THE NATIONAL INVASIVE SPECIES COUNCIL (NISC)

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ANS Task Force

Dedicated to the prevention and control of aquatic nuisance species

# National Invasive Species Council (NISC)

***And***

# Aquatic Nuisance Species (ANS) Task Force

****

# NISC Prevention Committee Pathways Work Team

****

## Focus Group Conference Report And Pathways Ranking Guide

June-August 2005

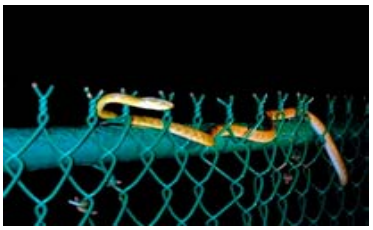

Figure 1. Scientific name: *Boiga irregularis*
Common name: Brown Tree Snake

Figure 2. Scientific name: *Dreissen polymorph*
Common name: Zebra Mussel

Figure 3.Scientific name:*Anoplophora glabripennis*
Common name: Asian Longhorned Beetle

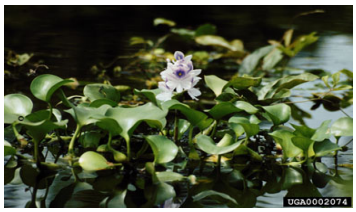

Figure 4. Scientific name: *Eichhornia crassipes*
Common name: Water Hyacinth

THE NATIONAL INVASIVE SPECIES COUNCIL (NISC)

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ANS Task Force

**Pathways Work Team Conference**

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A limited number of printed copies are available from:
U.S. Department of Agriculture
Animal Plant Health Inspection Service
Plant Protection and Quarantine
301-734-8412

Electronic copies are available on the Internet at following NISC URL:
http://www.invasivespeciesinfo.gov

Second Print July 2006. (Original Print December 2005)
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## Executive Summary

This document represents the second version of a guide and process for pathway definition, analysis and prioritization. It is expected that this document will undergo another trial test and revision prior to full implementation, though we strongly believed this is a 'workable' product that only requires refinement.

Throughout this systems development process, the Pathways Work Team struggled with several issues relevant to scientific data and public policy. While this report in no way attempts to resolve such intricate issues, it is essential that these considerations be brought to the forefront for future decision-making efforts and as such are enumerated below:

- International competitiveness is impacted by invasive species
- Pathway ranking combines community, government and corporate interests
- Sound science, transparency and consistency are essential for formulating policy
- Neutrality is essential in providing scientific advice to decision makers
- Market and non-market forces must be analyzed for final decisions
- Invasive species prevention is inherently an international activity
- Methodology must include public, stakeholder and expert participation
- Assessment is to provide common perspectives
- Decisions must occur at individual agency levels
- Outcome of the process is the characterization of relative risk of pathways
- Policy makers must devise plans for pathway management, resource leveraging, policy development, budget decisions and technology transfer/development.

In conclusion, the Pathways Work Team strongly supported the position that policy decides the direction to take (with human health, commerce, then ecosystems being the priorities for ranking), but science must maintain the focus. [1]

Penny Kriesch, Chair
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[1] Source: Arizona State University Consortium for Science, Policy and Outcomes, College of Liberal Arts and Sciences

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## CHAPTER 1 – DESIGN VERSION 1

### Phase 1: Assignment – 2002

The Invasive Species Pathways Work Team was established in June 2002 by the Invasive Species Advisory Committee to accomplish discreet tasks contained within the National Invasive Species Management Plan. Assignment scope extended to addressing issues related to unintentional introductions of invasive species, specifically addressing those action items numbered 16, 17, and 20, as recounted below:

