Current Risk Assessment Protocols

This document outlines the current risk assessment protocols in use throughout the Great Lakes region and at the federal level, both in Canada and the United States. It was developed in partnership between the Great Lakes Commission and The Nature Conservancy, with input from the risk assessment ad-hoc committee of the Great Lakes Panel on Aquatic Nuisance Species.

Agencies with risk assessment protocols in place for aquatic species

Plants and animals

- University of Notre Dame Science-Based Tools for Assessing Invasion Risk (STAIR)
- Aquatic Species Invasiveness Screening Kit **individual assessments not available online*
- New York Invasive Species Information
- NOAA Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS)
- Fisheries and Oceans Canada Centre of Expertise for Aquatic Risk Assessment (CEARA)
- Ontario Ministry of Natural Resources and Forestry **assessment protocol not yet finalized/published online*
- Minnesota Invasive Species Advisory Council
- Wisconsin Department of Natural Resources
- Indiana Department of Natural Resources
- USGS Nonindigenous Aquatic Species

Plants exclusively

- USAqWRA (Gordon et al., 2011) (plants) *individual assessments not available online*
- Michigan Department of Agriculture and Rural Development (plants) **USDA-APHIS protocol*
- Illinois Invasive Plant Species Council (plants)
- Ohio Invasive Plants Council (plants)
- U.S. Department of Agriculture-Animal and Plant Health Inspection Service (plants)

Animals exclusively

- Fish Invasiveness Screening Kit (fish) *individual assessments not available online*
- Freshwater Invertebrate Invasiveness Screening Kit (invertebrates) *individual assessments not available online*
- Michigan Department of Natural Resources (animals) **U.S. FWS protocol*
- U.S. Fish and Wildlife Service (animals)

Risk assessment protocols for plants:

- University of Notre Dame STAIR*plants*
  - **Type of information provided**:
    - Climate match to Great Lakes region, i.e. the ability to grow in plant hardiness zones 1-7.
    - Great Lakes-adapted version of the USAqWRA
  - **How risk is determined**: Cumulative score of all questions
  - **Quantitative or qualitative?** Quantitative score determines risk

- USAqWRA (Gordon et al., 2011)
  - **Type of information provided**:
    - Temperature tolerance for this tool assesses the growth response of a plant to "winter"; when this information could not be found, climate matching via the Climate Wizard model (http://www.climatewizardcustom.org/Global_Historical) was substituted
    - Biological traits, e.g. water quality parameters and tolerance; habitat type; dispersal mechanisms; reproduction mechanisms
    - Behavioral traits, e.g. ability to establish and colonize; competition traits; spread within a waterbody; impacts to biodiversity, water quality, and physical parameters; ease and effectiveness of management/control strategies
  - **How risk is determined**: Cumulative score of all questions
  - **Quantitative or qualitative?** Quantitative

- Illinois Invasive Plant Species Council
  - **Type of information provided**: *No information available*
  - **How risk is determined**: *No information available*
  - **Quantitative or qualitative?** *No information available*

- Indiana Department of Natural Resources
  - **Type of information provided**:
    - Distribution, both native range and within the United States
    - Description of growth form
    - Life cycle biology
    - Pathways and history of spread
    - Dispersal mechanisms
    - Risks/impacts
    - Management/prevention
  - **How risk is determined**: An overall risk score is not provided in this protocol.
  - **Quantitative or qualitative?** Qualitative; each section provides a succinct qualitative description of the relative traits that may contribute to a species' invasive behavior.

- Michigan Department of Agriculture and Rural Development; USDA-APHIS protocol
    - **Type of information provided**:
        - Establishment/Spread, e.g. shade tolerance; reproduction mechanisms; dispersal mechanisms; herbicide resistance.
            - Climate match, based on plant hardiness zones, annual precipitation bands, and Koppen-Geïger climate classes
        - Impact
            - Natural systems, e.g. impact to physical parameters; species diversity.
            - Anthropogenic systems, e.g. impact to infrastructure; human health.
            - Production systems, e.g. impact to crop quantity/quality; irrigation availability.
    - **How risk is determined**: Each question is assigned a numeric value based on its response and weight. The sum of scores from the Establishment/Spread questions is plotted as the X coordinate, and the sum of scores from the Impact questions is platted as the Y coordinate on a visual threshold graph based on the 204 species used to validate the model. The resultant plot point determines the final risk ranking, based on where the point falls in relation to the thresholds.
    - **Quantitative or qualitative?** Primarily quantitative; the final assignment of risk is based on aggregate quantitative scores, but qualitative evidence is provided to support each question's response.

