Plant Risk Assessment & Management Protocol for Minnesota

Introduction, Objectives, & Rationale

The Minnesota Plant Risk Assessment & Management Protocol is intended to serve as a tool for the objective assessment of the potential risks associated with the introduction of non-native, terrestrial plant species into Minnesota and the regulation and management of species documented as being harmful (native and non-native) that are already variously present in the State. Recognizing that decisions to regulate the introduction and use of plants can have significant impacts on plant industries and the livelihoods of people, the protocol has been thoughtfully and carefully designed to incorporate the best scientific information available pertaining to risks. The protocol also strives to balance concerns about potential negative impacts with any recognized benefits associated with the plants in question.

While their numbers are limited, comprising considerably less than 1% of the species introduced (Williamson and Fritter, 1996), examples of non-native plants becoming invasive and subsequently having significant negative impacts on native and cultivated plant communities are well documented. Examples of introduced plants that have had significant negative impacts on Minnesota landscapes and ecosystems include leafy spurge (*Euphorbia esula* L.), Canada thistle [*Cirsium arvense* (L.) Scop.], quackgrass [*Agropyron repens* (L.) Beauv.], purple loosestrife (*Lythrum salicaria* L.) and common (*Rhamnus cathartica* L.) and glossy [*Frangula alnus* (L.) P. Mill.; syn. *Rhamnus frangula* L.] buckthorn.

Predicting invasive potential is not an easy task for both statistical and biological reasons (Williamson, 2001). The potential exists for predictive efforts to restrict the introduction of species having economic value, yet still not prevent the introduction of the occasional invasive species (Lonsdale and Smith, 2001). Even with these limitations, prediction remains a useful tool in the effort to prevent the introduction of invasive species. Several traits, including a short juvenile phase, the production of large amounts of viable seed, especially when combined with effective vectors of dissemination such as through the activities of animals, and, perhaps most disturbingly from a horticultural standpoint, the ability to survive under adverse conditions – a desirable trait for horticultural selections – can, however serve as indicators of a plant's invasive potential and the basis for risk assessment and possible regulation.

To these ends, the primary objectives of the Minnesota Plant Risk Assessment & Management Protocol are to:

- Prevent the introduction of non-native plant species that have the potential to become invasive and harm native, agricultural, or managed plant communities in Minnesota.
- Raise awareness of the problems associated with invasive plants and promote cooperative efforts to prevent or minimize any negative effects of future plant introductions or previously introduced plants now documented as being of concern.
- Provide a mechanism for categorizing plants already present in Minnesota from a regulatory perspective based on the provisions of the Minnesota Noxious Weed Law wherein harmful plants are categorized as Prohibited Noxious Weeds, Managed Noxious weeds, Restricted Noxious Weeds, and Allowed Noxious Weeds.
- Limit the potential for negative effects on native plant populations through hybridization with non-native species or ecotypes relative to the potential threat associated with such hybridization.
- Provide an objective process for reviewing non-native plants and genotypes based on their potential to escape cultivation that protects the ability to introduce new plants from arbitrary prohibitions based on the simple fact that they are non-native.

The protocol provides a process for gathering information about the invasive potential of a given species and ultimately using that information to make a determination of how the species should be regulated or managed in Minnesota. Great care has been taken to ensure that the protocol is comprehensive and is not biased for or against any species or group of plants – all plants evaluated are subject to the same review process and standards. Dioecious species are, perhaps, unique depending on whether both male and female plants are currently present and their risk will, therefore, be reviewed based on the presence of male plants alone, female plants alone, and both male and female plants being present and the ability to exclude plants of the opposite sex as determined by the Minnesota Noxious Weed Advisory Committee (NWAC). The Protocol recognizes that some plants may require regulation for reasons other than invasive potential including health concerns or significant negative economic impacts. For these reasons, the ability to review and regulate native species is retained, but such regulation should be an uncommon occurrence and reasons for regulating native plants must be clear and convincing.