> **16. Federal agencies will take the following steps to interdict pathways that are recognized as significant sources for the unintentional introduction of invasive species:**
>
> > **a. By July 2001, NOAA, the Coast Guard, Interior, and EPA will sponsor research to develop new technologies for ballast water management, because the current method of ballast water management--ballast water exchange--is recognized as only an interim measure to address non-native species introductions.**
> > **b. By January 2002, the U.S. Coast Guard will issue standards for approval of ballast water management technologies, because actual deployment of new ballast water technologies on ships is contingent on a standard by which to judge their efficacy.**
> > **c. By January 2002, USDA will issue additional regulations to further reduce the risk of species introductions via solid wood packing materials.**
>
> **17. By January 2002, the Council will implement a process for identifying high priority invasive species that are likely to be introduced unintentionally, e.g., Mediterranean fruit fly and brown tree snake, and for which effective mitigation tools are needed.**
>
> **20. By January 2003, the Council will implement a system for evaluating invasive species pathways and will issue a report identifying, describing in reasonable detail, and ranking those pathways that it believes are the most significant. The report will discuss the most useful tools, methods, and monitoring systems for identifying pathways, including emerging or changing pathways, and for intervening and stopping introductions most efficiently.**

Agency collective experiences indicated the most effective method of preventing unintentional introduction of non-native species was through identifying the pathways by which they were introduced; with the need to develop environmentally sound methods to interdict introductions. Past experiences also indicated that some pathways are/were already known to be significant sources of invasive species. For example, ballast water is probably the largest single source of non-native species introductions into coastal and estuarine waters. Wood packing materials are a source of serious forest pests. As a first step in dealing with unintentional introductions, the Pathways Work Team was instructed to address these already known ‘significant’ pathways.

**Phase 1: System Design - 2003**

In response to these challenges, the Invasive Species Pathways Work Team convened and developed methods for stratifying and evaluating all pathways. This initial report was published on October 29, 2003 (see www.invasivespeciesinfo.gov postings) and was formally ratified by the National Invasive Species Council during FY 2004.

Specific principles guided risk assessment and analysis. It was believed that invasive species risk assessments should reflect the reality of U.S. commerce and ecosystems. Thus, since U.S. government agencies' regulatory decisions apply to a broad range of sometimes multiple receiving habitats or endpoints (that range from large continent to island environments) risk assessment could not singly focus on the conditions of the expected site of first arrival.

As such, the Pathways Work Team developed core values or operating norms that were to be imbued in the risk assessment portion of the guide. They are as follows:

- Methods and rationale to be transparent
- Work products are to be open to public review
- Methods to be expert reviewed via consensus evaluation
- Products should be valid and reliable, as is operationally feasible
- Methods will make use of expert opinion (qualitative) and incident datasets (quantitative) information
- Methods will address all phases of invasion including transport, establishment, spread and impact
- Assessments must recognize that species and ecosystems interact
- Circumstances of the potential invasion can give varying importance to species or ecosystem traits
- Methods must be able to capture the uncertainty and quality of data
- When assessment relies on expert opinion, assessment be clear about the basis of that reliance and 'expert' qualifications
- Methods must be realistic relative to available resources.

It was also expressed that eventual policy decisions regarding pathway priority should meet the following considerations:

- Cost of actions should be weighed against benefits
- Actions should be proactive and take advantage of opportunities
- Special attention should be given to pathways that are not regulated
- Pathways should be re-evaluated periodically since risks associated with any particular pathway can change over time due to changes in magnitude (propagule pressure), changes in sending or receiving ecosystem(s) and other factors
- Pathway evaluation should be open and participatory; involving experts and stakeholders.
- Broad-based involvement gives greater credibility for the finished product.

The Pathways Work Team also noted that it is important to prioritize preparation of risk assessments since pathways usually remain open until the risk assessment is concluded. Agencies should conduct risk assessments even if the NISC process of evaluating pathways is not complete.

It was also determined that developed criteria for assessing risk priority depended upon the probability or consequence of introduction. At a minimum, this portion of the assessment should include the factors below:

- Pathway magnitude (number of species, inoculation strength and frequency, diversity of species carried via pathway)
- Survivability or viability of organisms during transit
- Likelihood of pathway to transmit invasive species that are difficult to detect or manage during transit in the pathway
- Environmental comparability of origin and destination habitats
- Ease of spread (via artificial or natural means) once present (i.e., Does it have high reproductive rates? Is it highly mobile? Are there other factors that would facilitate its rapid spread?)
- Difficulty of control if the species becomes established.