- Minnesota Invasive Species Advisory Council
    - **Type of information provided**: *No information available*
    - **How risk is determined**: *No information available*
    - **Quantitative or qualitative?** *No information available*

- New York Invasive Species Information
    - **Type of information provided**:
        - Ecological impact
        - Biological characteristic and dispersal ability
        - Ecological amplitude and distribution
        - Difficulty of control
    - **How risk is determined**: Risk scores are calculated as 100(a/b) to two decimal places, where a is the total number of questions answered, and b is the cumulative score of those questions. Thresholds for risk scores are used to determine level of risk.
    - **Quantitative or qualitative?** Each question has pre-determined multiple-choice response options, each with a quantitative score assigned. Very brief qualitative explanations are provided for each question to support the response choice.

- Wisconsin Department of Natural Resources
    - **Type of information provided**:
        - Establishment range (each factor is described on a national and state level), i.e. abundance; range expansion; and density.
        - Habitat tolerance, i.e. trophic state; alkalinity; conductivity; light incidence; pH; depth; and temperature.
        - Regulations, i.e. where the plant is regulated as a noxious weed; and regulation status in Michigan, Minnesota, and Wisconsin.
        - Life history, i.e. fecundity; reproduction mechanisms; hybridization; and ability to overwinter.
        - Establishment, i.e. preferred climate; taxonomic similarities to native plants in Wisconsin; competition (predators, pathogens, competitive strategy); reproduction rate; and reproduction timeframe (e.g. how long it takes for population to double).
        - Dispersal mechanisms
        - Ecosystem impacts, e.g. habitat structure; biodiversity; abiotic effects
        - Socio-economic effects, e.g. benefits; impacts of restriction; cost of eradication
        - Control and prevention, i.e. detection; and management goals.
    - **How risk is determined**: An overall risk score is not provided in this protocol.
    - **Quantitative or qualitative?** Qualitative.

- NOAA GLANSIS
    - **Type of information provided**:
        - Botanical description
        - Range, both native and within the Great Lakes basin
            - Also provides a list of non-indigenous occurrences by state
        - Ecology
        - Means of introduction and current establishment status
        - Great Lakes impacts, i.e. environmental impact; socio-economic impact; and beneficial effect.
        - Management, i.e. regulation; and control methods.
    - **How risk is determined**: An overall risk score is not provided in this protocol.
    - **Quantitative or qualitative?** Qualitative. Much of the information shared here mirrors that presented on the USGS site, but on a regional, Great Lakes scale.

- USGS Nonindigenous Aquatic Species
    - **Type of information provided**:
        - Botanical description
        - Range, both native and within the United States watersheds
            - Also provides a list of non-indigenous occurrences by state
        - Ecology

        - Means of introduction and current establishment status
        - Impacts of introduction
    - **How risk is determined**: An overall risk score is not provided in this protocol.
    - **Quantitative or qualitative?** Qualitative. Much of the information shared here mirrors that presented on the GLANSIS site, but on a national scale.

- Fisheries and Oceans Canada CEARA
    - **Type of information provided**: Only phytoplankton and one species of macroalgae have currently been assessed; only the macroalgae (*Codium fragile* ssp. *tomentosoides*) assessment is available online.
        - Botanical description
        - Geographical distribution and dispersion
        - Habitat
        - Environmental tolerance
        - Growth and reproduction
        - Ecological impacts
        - Economic and social impacts
        - Expert interview to address gaps in literature and dispersal vectors and habitat suitability
            - Analyzed with Analytic Hierarchy Process to assign weight to expert testimony
        - Expert judgments regarding probability and magnitude of impacts
    - **Quantitative Biological Risk Assessment Tool (QBRAT):**
        - Probability of arrival, survival, establishment
        - Probability of further spread
        - The magnitude of biological, social, and economic impacts
    - **How risk is determined**: Risk is given according to the three areas of QBRAT analysis (see above), rather than one overall risk score.
    - **Quantitative or qualitative?** Unclear. The QBRAT framework was unavailable, so it is unclear how that information is processed.