It is expressly not the intent of this protocol to arbitrarily prevent the introduction and use of non-native plant species in the State of Minnesota. That most plant introductions will not escape cultivation and become invasive and the potential benefits associated with future plant introductions are recognized; history shows, however, that even one bad actor can have significant environmental and economic consequences and justifies the effort to prevent the introduction of such species into the State. To these ends the protocol strives to treat all plants in a standardized, equal, and unbiased fashion and to carefully document the information used to make regulatory decisions.

The ultimate goal of this risk assessment protocol is to protect native, agricultural, and managed plant communities in Minnesota from harmful effects that might be associated with introduced species without unduly hampering new introductions and their potential benefits. To this end, the Minnesota Noxious Weed Advisory Committee (NWAC) encourages continuing input from interested parties to update and improve the effectiveness and objectivity of this protocol.

PLANT RISK ASSESSMENT & MANAGEMENT PROTOCOL FOR MINNESOTA

(2/18/03; revised 9/22/10 and 2/3/11)



Overview:

The purpose of Box #1 is to separate native species from non-native species and genotypes. As a general rule, native species should not be regulated as noxious weeds. It is recognized, however, that in a limited number of instances regulation of native species may be justified under certain conditions. The Minnesota Department of Natural Resources, Native Plant Database will serve as the authority on what plants are and are not native to Minnesota.

Questions to Consider:

A. Is the species or genotype non-native?

- Yes \rightarrow Go to Box #3 of the Plant Risk Assessment & Management Protocol
- No \rightarrow Go to Box #2 of the Plant Risk Assessment & Management Protocol

2 – THE PLANT POSES SIGNIFICANT HUMAN OR LIVESTOCK HEALTH CONCERNS OR HAS THE POTENTIAL TO SIGNIFICANTLY HARM AGRICULTURAL PRODUCTION

Overview:

The purpose of Box #2 is to determine whether there is justification for the regulation of a native species. Although it is envisioned that regulation of native species will be an infrequent occurrence, the ability to review any potentially harmful effects associated with native species and to regulate native plants should remain an option.

Criteria for Decision:

The plant evaluation committee may or may not have the expertise required to arrive at a determination for Box 2; when additional information or expertise is needed, reliable information that will be helpful in making and documenting a sound determination should be solicited from a variety of outside sources including:

- Expert advice
- Scientific studies
- Documented examples

- A. Does the plant have toxic qualities that pose a significant risk, to livestock, wildlife, or people?
 - Yes \rightarrow Go to Box #9 of the Plant Risk Assessment & Management Protocol
 - No \rightarrow Go to Question B below
- B. Does the plant cause significant financial losses associated with decreased yields, reduced quality, or increased production costs?
 - Yes \rightarrow Go to Box #9 of the Plant Risk Assessment & Management Protocol
 - No \rightarrow THE SPECIES IS NOT A RISK

Overview:

One of the best predictors of invasiveness is whether or not a particular species is invasive in other parts of the world (Reichard, 2001). Box #3 seeks documentation that the plant in question is a problem in habitats similar to those found in Minnesota; if so, there is at least a theoretical chance that the plant could be of concern if it can survive in Minnesota. Experience with the plant in other areas may, thus, be helpful in determining if a plant has the potential to become a problem in Minnesota.

Questions to Consider:

A. Is the plant, or a related species, documented as being a problem elsewhere?

Yes	\rightarrow	Go to Box #6 of the Plant Risk Assessment & Management Protocol
No	\rightarrow	Go to Box #4 of the Plant Risk Assessment & Management Protocol



Overview:

Just because a particular plant has not been documented as being a problem somewhere else doesn't eliminate the possibility that the plant may have the potential to become a problem in Minnesota. To make a sound determination regarding the invasive potential of the plant being evaluated, the plant's life history, tolerances, growth requirements and phenology must be characterized and sufficiently understood to allow for a reliable review of the plant's invasive potential. The information collected at this stage will be needed to answer the questions associated with Boxes #6 and #7 of the Plant Risk Assessment & Management Protocol and ultimately any determination regarding the invasive potential of the plant in question. It is imperative that the information collected be comprehensive, based on the best scientific information available, and well documented. 6 – THE PLANT HAS THE CAPACITY TO ESTABLISH AND SURVIVE IN MINNESOTA

Overview:

Climate conditions in Minnesota, particularly the cold winters, can make it difficult for many non-native plant species to establish and survive in Minnesota. The goal of this "filter" is to remove from consideration those plant species that are <u>very</u> unlikely to persist in the Minnesota climate. If information about a species indicates the possibility of it being able to tolerate Minnesota conditions, the plant should be evaluated further. Because climate is often a primary factor that determines whether a plant will be able to establish and survive in Minnesota

CLIMEX software (<u>http://www.ento.csiro.au/climex/climex.htm</u>) will be used as part of the risk assessment analysis – it considers temperature (minimum/maximum), precipitation, and humidity as plant distribution factors. MN DNR has the software; comparisons should consider the plant's native range and naturalized range (where applicable) in relation to conditions in Minnesota.

Criteria for Decision:

The ability of a plant to become established and survive in Minnesota can be demonstrated in two ways:

- The plant, or a closely related species, is documented as already being present in Minnesota.
- The output from the climate matching component of the CLIMEX model indicates that either the native or naturalized ranges of the species are similar to the climate conditions of Duluth, Fargo, or Minneapolis, or some other locale within Minnesota, indicating the plant would be likely to survive in Minnesota (Perhaps having a map of places having climates similar to MN would be helpful).

It is recognized that the ability of a plant to survive in Minnesota and in specific locations will also be dependent on other tolerance factors related to adaptability which should also be considered – soil factors (fertility, pH, etc.), light requirements (full sun vs. various levels of shade tolerance), disturbance factors (disturbed vs. undisturbed sites - flooding/drawdowns, fire, compacted soils, cultivation, herbicide management, etc.), habitat specificity (woodland, prairie, wetland, urban sites, etc.), pest interactions, etc.

- A. Is the plant, or a close relative, currently established in Minnesota?
 - Yes \rightarrow Go to Box #7 of the Plant Risk Assessment Protocol
 - No \rightarrow Go to Question B below
- B. Has the plant become established in areas having a climate and growing conditions similar to those found in Minnesota?
 - Yes \rightarrow Go to Box #7 of the Plant Risk Assessment Protocol
 - No \rightarrow THE SPECIES IS NOT A RISK

7 – THE PLANT HAS THE POTENTIAL TO REPRODUCE & SPREAD IN MINNESOTA

Overview:

At this point in the Plant Risk Assessment & Management Protocol, it has been determined that the plant species has a high probability of being able to establish and survive in Minnesota. Box #7 focuses on identifying those species that have a high likelihood of spreading once established. This assessment is largely based on life history characteristics that have been linked with invasiveness in other risk assessment models or in scientific studies. Once again, the output of this filter tends to be conservative – it recommends further evaluation of species with any reasonable potential for invasion and establishes a Watch List of plants whose invasive potential has not been sufficiently quantified and, therefore, remains unknown.

Criteria for Decision:

If the plant has any of the following characteristics, and no natural controls that are native to Minnesota have been documented to check the spread of the species, the plant is considered to have a high likelihood of reproducing and spreading in Minnesota:

- The species reproduces successfully by vegetative means and the vegetative propagules are readily dispersed to new sites by natural means (wind, water, animals, birds, etc.) or human activity (machinery, transport of agricultural products, etc.).
- The species reproduces successfully by seed and the seeds produced are numerous, cold hardy, and readily dispersed to new areas by natural means (wind, water, animals, birds, etc.) or human activity (machinery, vehicles, transport of agricultural products, etc.).
- The species is self-fertile and produces seeds that are readily dispersed to new sites by natural means (wind, water, animals, birds, etc.) or human activity (machinery, vehicles, transport of agricultural products, etc.).
- The species has the capacity to hybridize with native species resulting in fertile offspring without human intervention.
- The species is a woody vine or shrub that reaches sexual maturity (becomes reproductive) within three years; within five years for tree species.
- The species is documented to spread, despite not fitting any of the above criteria.