**Phase 1: Design 1 Report**

In synopsis, the Pathways Work Team report of October 2003 presented three major products: (1) scientific and 'philosophical' concepts forming the basis to pathway rankings; (2) a pathway factors assessment tool; and (3) exemplar tree-diagrams or charts of pathway constructs (see Chapter 3 and Appendices G and H of this document for updated versions). It was determined at that point, due to limitations on available and accurate quantitative data, assessment would have to be based upon subjective, expert opinion, supported by existing literature and invasive-specific datasets. For risk assessments, it was deemed critical for pathway risk analysts to be able to attend to all relevant taxonomic groups; that jurisdiction was limited to human-assisted movement of organisms; and, that the instrument(s) should be sufficiently flexible to address local to national perspectives, as well as the full range of taxa and pathways. This 2003 report is available on www.invasivespeciesinfo.gov

**Phase 2: Design 1 Field Test - 2005**

On June 21-22, 2005, the National Invasive Species Council, Pathways Work Team sponsored an Invasive Species Pathways Focus Group Assessment Conference. The Conference was held at USDA APHIS, Oklahoma Memorial Conference Center, Riverdale, Maryland. The objectives of the conference were two-fold: (1) to provide an avenue for federal, state, tribal governments, industry and academia to jointly analyze three specific pathways that unintentionally introduce invasive species into U.S. ecosystems; and, (2) to receive evaluative feedback on the validity and efficacy of proposed pathway risk assessment methodology and diagrams.

The following processes were used to achieve conference objectives: (1) convened expert focus groups comprised of government, industry and academic experts to qualitatively evaluate the invasive risk levels associated with Air Cargo, Wood Packing Material and Shipping Industry/Ballast Water pathways (which would address such invasive species as brown tree snake, Asian Longhorned Beetle and zebra mussels); (2) assessed quantitative pathway risk analysis datasets; and (3) conducted a 'test' training session relevant to education of agency personnel on invasiveness species.

The anticipated outcomes from the conference included the following: (1) cross-agency and industry assessment of the threat of invasive species introduced via the specified pathways; (2) evaluation of the validity and efficacy of proposed pathway risk assessment methodologies; and, (3) recommendations on future training and prioritization efforts.

Conference planners' intended that results would provide data and resultant analysis to agency decision makers to assist in collaborative efforts such as resource leveraging, targeting of invasive populations, and identification of gaps or inconsistencies between organizations that may inhibit efforts to prevent unintentional introduction of invasive species.

**Phase 2: Design 1 Field Test Report**

Feedback from these focus groups on the assessment tools, methods and outcomes was highly productive but nearly overwhelming as it forced the Pathways Work Team to reconstruct virtually all pathway assessment methods and tools. As such, activities were deemed successful, as they precluded the implementation of a product in need of significant revisions. A by-product of this conference was the realization that the assessment tools and methods will be a continually evolving process; as sophistication of tools and supportive datasets improve.

There were a total of 42 conference attendees that participated in two evaluations: (1) critical assessment of pathway tools; and (2) evaluation of the process for administering the tools. Thirty-three (33) participants provided written comments regarding the pathway criteria and ranking processes; thirteen (13) provided feedback on conference processes.

Conclusions were, despite three separate work groups, nearly unanimous in suggested changes. Recommendations are provided below in synopsis format:

***The Guide:*** Overall, the process and use of an assessment guide was supported. However, participants indicated that extensive revisions would be required. Revisions (as described below) fell into one of the 4 categories of: (a) assessment process; (b) assessment tool and questions; (3) diagrams; and (4) evaluation scales:

> ***Assessment Process:*** It was the general consensus that the assessment tool should be completed by experts on an individual basis, then via focus group procedures. Revised methodology is contained in Chapter 3 of this report.
>
> ***Assessment Tool:*** Numerous additions or changes were recommended for the assessment tool - - and were so extensive that field test evaluations of wood packing material, air transport and ballast water cannot be said to be reliable or valid assessments based on conference focus group assessments. This is not to indicate that expert assessments made of the pathways were invalid, just that the tools used must be significantly revised to ensure credibility, validity and reliability. The following is an overview of salient points:
>
> - Specific invasive characteristics of a pathway's start, transition and endpoint(s) must be defined
> - Geographic and eco-region issues are critical to assessments
> - Questions must be reworded to current assessment, only
> - Questions must contain more defined, specific language
> - Duplication of similar questions must be avoided to preclude unfair weighting of instrument
> - Uncertainty factors must be more thoroughly assessed
> - Terms and definitions should be included or indicated as same as ISPM Glossary of Terms
> - Scientific assessment is separate from policy, cost/benefit issues or action plans

