms, cuttings, and other propagative material.*		
	Hay and Straw			
	Manure			
	Livestock			
	Raw wool and raw hides	Raw wool and raw hides imported to Canada from all countries require CFIA inspection and must be free of dirt, including plant and plant parts. Vegetative matter is removed from commercial wool by carbonization.		
	Motorized vehicles	*Including agricultural, military, recreational, mining equipment, vehicle parts and used tires*		
	Nursery stock with soil	*Refers to propagules of the species under discussion present as contaminants in potted or balled nursery stock of other plant species*		
	Used recreational gear and clothing (excluding motorized vehicles)	*Including camping gear, footwear and tools*		

*Probability of Entry Rating Summary

Risk Rating for Probability of Entry: Use wording from ratings here – e.g., Probability of entry is rated "NEGLIGIBLE"; the probability is considered extremely low given the combination of factors including the distribution of the weed at source, management practices applied, low commodity volume, low probability of weed survival in transit, or low probability of distribution in the PRA area given the intended use of the commodity.

Uncertainty and Information Gaps:

Probability of Establishment

Briefly describe the probability of establishment. Outline current distribution and describe the potential range in Canada. To determine the potential range, first determine the coldest hardiness zone the species can establish in using the 30-yr 2012 NAPPFAST plant hardiness map; then determine the potential range in Canada using the 10-yr 2012 NAPPFAST plant hardiness zone map. If the plant can grow anywhere in Canada, plant hardiness map of the potential range. Other plant hardiness websites http://www.planthardiness.gc.ca/

http://landscapetrades.com/2015/01/canadas-new-plant-hardiness-zones

Factors to consider include the following:
Suitability of environment and potential range in the PRA area

What is the weed's current distribution? Is there evidence of successful introductions in other world regions?

Are suitable climatic conditions available in the PRA area? (include map if possible) Are there any known climatic factors limiting establishment of the weed? Where applicable, consider the climatic factors required for initiation of different life stages (e.g. germination, flowering, seed set, vegetative growth, etc) and/or climatic conditions necessary for hosts, vectors, and pest-host-vector relationships. Consider also the possibility of establishment in a protected environment, e.g. in glasshouses.

Are there other abiotic factors that could affect establishment? (e.g. soil type, topography, environmental pollution, climate change)

Availability of suitable habitats in the PRA area

Are suitable habitats (or hosts, for parasitic plants) available in the PRA area? How abundant or widely distributed are they? Do they occur in discrete locations or are they distributed contiguously over a wide area? (include map if possible)

Are some habitats (/hosts) preferred or more susceptible than others? (e.g. stages of succession; level of disturbance, etc) (this may be hard to measure / assess, as many new weeds will colonize ruderal sites before invading agricultural areas, when their 'native' habitat is unavailable - eg. dock yards, railway yards, roadsides, ditches)

In the absence of the usual habitats (/hosts), does the weed have the ability to use new ones? (adaptability / host specificity)

Do suitable habitats (/hosts) occur near ports of entry or major destinations? Do they occur within sufficient geographic proximity to allow the weed to establish?

Cultural practices and control measures

Are there any existing cultural practices or control measures used in the PRA area that could affect establishment? Where possible, compare practices employed during the cultivation / production of host crops in the area of origin and the PRA area, to determine if there are similarities or differences.

Are there natural enemies that could affect establishment?

Is control or eradication possible once the weed is introduced and established? Weeds for which control or eradication is not feasible may present a greater risk than those for which treatment is easily accomplished.

Other characteristics of the pest affecting the probability of establishment

Will the weed be able to reproduce in the PRA area? How many generations are possible? Are there reproductive strategies that might confer an advantage? Consider characteristics such as parthenogenesis / self-crossing, duration of the life cycle, vegetative reproduction, etc.

Is the species variable / polymorphic? Does it have a demonstrated ability to adapt to new habitats (/hosts)? (eg. annuals will adapt faster) Note that genotypic (and phenotypic) variability facilitates a pest's ability to withstand environmental fluctuations, to adapt to a wider range of habitats, to develop pesticide resistance and to overcome host resistance. Are there any risks of transferring the weed to a suitable habitat with by-products and waste?