If any of the above characteristics apply to the species in question, it should be further evaluated, progressively, against the following criteria:

- The species produces prolific amounts of viable, cold hardy seeds (e.g., purple loosestrife).
- The species exhibits strong seed/seedling vigor including extended dormancy and the ability to establish significant seed banks resulting in increased establishment success.
- The species produces low numbers of viable seeds, but still has a strong ability to become established (e.g., leafy spurge).
- The seeds, and/or vegetative material, have effective dispersal vectors, either by natural means (wind, water, animals, birds, etc.) or by human intervention (by machinery or vehicles).
- There are no existing natural controls, species native to Minnesota, documented to check the spread of the species being evaluated.

Supporting Materials:

Seed vs. vegetative reproduction – In a study of invasive, woody species, 53% of invasive species reproduced well by both seed and vegetative means compared with only 23% for non-invasive species (Reichard, 2001); the assessment assumed, however, that those species reproducing by vegetative means only are not a serious invasion threat. This is not surprising for terrestrial species, but <u>can</u> be of considerable concern for aquatic species. Other studies have documented correlations between vegetative reproduction and invasiveness (Kolar and Lodge, 2001).

Length of juvenile period – Short juvenile periods have been associated with invasiveness. Woody species that are invasive have juvenile periods that are typically three years shorter than non-invasive species (Reichard, 2001). Other studies have documented significant correlations between length of juvenile period and invasiveness (3 studies) while still others (2 studies) have not (Kolar and Lodge, 2001).

Ability to hybridize with native species – The ability to hybridize with native species can increase the probability of invasion and spread and difficulty of control (reference???).

Prolific seed production -- Prolific seed production has been positively associated with invasive potential (reference???).

Seed germination requirements – A lack of seed pregermination requirements has been correlated with invasiveness (Reichard, 2001).

- A. Does the plant reproduce by asexual/vegetative means?
 - $Yes \quad \rightarrow \qquad \text{Go to Question B below}$
 - No \rightarrow Go to Question C below

B. Are the asexual propagules - vegetative parts having the capacity to develop into new plants - effectively dispersed to new areas?

 $\begin{array}{rcl} \text{Yes} & \rightarrow & \text{Go to Question I below} \\ \text{No} & \rightarrow & \text{Go to Question C below} \end{array}$

- C. Does the plant produce large amounts of viable, cold hardy seeds?
 - Yes \rightarrow Go to Question F below No \rightarrow Go to Question D below
- D. For species that produce low numbers of viable seeds, do they have a high level of seed/seedling vigor or remain viable for an extended period (seed bank)?

Yes	\rightarrow	Go to Question F below
No	\rightarrow	Go to Question E below

E. Is the plant self-fertile?

Yes \rightarrow Go to Question F below No \rightarrow Go to Question G below

- F. Are sexual propagules viable seeds effectively dispersed to new areas?
 - Yes \rightarrow Go to Question I below No \rightarrow Go to Question G below
- G. Can the species hybridize with native species (or other introduced species) and produce viable seed and fertile offspring in the absence of human intervention?
 - Yes \rightarrow Go to Question I below
 - No \rightarrow Go to Question H below
- H. If the plant is woody (trees, shrubs, and woody vines), is the juvenile period less than or equal to 5 years for tree species or 3 years for shrubs and vines?
 - Yes \rightarrow Go to Question I below
 - No \rightarrow THE SPECIES IS NOT CURRENTLY BELIEVED TO BE A RISK
- I. Do natural controls exist, species native to Minnesota, that are documented to effectively prevent the spread of the species in question?
 - Yes \rightarrow THE SPECIES IS NOT CURRENTLY BELIEVED TO BE A RISK
 - No \rightarrow Go to Box #8 of the Plant Risk Assessment Protocol

8 – THE PLANT POSES SIGNIFICANT HUMAN OR LIVESTOCK CONCERNS OR HAS THE POTENTIAL TO SIGNIFICANTLY HARM AGRICULTURAL PRODUCTION, NATIVE ECOSYSTEMS, OR MANAGED LANDSCAPES

Overview:

The purpose of this box is to identify and quantify the potential for harmful impacts to agricultural production, native ecosystems, or managed landscapes associated with the plant under review from an economic and environmental standpoint. The potentially harmful impacts and their significance must be documented and supported by expert testimony. An affirmative outcome at this level of review will result in a recommendation that the plant be regulated in some fashion. If the potential for harm associated with a particular plant remains essentially unknown, it may be placed on a Watch List pending further review.