- Pathway characteristics need to be defined and coupled with species-specific invasive qualities
- Evaluation should be done by a mix of experts
- Need more intensive instruction as to how to complete the tools

***Diagrams***

Suggestions for expanding the diagrams included the following pathways:

- military baggage and gear
- travelers (themselves)
- pets and animals for entertainment
- travel/tourism, cut flowers
- fruits and vegetable commodities
- domestic waste streams
- movement of raw logs within U.S.
- garbage transport
- recreational boats and vessels (T12.2)
- non-food aquaculture,  and
- animal liberation

***Evaluation Scales***

- Rankings do not provide sufficient complexities for stratifying pathways
- Scale of severity needs to be established (i.e. what is high versus low)
- The average of categories doesn't give value. Need logistic regression analysis
- Clarification is needed on certainty/uncertainty issues
- Assessments be accurate, reliable and predictive in orientation

The Pathways Work Team incorporated/amended all tools and methodologies relative to the above recommendations.  However, some of the comments expressed needs that outstripped the current sophistication level of information gathering and management.  These recommendations will not be overlooked or 'lost', but will have to be deferred to future revisions of the guide and the incorporation of mathematical algorithms or indices into database queries.

## CHAPTER 2 - REDESIGN

**Conceptual Framework:** The underlying conceptual framework and issues posed to the Pathways Work Team group via focus group feedback was: How could NISC promote a methodology and infrastructure for cooperative management of invasive species pathways in a matrix-method that crossed federal, state, tribal, local, academic and special interest group lines? Subsidiary to this issue was the development of a way to rank risk (i.e., scale of severity) or threat posed by a particular invasive. This determination would bring resolution (at best) or at minimum, prioritization, to competing interests as to which invasive(s) would pose the greatest consensus risk to the entire United States populace (i.e., not just a single stakeholder strata). In addition, the 'consensus on risk' had to ensure prioritization gave precedent to human health, economy and ecology issues, in respective order.

The work group early recognized that diligence in addressing scientific pathway identification and prioritizing issues was essential; as the ultimate outcome of all these recommendations - - namely the allocation and assignment of Federal resources and programmatic priorities - - was of great consequence to multiple stakeholders.

The national invasive species effort, in tandem with current trends of international collaboration and resource management, must fulfill the role of expert science in policy processes for multi-layered decision-making. The construct of pathway assessments, therefore, had to 'break new ground' in developing a methodology that was democratic, transparent, scientifically expert and yet geo-politically sensitive. The methodology had to be sufficiently flexible so that it could be used by various stakeholders on local, regional and national levels; while giving platform for cross-organizational forums for integrated action planning between those with shared national interests on a specific pathway. The end-goal is a full systems-approach to invasive species detection, management and mitigation.

### Qualitative and Quantitative Assessment

The International Organization for Standardization defines risk as "the combination of the chance of an event and its consequences" (IOS, 2002). The Pathways Work Team made early agreement that pathway analysis and prioritization would parallel risk assessment (i.e., the scientific evaluation of the biological risks and potential consequences) procedures. In addition, it was decided that questions regarding risk management (i.e., a process of determining appropriate measures to reduce risk) would also be included in assessment data as reduction of risk practices directly impact severity of pathway invasiveness. Ultimately, it was decided that pathway prioritization and analysis was so broad in scope, it would require both quantitative and qualitative methods to give the most accurate assessment based on existing information and expertise.

> **Qualitative Assessment - The Proposed Process and Tools:** As delineated in the opening remarks made by Hilda Diazo-Soltero, USDA Invasive Species Liaison, the purpose of the June 21-22, 2005, Invasive Species Pathways conference was to trial test the process and instruments developed for assessment of national pathways. The processes and tools (recounted below) was the Pathways Work Team's best attempt at creating a democratic, scientific policy process that utilizes the best practices for qualitative and quantitative assessments; accommodating multi-layered factors and perspectives. Components of the process are further elucidated below: [2]

[2] See *User-Friendly Handbook for Project Evaluation* (NSF 93-152) as paraphrased and applied to remainder of section.