This rating reflects the probability of establishment and potential range of a weed or invasive plant introduced into the PRA area. Factors considered include the climatic and habitat requirements of the species and the ease with which it may obtain these in the PRA area, as well as adaptability and other factors affecting its life cycle and survival. Introduced plants can be expected to behave as they do in their native area (or in other areas where they have been introduced) if suitable habitats and climatic conditions are present. Analysis may involve the use of geographic information systems (GIS) and other computerized systems such as CLIMEX to model and map potential distributions in PRA area.

Probability of Establishment Rating Scores

Rating = negligible (numerical score is 0): The weed has no potential to survive and become established in the PRA area.

Rating = low (1): The weed has potential to survive and become established in Plant Hardiness Zones 8 to 10 or approximately ≤0.6% of Canada.

Rating = medium (2): The weed has potential to survive and become established up to Plant Hardiness Zones 6 and/or 7 or approximately 0.6 to 1.9 (zone 7)-3.9 (zone 6)% of Canada.

Rating = high (3): The weed has the potential to survive and become established in Plant Hardiness Zones 5 and below) or approximately >3.9% of Canada.

Note that the vast majority of Canada's diversity in climate and ecosystem types, are concentrated in a relatively small proportion of the total land area in the southern part of the country. The majority of Canada's population, agriculture and other human activities (e.g. trade) is also concentrated in these southern portions of the country. For this reason, the rating guidelines for probability of establishment have been skewed in favour of the groupings of plant hardiness zones representing these southern portions of the country rather than proportion of total land area. This is not to downplay the importance of arctic and subarctic ecosystems, but rather to acknowledge the importance of climate and ecosystem types that may only be represented in very small areas.

*Probability of Establishment Rating Summary

Risk Rating for Probability of Establishment: Probability of establishment is rated XXXX for Scientific name, as it has the potential to…

Uncertainty and Information Gaps:

Probability of Spread

This section considers the probability and potential rate of spread of the weed, both into and within the PRA area. Describe reproductive and dispersal mechanisms and any related evidence for rate or extent of spread. Factors to consider include:

Natural spread potential

Do suitable natural and/or managed environments exist in the PRA area for natural spread of the weed? Consider the distribution and abundance of suitable habitats (/hosts) (contiguous distribution?), as well as any known climatic factors that might limit the spread of the weed.

What is the weed's ability for natural dispersal, e.g. wind- or water-borne transport of spores etc.? What is the weed's natural rate of spread per year?

What is the weed's reproductive potential? (e.g method of reproduction, reproductive output, growth habit, storage tissue, dormancy)

Potential hybridization with natural relatives in PRA area?:

Are there natural barriers to spread of the weed in the PRA area? Are vectors required for the weed to spread, and if so are they present in the PRA area? Are there natural enemies that may affect the weed's ability to spread in the PRA area?

Human-mediated spread potential

Does the pest have the ability to use human activity for dispersal?

Is the pest likely to move with commodities or conveyances?

Does the intended end-use of the commodity have implications for the spread of the pest?

Are there industry practices which contribute to human-assisted transportation, such as exchange of germplasm between growers of a particular crop kind?

History of introductions / Behaviour outside natural range

Is there evidence of successful introduction in other world regions?

Are the means of dispersal and rate of spread known for other regions?

Other factors affecting the probability of spread

What is the likelihood of early detection of a newly established population based on visual observation?

Is the spread of the pest likely to extend beyond the PRA area?

Are there currently measures in place that would effectively slow or stop spread from occurring?

This rating reflects the probability and potential rate of spread of the weed within the PRA area. A pest with a high potential for spread may also have a high potential for establishment, and possibilities for its successful containment and/or eradication are more limited. Natural means of spread may include wind, water, soil, and live vectors, all of which can transport seed, pollen, and vegetative plant parts, sometimes over great distances. Human-mediated spread may include both intentional and unintentional movement. In the case of plants intended for cultivation, this section will also consider the probability of escape and spread outside of cultivated environments.