Criteria for Decision:

The plant evaluation committee may or may not have the expertise required to arrive at a determination for Box 8; when additional information or expertise is needed, reliable information that will be helpful in making and documenting a sound determination should be solicited from a variety of outside sources including:

- Expert advice
- Scientific studies
- Documented examples

- A. Does the plant have toxic qualities, or other detrimental qualities, that pose a significant risk to livestock, wildlife, or people?
 - Yes \rightarrow Go to Box #9 of the Plant Risk Assessment Protocol
 - No \rightarrow Go to Question B below

- B. Does, or could, the plant cause significant financial losses associated with decreased yields, reduced crop quality, or increased production costs?
 - Yes \rightarrow Go to Box #9 of the Plant Risk Assessment Protocol
 - No \rightarrow Go to Question C below
- C. Can the plant aggressively displace native species through competition (including allelopathic effects)?
 - Yes \rightarrow Go to Box #9 of the plant Risk Assessment Protocol
 - No \rightarrow Go to Question D below
- D. Can the plant hybridize with native species resulting in a modified gene pool and potentially negative impacts on native populations?
 - Yes \rightarrow Go to Box #9 of the Plant Risk Assessment Protocol No \rightarrow Go to Question E below
- E. Does the plant have the potential to change native ecosystems (adds a vegetative layer, affects ground or surface water levels, etc.)?
 - Yes \rightarrow Go to Box #9 of the Plant Risk Assessment Protocol
 - No \rightarrow Go to Question F below
- F. Does the plant have the potential to introduce or harbor another pest or serve as an alternate host?
 - Yes \rightarrow Go to Box #9 of the Plant Risk Assessment Protocol
 - No \rightarrow THE SPECIES IS NOT CURRENTLY BELIEVED TO BE A RISK

Overview:

Plants reaching this level of the Plant Risk Assessment & Management Protocol will be regulated in some fashion under the Minnesota Noxious Weed Law. They have been shown to have the capacity to become established and spread in Minnesota with the potential for significant, negative economic or environmental impacts through their impacts on agricultural production, native ecosystems, or managed landscapes.

Plants will be placed into one of four regulatory options under the Minnesota Noxious Weed Law:

- 1. Prohibited / Eradicate Noxious Weeds must be eradicated in all locations statewide; importation, sale, and transportation within the State are prohibited.
- 2. Prohibited / Control Noxious Weeds must be managed to prevent seed production and spread to new areas; importation, sale, and transportation within the State are prohibited.
- 3. Restricted Noxious Weeds importation, sale, and transportation within the State are prohibited.
- 4. Specially Regulated Plants allowed but subject to a statewide management plan with management requirements that may vary within the State.

The level of regulation will depend on whether the plant is currently present in Minnesota and the value of the plant and the ability to control the plant in relation to the damage the plant might cause. It is therefore necessary to consider how the plant is used or would be used if introduced – in other words, does the plant have value relative to its negative characteristics? If the plant has clearly defined benefits, it must then be determined if the spread of the plant can be prevented through best management practices or use of an alternative plant. If control is not possible, the Minnesota Noxious Weed Advisory Committee must then consider the economic (state economy, provides livelihood, important food value, etc.), environmental (erosion control, nutrient sink, wildlife benefits, etc.), and/or cultural benefits of the plant and decide whether those benefits outweigh the negative impacts identified at Box #8.

Criteria for Decision:

It will be necessary to gather the following information in order to come to a decision for Box #9:

- Document whether the plant is currently present and/or in use in Minnesota and serves a valuable function (including native species) in Minnesota and, if so, for what purpose?
- Determine whether the spread of the plant can be prevented through the implementation of best management practices?
- Determine if suitable alternatives to the plant are available?