**Stage 1: Individual Expert Qualitative Review.** Initially, individual experts gathered and codified their first-hand information and expertise relative to a specific pathway. In their assessments, the experts openly explored pathway nuances germane to their working environment and orientation. In addition, these experts developed a pathway prioritization based on a 'full system' (i.e., full pathway cycle) context. This was particularly important as pathways are viewed as a series of events that may lead to the introduction of an invasive species. The first step of the method (i.e., individual participants first completing the assessment tool, independently) ensured that evaluators adequately represent their particular stakeholder group's perspectives and issues. (This approach is only effective if participants are well-qualified, content experts.) The questions contained in the assessment tool provided a structured protocol to guide individuals to make thorough observations via a set of targeted concepts and criteria that would be later used for consensus assessment.

**Stage 2: Group Expert (Consensus) Qualitative Review.** The second stage of evaluation was accomplished by a pathway-specific focus group of experts that represented pathway-specific stakeholder groups. Expert determination was based on professional credentials, organizational liaisons, work history and academic credentials. These focus group reviews, in themselves, provided very different data from individual assessments. They enabled the capturing of multiple consensus perspectives of various stakeholders; creating a common vision or analysis of a specific pathway. This enabled identification of common aspects of a pathway while setting a group forum for addressing related issues.

The pathway focus groups combined elements of both interview and participant observation; while capitalizing on collective group intelligence. Group interaction generated data and insights that most likely would not have emerged through individual evaluation.

Based on conference outcomes, the Pathways Work Team recommends focus groups be limited to 8 to 12 persons; be managed by facilitator; and have a designated official recorder. This meeting format not only is conducive to reviewing the efficacy of the assessment tools and efficacy of quantitative datasets; but is conducive towards the emergence of new ideas.

**Guiding the Focus Groups.** A challenge for these focus group proceedings was the gleaming of usable, consistent, descriptive statistics for cross-organization and pathway comparison. The assessment tool served as a topic guide to assist focus group facilitators in keeping various perspectives on a unified track. The tool also served as a road map in developing the joint findings and the final report.

**Focus Group Facilitation**. Focus group participants were asked to reflect on the questions asked by the moderator; were permitted to hear one another's individual responses and then make additional comments beyond their own original responses. It was neither necessary to reach consensus nor to resolve disagreements as this effort was a 'field test' of the tools. The facilitators kept the discussion flowing and ensured that no one or more persons dominated the discussion. [3] in the future, however, the facilitator(s)' role will be to seek

[3] *User-Friendly Handbook for Project Evaluation* (NSF 93-152).

consensus between participants on pathway risk prioritization (see Chapter 3 of this guide).

**Focus Group Construct**. It was decided that one group per pathway was essential due to pathway complexities and the subsequent varied expertise required. Though a good rule is to conduct at least two focus groups per pathway to ensure response validity; in that pathways are limited in scope (i.e., a pathway can be succinctly defined and assessed) single focus group assessment were/are deemed sufficient. (This is not to say once evaluated, always evaluated. In fact, it is expected that pathways will be re-assessed, as needed, due to changing conditions.)

**Recording Focus Group Data***.* The procedures for recording focus group sessions were basic. The focus group facilitator was assigned a non-expert person designated as the recorder to take notes on both comments and assessments. A major advantage to this is the recorder focuses on observing and taking notes, while the facilitator concentrates on asking questions, facilitating group interaction, following up on ideas, and making smooth transition from issue to issue. It was understood that these results would be codified in a final report but without individual names or organizations attributed to specific comments.[4] (Feedback from conference attendees on use of facilitators/recorders was assessed as highly favorable per a separate evaluative survey).

**Other Qualitative Methods - -Document Studies.** Though quantitative benchmarks/datasets were researched to assist pathway prioritization, a significant lack of data history caused use of one other method for pathway assessment - - document and scientific studies. Pathway-specific documents were supplied to participants several weeks prior to the conference to provide exemplar pathway cases and to create a common knowledge base for discussion and comparison. Successful, the Pathways Work Team encourages the augmentation of qualitative and quantitative datasets with document studies for all future pathway assessments.

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[4] *User-Friendly Handbook for Project Evaluation* (NSF 93-152).