Probability of Spread Rating Scores

Rating = negligible (numerical score is 0): The weed has no potential for spread within its potential range in the PRA area [e.g. *Tulipa* spp. (tulip)].

Rating = low (1): The weed has potential for spread locally in its potential range in the PRA area within a year (some reproductive potential and/or some mobility of propagules) [e.g. *Malus domestica* (apple), *Convallaria majalis* (lily-of-the-valley)].

Rating = medium (2): The weed has potential for moderate spread throughout its potential range in the PRA area within a year (e.g., It has either high reproductive potential OR highly mobile propagules) [e.g. *Phragmites australis* subsp. *australis* (common reed), *Persicaria perfoliata* (devil's-tail tearthumb)].

Rating = high (3): The weed has potential for rapid spread throughout its potential range in the PRA area (e.g., It has high reproductive potential AND highly mobile propagules) [e.g. *Taraxacum officinale* (common dandelion), *Chenopodium album* (common lamb's quarters), *Tamarix* spp.(saltcedar)].

*Probability of Spread Rating Summary

Risk Rating for Probability of Spread: Probability of spread is considered "XXXXX" for Scientific name as it has …. (consider the probability of the weed being able to spread in the PRA area, as well as how rapidly and to what extent it might spread if it enters and becomes established?).

Uncertainty and Information Gaps:

Potential Economic and Environmental Consequences

This stage of the assessment considers the potential economic and environmental consequences in the PRA area. Economic and environmental consequences are considered together as it is not possible to fully separate them. Factors to consider include:

Direct economic effects

What are the known or potential habitats of the weed (or hosts for parasitic plants), including impacted crops, natural habitats (if applicable), or those under protected cultivation? Are any of them of economic importance?

What are the types, amount and frequency of damage caused by the weed? Are some habitats (/hosts) more susceptible than others?

Does the weed cause crop losses, in yield and quality? (e.g. by parasitism or competition - specify type(s), amount and frequency of damage, how many crops are affected? consider type of crop affected, eg. cereal/oilseed more important than fibre, consider also palatability/toxicity to livestock). What revenue losses can reasonably be expected?

Are there other biotic factors (e.g. adaptability of the pest) that may affect damage and losses?

Are there abiotic factors (e.g. climate) that may affect damage and losses?

What is the weed's rate of reproduction and spread?

What measures exist for control of the weed, and what is their efficacy and cost?

What effect might the weed have on existing production practices in the PRA area? Consider changes in production methods and associated costs.

Would presence of the weed necessitate additional costs over those already incurred in production of the commodity?

Note that economic consequences are expressed over time, and may be felt in one year, several years, or over an indeterminate period. Various scenarios should be considered.

Indirect economic effects

Could introduction of the weed cause effects on domestic and export markets, including in particular export market access? The potential consequences for market access which may result if the weed becomes established, should be estimated, including the extent of any phytosanitary regulations imposed (or likely to be imposed) by trading partners.

Could introduction of the pest cause changes to producer costs or input demands, including control costs?

Could introduction of the pest cause changes to domestic or foreign consumer demand for a product resulting from quality changes? Loss of marketability? Diversion of the product to a lower value end-use?

Could the pest act as a vector for other pests?

Once introduced, would eradication or containment of the pest be feasible? How much would it cost?

Would resources be needed for additional research and advice?

Could the pest have economic effects on other sectors (e.g. tourism)?

Direct environmental effects

Could the pest cause a reduction of keystone plant species (i.e., plant species that are of fundamental importance to the maintenance and character of the ecosystem in which they are found)?

Could the pest cause a reduction of plant species that are major components of ecosystems (in terms of abundance, size or ecological importance), and endangered native plant species, including effects below species level where there is evidence of such effects being significant?

Could the pest cause significant reduction, displacement or elimination of other plant species?

Indirect environmental effects

Could the pest have significant effects on plant communities through competition for resources?