- A. Is the plant currently being used or produced and/or sold in Minnesota or native to Minnesota?
- B. Is the plant an introduced species and can its spread be effectively and easily prevented or controlled, or its negative impacts minimized, through carefully designed and executed management practices?
 - Yes \rightarrow Go to Box #11 of the Plant Risk Assessment Protocol
 - No \rightarrow Go to Question C below
- C. Is the plant native to Minnesota?
 - Yes \rightarrow Go to Question E below
 - No \rightarrow Go to Question D below
- D. Is a non-invasive, alternative plant material commercially available that could serve the same purpose as the plant of concern?
 - Yes \rightarrow Go to Box #10 of the Plant Risk Assessment Protocol
 - No \rightarrow Go to Question E below
- E. Does the plant benefit Minnesota to a greater extent than the negative impacts identified at Box #8?
 - Yes \rightarrow Go to Box #11 of the Plant Risk Assessment Protocol
 - No \rightarrow Go to Box #10 of the Plant Risk Assessment Protocol

10 – ENFORCE CONTROL AS A NOXIOUS WEED TO PREVENT INTRODUCTION &/OR DISPERSAL; DESIGNATE AS PROHIBITED or RESTRICTED

Overview:

Plants routed to Box #10 of the Plant Risk Assessment & Management Protocol will be regulated in one of three ways – they will be designated as Prohibited Noxious Weeds / Eradicate, Prohibited Noxious Weeds / Control, or Restricted Noxious Weeds under the Minnesota Noxious Weed Law. They have been documented as being harmful and lack sufficient benefit to justify their use. Plants not currently present in the State will be regulated to prevent their introduction and establishment within the State (Prohibited / Eradicate; eradication required) while those that are already present in the State will be regulated to prevent their spread to new areas within the State (Prohibited / Control or Restricted). For plants already established within the State, the level of regulation (Prohibited / Control <u>vs</u>. Restricted) will be dependent on the level of harm and the ability to control the plant using the technology and resources available. For example, if a species is widely distributed such that control is no longer possible from a technological or fiscal standpoint, the weed may be designated as a Restricted Noxious Weed rather than a Prohibited / Control Noxious Weed to help prevent its spread to new areas within the State.

Criteria for Decision:

It will be necessary to gather the following information in order to come to a decision for Box #10:

- Is the plant currently established in Minnesota and if so where?
- Can the plant be reliably controlled or eradicated using existing practices and available resources (including financial resources)?
- What are the negative impacts of the plant?

- A. Is the plant currently established in Minnesota?
 - Yes \rightarrow Go to Question B below
 - No → LIST THE PLANT AS A PROHIBITED / ERADICATE NOXIOUS WEED (If the plant appears anywhere in the State, an eradication plan must be developed and implemented)
- B. Does the plant pose a serious human health threat?
 - Yes \rightarrow LIST THE PLANT AS A PROHIBITED / CONTROL NOXIOUS WEED
 - No \rightarrow Go to Question C below
- C. Can the plant be reliably eradicated (entire plant) or controlled (top growth only to prevent pollen dispersal and seed production as appropriate) on a statewide basis using existing practices and available resources?
 - Yes → LIST THE PLANT AS A PROHIBITED / ERADICATE NOXIOUS WEED (eradication possible and reasonable) or PROHIBITED / CONTROL NOXIOUS WEED (eradication not possible or reasonable) as appropriate
 - No \rightarrow LIST THE PLANT AS A RESTRICTED NOXIOUS WEED

11 – ALLOWED BUT CONTROLLED VIA A SPECIES SPECIFIC MANAGEMENT PLAN; DESIGNATE AS SPECIALLY REGULATED

Overview:

Plants routed to Box #11 of the Plant Risk Assessment & Management Protocol will be designated as Specially Regulated Plants; allowed, but their use is regulated through a species specific management plan. Plants designated as Specially Regulated Plants have been shown to have the potential to survive and become established and spread in Minnesota and have the potential to cause significant negative impacts, but have also been documented as having significant benefits that outweigh the associated impacts and warrant their use under certain circumstances. To this end a management plan will be developed which seeks to limit the impacts of the plant on the people and the environment of the State.

Some plants may be of greater concern in certain locations or situations. Local government units that decide that a plant designated as a Specially Regulated Plant should be more tightly regulated in their area may petition (Minnesota Rules, part 1505.0750) to have the plant designated as a Prohibited or Restricted Noxious Weed in their jurisdiction. The Minnesota Noxious Weed Advisory Committee will review petitions and make recommendations regarding whether it is reasonable to allow plants designated as Specially Regulated Plants to be designated as Prohibited or Restricted Noxious Weeds at the local level.