- Ontario Ministry of Natural Resources and Forestry
    - **Type of information provided**: *No information available*
    - **How risk is determined**: *No information available*
    - **Quantitative or qualitative?** *No information available*

Risk assessment protocols for animals:

- University of Notre Dame STAIR*fish*
  - **Type of information provided**:
    - Ecological traits, i.e. diet breadth; habitat (lentic/lotic); salinity tolerance; temperature tolerance; and trophic guild.
    - Life history traits, i.e. maximum total body length; egg diameter; fecundity; larval size; longevity (maximum lifespan); maturation size; reproductive guild; and spawning frequency.
    - Invasion risk parameters, i.e. climate match using the CLIMATCH program; relatedness (absolute value of the difference in family-level rank (from Nelson, 2006) between the non-native species and the most closely related native or non-native species established in the first invaded Great Lake); phylogeny; prior establishment success; and size of native range (area).
  - **How risk is determined**: This model assigns risk based on a classification tree. A climatic match >71.7% indicates that a species is likely to establish in the Great Lakes. Of the species that are likely to establish, those in the top trophic levels (invertivore–piscivore, piscivore) are classified as "high-impact" (high risk), while species in the lower trophic levels (herbivore-detritivore, invertivore, omnivore) are classified as "high-impact" if the individual fecundity of spawning female is >1,013,000.
  - **Quantitative or qualitative?** Data is primarily quantitative when available, but final assignment of risk is based on a qualitative classification tree.

- University of Notre Dame STAIR*mollusks*
  - **Type of information provided**:
    - Climate match for the Great Lakes (no information provided regarding *how*)
    - History of invasion elsewhere
    - The number of eggs or live offspring released per female per year (annual individual female fecundity).
    - If the species is a carrier of parasites or pathogens of concern
  - **How risk is determined**: Species with an annual individual female fecundity that is >162 are considered nuisance species. Climate match likely narrows these species to those that could exist in the Great Lakes basin.
  - **Quantitative or qualitative?** Quantitative.

- University of Notre Dame STAIRcray*fish*
  - *Still in development

- Aquatic Species Invasiveness Screening Kit (AS-ISK)
  - **Type of information provided**:
    - Biogeography/History, i.e. domestication/cultivation; climate, distribution, and introduction risk; invasive elsewhere.

        - Biology/ecology, i.e. undesirable/persistence traits; resource exploitation; reproduction; dispersal mechanisms; tolerance attributes.
        - Climate change
    - **How risk is determined**: Each question is assigned an individual score based on response and weight. These scores are summed for an overall risk score, which is then compared to score thresholds for "Accept" (low risk), "Evaluate" (moderate risk/evaluate further), or "reject" (high risk).
    - **Quantitative or qualitative?** Primarily quantitative; the final assignment of risk is based on summed quantitative scores, but qualitative evidence is provided to support each question's response.

- Fish Invasiveness Screening Kit **has been replaced by single risk identification (screening) tool that is applicable to all aquatic plants and animals, titled AS-ISK (see above)*
    - **Type of information provided**:
        - Biogeography/History, i.e. domestication/cultivation; climate and distribution; invasive elsewhere.
        - Biology/ecology, i.e. undesirable traits; feeding guild; reproduction behaviors; dispersal mechanisms; persistence attributes.
    - **How risk is determined**: Each question is assigned an individual score based on response and weight. These scores are summed for an overall risk score, which is then compared to score thresholds for "Accept" (low risk), "Evaluate" (moderate risk/evaluate further), or "reject" (high risk).
    - **Quantitative or qualitative?** Primarily quantitative; the final assignment of risk is based on summed quantitative scores, but qualitative evidence is provided to support each question's response.

- Freshwater Invertebrate Invasiveness Screening Kit **has been replaced by single risk identification (screening) tool that is applicable to all aquatic plants and animals, titled AS-ISK (see above)*
    - **Type of information provided**:
        - Biogeography/History, i.e. domestication/cultivation; climate and distribution; invasive elsewhere.
        - Biology/ecology, i.e. undesirable traits; temperature tolerance; feeding guild; reproduction behaviors; dispersal mechanisms; persistence attributes.
    - **How risk is determined**: Each question is assigned an individual score based on response and weight. These scores are summed for an overall risk score, which is then compared to score thresholds for "Accept" (low risk), "Evaluate" (moderate risk/evaluate further), or "reject" (high risk).
    - **Quantitative or qualitative?** Primarily quantitative; the final assignment of risk is based on summed quantitative scores, but qualitative evidence is provided to support each question's response.

- Indiana Department of Natural Resources
    - **Type of information provided**:
        - Distribution, both native range and within the United States
        - Description of growth form
        - Life cycle biology
        - Pathways and history of spread
        - Dispersal mechanisms
        - Risks/impacts
        - Management/prevention
    - **How risk is determined**: An overall risk score is not provided in this protocol.
    - **Quantitative or qualitative?** Qualitative; each section provides a succinct qualitative description of the relative traits that may contribute to a species' invasive behavior.