**Quantitative Assessment.** The goal of developing quantitative datasets is to give statistical indicators to aid in assessing the likelihood of invasive species entry or occurrence, establishment or spread of a pest or disease within the territory, phytosanitary measures which might be applied, and the associated potential biological and economic consequences or the evaluation of the potential for adverse effects on human or animal health. Assessment should first be rooted in the unmitigated (unmanaged) pest or disease risk but then modified to address mitigation/management practices. Biological, economic or ecosystem consequences should also be addressed, but in terms of merging risk 'science' with policy decisions.

Specific risk factors for quantitative assessment included such factors as the following

- Prevalence of a pest or disease agent in the exporting area;
- Geographic and environmental characteristics;
- Sanitary and phytosanitary status of the adjoining or neighboring areas;
- Trading partners and practices;
- Regulatory infrastructure of the exporting country;
- Invasive species surveillance and monitoring system(s);
- Pest or disease agent survival rate in transit;
- Interception data;
- Invasive species destination risk factors such as likelihood and consequences of a particular pest or disease agent surviving, multiplying, establishing and spreading in the territory of the importing country;
- Uncertainty about the organisms, the human error factor, or methods used;
- Distribution of the commodity or vectoring agents; and,
- Availability of susceptible hosts and/or competent vectors.

The relevant economic factors include:

- The potential damage due to loss of production or sales in the event of the entry, establishment or spread of a pest or disease;
- The cost of control and eradication;
- The relative cost-effectiveness of risk mitigation strategies; and.
- Cost-benefit analysis of mitigation versus consequence of introduction.

As previously indicated, quantitative data was unavailable, sporadic or incomplete. The Pathways Work Team could not, therefore, statistically define acceptable levels of risk but rather had to create evaluative scales of relative risk for pathway analysis. The Team recommended a special work group to be convened to develop statistical indices at a later date.

**Qualitative Vs Quantitative: The Search for Reliable Data**

The qualitative approach primarily uses categorical values for inputs and outputs. The input variables were then assigned a particular ranking such as low, moderate, or high risk. The Team also found that due to a lack of valid, consistent datasets, pathway analysis would have to rely more heavily upon qualitative (i.e., expert) opinion. It is anticipated as data collection and predictive indices increase in sophistication, there will be a shift towards more quantitative analysis - -but this shift will only result after several edifications or 'design evolvements' of this process. The complexities yet potential benefits expressed by participants regarding quantitative assessments were extensive and call for future statistics-based program development. The section below [concepts by Dr. Susan Cohen (PhD, Environmental Biology and Public Policy; Assistant Chair, Pathways Work Team); written for the

Pathways Work Team by Laura Biven, (PhD, Applied Mathematics, Advisor to Pathways Work Team] elucidates these future challenges. The Team welcomes comments, feedback and discussion on the concepts posed below:

## In Search of an Objective Measure of Pathway Risk

Any risk assessment process has two key components 1) identifying a projected outcome and 2) assessing the likelihood of that outcome being realized. In the case of assessing the risk posed by potential invasive species, this can be broken down further into the following three components:

1) *The likelihood of introduction*
2) *The likelihood of establishment*
3) *The magnitude of damage*

The likelihood of introduction can be quantified for a particular species and well defined pathway. This measure can be objective in so far as the total likelihood is based on the individual probabilities that the species follows each stage of the pathway. The caveat is that it is the risk assessor who identifies the various stages and assigns their relative importance. Errors in this measure (and they may be considerable) are mostly due to the lack of accurate information about the various stages of the pathway (e.g., infection rates; likelihood of incidental infestations of cargo; efficacy of natural and artificial mitigations, etc).

The likelihood of establishment can be estimated for a particular species and target habitat. Estimates are usually semi-quantitative (high, medium or low) and are inaccurate, not for lack of information, but because the establishment of a species is critically dependent on a large and unknown set of variables. Starlings, for instance, were introduced into Central Park in New York City eight times. Only two of these populations established.[1]

The magnitude of damage resulting from the establishment of a particular species can be assessed by considering each affected commodity (e.g., the environment; human or animal populations; agricultural crops , etc). These estimates are often quantified as dollar amounts but are nonetheless inherently subjective or, at least, dependent on cultural values. It is the risk assessor or community that decides how to assess the relative value of human health and freedom from trade barriers, for example. Expressing these values as dollar amounts is simply a useful tool for recording these decisions.