Development and implementation of a management plan will be the key component of this level of regulation and will require an understanding of where, and under what circumstances, a Specially Regulated Plant may be allowed to be grown. The Minnesota Noxious Weed Advisory Committee will be responsible for overseeing the development of species specific management plans and recommending their approval.

Literature Cited:

Lonsdale, W.M., and C.S. Smith. 2001. Evaluating pest-screening systems - insights from epidemiology and ecology. *In:* Weed Risk Assessment. R.H. Groves, F.D. Panetta and J.G. Virtue, eds. ISBN 0 643 06561 X. CIRSO Publishing, Collingwood, Australia. [Challenges for predictions to not exclude desirable species and yet, fail to keep out invasive species]

Reichard, S. 2001. The search for patterns that enable prediction of invasion. *In:* Weed Risk Assessment. R.H. Groves, F.D. Panetta, and J.G. Virtue (eds.). ISBN 0 643 06561 X. CIRSO Publishing, Collingwood, Australia. [Overview of a predictive approach to invasiveness]

Williamson, M. 2001. Can the impacts of invasive species be predicted? *In:* Weed Risk Assessment. R.H. Groves, F.D. Panetta, and J.G. Virtue (eds.). ISBN 0 643 06561 X. CIRSO Publishing, Collingwood, Australia. [Overview of limitations to predictive efforts]

Williamson, M. and A. Fritter. 1996. The varying success of invaders. Ecology 77:1661-1665.

Lists of Plants Considered Invasive Elsewhere:

Gateway to Federal & State Invasive Species Activities & Programs http://www.invasivespecies.gov

Illinois Department of Natural Resources. 1994. The Changing Illinois Environment: Critical Trends. Technical Report of the Critical Trends Assessment Project. Volume 3: Ecological Resources.

Invasive Plants of Canada Project http://www.plantsincanada.com/index.html

Joint Venture – The Bugwood Network, USDA/Forest Service, USDA/APHIS PPQ, University of Georgia - Warnell School of Forest Resources, University of Georgia - College of Agricultural & Environmental Sciences/Dept. of Entomology http://www.invasives.org

Taxonomic Information on Cultivated Plants in the USDA-ARS Germplasm Resources Information Network (GRIN) <u>http://www.ars-grin.gov/npgs/tax/taxweed.html</u>

British Columbia Ministry of Agriculture & Food. Field Guide to Noxious & Other Selected Weeds of British Columbia http://www.agf.gov.bc.ca/croplive/cropprot/weedguid/weedguid.htm

U.S. Environmental Protection Agency http://www.epa.gov/glnpo/greenacres/wildones/wo29.htm

Urban Forest Associates, Inc. Invasive Exotic Species Ranking for Southern Ontario www.serontario.org/pdfs/exotics.pdf Wisconsin Department of Natural Resources Bureau of Endangered Resources: <u>http://bluto.uwex.edu:80/ces/shoreland/invasive_plants.html</u> http://www.dnr.state.wi.us/org/land/er/invasive/index.htm

Other Plant Risk Assessment Models & Information:

University of Florida, Institute of Food and Agricultural Sciences (IFAS) Assessment of Non-Native Plants in Florida's Natural Areas (2000) http://www.ifas.ufl.edu/

Biosecurity Australia Weed Risk Assessment System (1997) http://www.affa.gov.au/docs/market_access/biosecurity/plant/weeds1.html

Minnesota Nursery and Landscape Association (1998)

North American Plant Protection Organization (NAPPO)

National Plant Board (Sarah Reichard; University of Washington)

USDA Animal and Plant Health Inspection Service (APHIS), Plant Protection & Quarantine (PPQ) Pest Risk Assessment Template (2000) http://www.aphis.usda.gov/ppq/weeds/weedsrisk99.html

National Park Service (NPS), Exotic Species Ranking System

Bureau of Land Management (White Paper on exotic weeds)

Federal Interagency Committee for Management of Noxious and Exotic Weeds

Journal of Biological Invasions 2(2);93-102 (2000)

CLIMEX http://www.ento.csiro.au/climex.htm

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