- Michigan Department of Natural Resources; U.S. FWS protocol
    - **Type of information provided**:
        - Native range and status in the United States
            - Means of introduction
        - Biology and ecology
        - Impacts of introductions, i.e. biodiversity; health and social impact.
        - Global distribution
        - Distribution within the US
        - Climate matching using the CLIMATCH software
    - **How risk is determined**: If the species has a history of invasion elsewhere and is climate matched to the region, then the risk assessment is high. Otherwise, it is the assessor's best judgment that determines risk, with specific guidance from the USFWS ERSS Standard Operating Procedures manual. Risk is determined to be high, low, or uncertain.
    - **Quantitative or qualitative?** Primarily qualitative, however the climate matching software provides thresholds to determine if climate matching is high, medium, or low.

- Minnesota Invasive Species Advisory Council
    - **Type of information provided**: *No information available*
    - **How risk is determined**: *No information available*
    - **Quantitative or qualitative?** *No information available*

- New York Invasive Species Information
    - **Type of information provided**:
        - Ecological impact
        - Biological characteristic and dispersal ability
        - Ecological amplitude and distribution
        - Difficulty of control

- **How risk is determined**: Risk scores are calculated as 100(*a*/*b*) to two decimal places, where *a* is the total number of questions answered, and *b* is the cumulative score of those questions. Thresholds for risk scores are used to determine level of risk.
- **Quantitative or qualitative?** Each question has pre-determined multiple-choice response options, each with a quantitative score assigned. Very brief qualitative explanations are provided for each question to support the response choice.

- Wisconsin Department of Natural Resources
  - **Type of information provided**:
    - Current status and distribution, i.e. in Wisconsin; similar climate zones in the US; similar habitats in the US; status/distribution in surrounding states; competitive ability.
      - For invertebrates assessed in 2015: Invasive in similar climate zones; invasive in which habitats; habitat affected; native range; legal classification.
    - Establishment potential and life history traits, i.e. temperature tolerance; spawning temperature; number of eggs; reproduction mechanism; preferred spawning substrate; hybridization potential; salinity tolerance; oxygen regime; water hardness.
      - For invertebrates assessed in 2015: the above plus dispersal potential (pathways/vectors); characteristics that aid in survival/inhibit control.
    - Damage potential, i.e. presence of natural enemies; pathways/vectors; environmental impacts
      - For invertebrates assessed in 2015: the above plus competition with native species; rate of spread.
    - Socio-economic impacts, i.e. positive aspects; direct/indirect effects; type of damage; industry affected; loss of aesthetic value; increased cost to sectors; cost of prevention/control
    - Control and prevention, i.e. cost of prevention; responsiveness to prevention efforts; detection capability; effective control tactics (biological, chemical, mechanical); efficacy/feasibility of control; cost of control; non-target effects of control; threshold at which control can be attempted; efficacy of monitoring.
      - For invertebrates assessed in 2015: the above plus legal/landowner issues
  - **How risk is determined**: An overall risk score is not provided in this protocol.
  - **Quantitative or qualitative?** Qualitative responses to predetermined questions.

- NOAA GLANSIS
    - **Type of information provided**:
        - Size and identifying characteristics
        - Range, both native and within the Great Lakes basin
            - Also provides a list of non-indigenous occurrences by state
        - Ecology
        - Means of introduction and current establishment status
        - Great Lakes impacts, i.e. environmental impact; socio-economic impact; and beneficial effect.
        - Management, i.e. regulation; and control methods.
        - Remarks: any information that does not fit within the above categories
    - **How risk is determined**: An overall risk score is not provided in this protocol.
    - **Quantitative or qualitative?** Qualitative. Much of the information shared here mirrors that presented on the USGS site, but on a regional, Great Lakes scale.

- USGS Nonindigenous Aquatic Species
    - **Type of information provided**:
        - Size and identifying characteristics
        - Range, both native and within the United States watersheds
            - Also provides a list of non-indigenous occurrences by state
        - Ecology
        - Means of introduction and current establishment status
        - Impacts of introduction
        - Remarks: any information that does not fit within the above categories
    - **How risk is determined**: An overall risk score is not provided in this protocol.
    - **Quantitative or qualitative?** Qualitative. Much of the information shared here mirrors that presented on the GLANSIS site, but on a national scale.

- Fisheries and Oceans Canada CEARA
    - **Report content is inconsistent, and varies according to species.*