Could the pest have significant effects on designated environmentally sensitive or protected areas?

Could the pest cause significant changes in ecological processes and the structure, stability or processes of an ecosystem (including further effects on plant species, erosion, water table changes, increased fire hazard, nutrient cycling, etc)? (eg. alteration of hydrology, sedimentation rates, fire regimes, nutrient regimes, erosion processes, soil development / processes) (eg. density of a layer, extra layer, canopy cover)

Could the pest affect human use of resources (e.g. water quality, irrigation / navigation, recreational uses, tourism, animal grazing, hunting, fishing)?

Would there be environmental and other undesired effects of control measures? : (eg. toxic pesticides, introduction of exotic bio-control agents)

Would there be costs associated with environmental restoration?

In the absence of evidence of impacts caused elsewhere, consider whether the plant has any intrinsic attributes that indicate that it could cause significant harm to plants, such as:

Are other members of the genus or species considered weeds?

Is the organism aggressively competitive (e.g. known to form dense thickets, stands or floating masses; has a climbing or smothering growth habit; known to be allelopathic or parasitic; capable of abundant, viable seed production; resistant to herbicides, or; tolerant of environmental stress?

Does it produce spines, thorns or burrs?

Is it adaptable (e.g. known from a wide variety of habitats or known as a ruderal)?

Does it lack natural controls (e.g. insect pests or diseases) in the PRA area?

This stage of the assessment considers the potential economic and environmental consequences of the weed's introduction in the PRA area. Economic and environmental consequences are considered together as it is not always possible to fully separate them. Information from areas where the pest currently occurs is compared with conditions in the PRA area to estimate the potential importance of the pest. Case

histories concerning comparable pests, and intrinsic biological traits that may contribute to pest impacts (e.g., parasitism, allelopathy, thorns, etc.) may also be considered.

Consequences may be direct or indirect, and both should be evaluated as much as is possible. Sometimes indirect effects may be more difficult to evaluate as they require the consideration of side effects of a pest's establishment that may not be immediately apparent. Care should be taken not to take the evaluation of indirect effects to extremes, but to keep them limited to one or two orders of separation away from the direct effects. Probably some of the most common indirect effects are social consequences, secondary habitat consequences of control / eradication efforts and secondary habitat consequences of ecological changes induced by the pest.

Economic factors considered include impacts on crop production costs, yield, quality, and marketability, and variability of impacts among crop cultivars or varieties. Crops considered include cultivated and forest species, but only those that are managed.

Environmental factors considered include impacts on non-agricultural host(s) and natural ecosystems. This may include subjective consideration of direct biotic effects on endangered or threatened natural species and reduction of biodiversity. Examples of abiotic impacts considered include ecosystem destabilisation, environmental degradation, fire, and impacts on recreation and aesthetic values. Also considered are impacts on human and animal health, and indirect environmental effects of risk management options (e.g., pesticides).

A more detailed economic assessment than provided here may be required in some cases.

Probability for Potential Economic and Environmental Consequences Rating Scores

Rating = negligible (numerical score is 0): The weed has no potential economic impact and no potential to degrade the environment or otherwise affect ecosystems (e.g., Causes none of the above-listed impacts).

Rating = low (1): The weed has a limited potential to cause economic impacts or affect the environment (e.g., Causes one of the above-listed impacts unless there is potential to reduce populations of threatened or endangered species, in which case rating should be HIGH).

Rating = medium (2): The weed has moderate potential to cause economic impacts (e.g., Causes two of the above-listed economic impacts OR any one of these impacts on a wide range of economic plants, plant products, or animals (over 5 types)) or it has potential to cause moderate changes in the environment, such as obvious change in the ecological balance (affecting several attributes of the ecosystem), as well as moderate recreation or aesthetic impacts. (eg. Causes two of the above-listed environmental impacts).

Rating = high (3): The weed has significant potential to cause economic impacts (e.g., Causes all the above-listed impacts, OR causes any two of these impacts on a wide range of economic plants, plant products, or animals (over 5 types) or it has potential to cause major damage to the environment with significant losses to plant ecosystems and subsequent physical environmental degradation (eg. has potential to reduce populations of threatened or endangered species, OR affects three or more of the above-listed impacts).

*Probability for Economic and Environmental Consequences Rating Summary

Risk Rating for Potential Economic and Environmental Consequences:
Potential economic and environmental consequences are rated "XXX" for Scientific name, as it has…

Uncertainty and Gaps:

Summary

The following table summarises the risk and uncertainty ratings for *Scientific name*, assigned in each section of the risk assessment, above. The overall probability of introduction and spread, and associated uncertainty rating, were calculated following the guidance in Appendix 2.

	Risk Rating	Uncertainty
Probability		
Probability of Entry	*XXX*	*XXX*
Probability of Establishment	*XXX*	*XXX*
Probability of Spread	*XXX*	*XXX*
Overall Probability of Introduction and Spread	**XXX**	**XXX**
Consequences		
Potential Economic and Environmental Consequences	**XXX**	**XXX**

Conclusion

Briefly summarize overall risk and uncertainty. Consider also the concept of endangered areas. The endangered area is that area of the PRA area in which ecological and other conditions favour establishment of the pest and wherein economically important loss may occur. Definition of the endangered area, therefore, draws on the conclusions of the assessments of potential distribution and potential impacts. The endangered area may be all or part of the PRA Area, and may or may not be relevant in the case of plant species that are not host- or habitat-specific.

Technical Issues For Consideration

Describe any detection and identification issues that may arise (e.g., how issues surrounding pest detection or identification might influence a regulatory decision; comments on laboratory capability or capacity that may be important risk management considerations).

Contact Saskatoon Seed Lab to determine if seeds are visually distinguishable from those of other species, and include that information here.

May also mention any difficulties or challenges the plant may present with regard to mitigation measures to prevent entry (e.g., treatments, controls, etc).

GUIDELINES FOR CALCULATING OVERALL RISK AND UNCERTAINTY RATINGS FOR PROBABILITY OF INTRODUCTION AND SPREAD

The individual risk ratings given in examining the three probability factors, (i.e., probability of entry, probability of establishment and probability of spread) are taken into consideration to produce an overall rating for the probability of introduction and spread of the weed. This is done by translating the individual risk ratings into numerical scores (negligible = 0; low = 1; medium = 2; high = 3), and multiplying the numerical scores to produce a product score, as follows:

Probability of introduction and spread = **Probability of entry x Probability of establishment x Probability of spread**

Depending on the resulting overall score, the consequences of introduction will be rated as negligible (0), low (1-3), medium (4-12) or high (>12). The underlying assumption behind this approach is that the three factors are dependant, that is, all three would need to occur for there to be a risk. A parallel process is not necessary for potential economic and environmental consequences, because in that case there is only one rating. The table below is provided as a guide.

Product Scores (Probability of Entry X Probability of Establishment X Probability of Spread)	Overall Rating for Probability of Introduction and Spread
0	NEGLIGIBLE
1 - 3	LOW
4 – 12	MEDIUM
>12	HIGH

As with the risk ratings, the individual uncertainty ratings are also combined for the three probability factors (i.e., probability of entry, probability of establishment and probability of spread) to produce an overall uncertainty rating for the probability of introduction and spread of the weed. This is done by translating the individual uncertainty ratings into numerical scores (negligible = 0; low = 1; medium = 2; high = 3), and adding the numerical scores. Depending on the resulting overall score, the uncertainty will be rated as negligible (0), low (1-3), medium (4-6) or high (7-9). The underlying assumption behind this approach is that the three uncertainty scores are additive, not dependant. As with the risk ratings, a parallel process is not necessary for potential economic and environmental consequences, because in that case there is only one rating. The table below is provided as a guide.

Additive Scores for Uncertainty of Overall Probability of Introduction and Spread	Overall Rating for Uncertainty of Probability of Introduction and Spread
0	NEGLIGIBLE
1 - 3	LOW
4 – 6	MEDIUM
7-9	HIGH