### Objectivity is a Question of Detail

In searching for an objective measure of pathway risk, we must content ourselves with objective measures of 1 and 2: the likelihoods of introduction and establishment. It's worth noting that objectivity of these measures does not imply that the measures must be quantitative and, conversely, a quantitative measure is not necessarily objective. Indeed, it is relatively unimportant whether the measure is quantitative or qualitative. Of much more importance is the accuracy of the information on which the assessment is based.

All of the steps for assessing the risk of invasive species, above, place strict requirements on the level of detail needed in the definition of species and pathway (including pathway origin and target habitat). It is unrealistic, however, to perform risk assessments on all species/pathway combinations on a national scale. For this reason, the Pathways Work Team has defined a number of pathway categories (these are referred to as "pathways" although may be better thought of as collections of pathways or pathway categories).[2] The task of assessing the risk of pathway categories necessarily has two levels of detail: The first is the level of detail required to accurately assess risk as outlined in the steps 1—3 above. The second is the more general level on which pathway categories are defined.

Any assignment of risk to a category of pathway is necessarily a summary of the underlying specific species/ pathway risks. The summary may be the mean risk of the group or the maximum risk value or some other summarizing measure. Any summary, however, constitutes a loss of information. The mean value can mask high risk elements in the group whereas the maximum risk value loses information about the absolute potential for damage. Sensitivity analyses of the risk of particular species/ pathway combinations show that the value of risk depends critically on the details of the target habitat, season of introduction, species type, etc. The value of risk for two elements in the same category are almost surely unrelated, therefore. This lack of correlation among elements in the pathway category furthers the argument against assigning a single value of risk to the category.

When considering a pathway category, there are two possibilities for the available data:

I. Data exist (quantitative or qualitative) about specific species, pathways, origins, target habitats or combinations of these. Perhaps a pest risk assessment has been done for a particular species/ pathway combination that falls under this category. Perhaps there is only anecdotal evidence of a particular species entering via the pathway. In any case, the information will be about specific elements of the pathway category under consideration. Information of this type can be relevant for assessing the likelihood of introduction and/or the likelihood of establishment.
II. No such data exist or are available. Perhaps the pathway has never before been studied or no reliable conclusions have resulted from the study. In this case, assessment of the likelihood of introduction without further analysis is largely guesswork. Assessing the likelihood of establishment, given the introduction of a particular species, may be estimated with a predictive screening method with full understanding of the limitations of these methods.

### Methods for Assessing Likelihood

Assessing the likelihood of introducing a species differs depending on the details of the species and pathway in consideration. The method of diagramming the pathway and assessing the probability that some number of individuals of the species survives each stage of the pathway is well documented.[3]

Assessing the likelihood of establishment is a difficult task and many different approaches are possible, each with their pros and cons and underlying assumptions. What follows are evaluations of a selection of the methods available.

- *Gather of information about known species present in the pathway*. There are many (although insufficient) web accessible databases which contain information about invasive species; possible invasives; their modes of entry and spread in the US; their native habitats and means of reproduction.[4] Most of these databases deal with plant species.
- *Calculation of the overall flux of species through the pathway per year or per transport event*. Under the assumption that the number of invasive species present in a pathway is directly related to the total number of species in the pathway, this is one way to estimate the number of invasive species present in the pathway. Finding the data to perform this calculation may be difficult and incur large errors. Comparing pathways based on this measure is meaningless unless the species under consideration are similar.
- *Use of Predictive Screening Methods to Assess Invasiveness of Species*. Under the assumption that particular characteristics of a species can determine its likelihood to be invasive, there are a number of models which seek to identify these characteristics for a narrow enough class of species. The invasiveness of the genus *Pinus* in North America has been linked to characteristics of mean seed mass and minimum juvenile period, for example[5]. These methods tend to develop cautious criteria. The emphasis is on correctly diagnosing a species as invasive while some non-invasives may be misdiagnosed as invasive. The only criterion consistently linked with invasiveness of plant species and broadly accepted in the professional communities is whether or not the species is invasive in any other environment.
- *Use of Predictive Screening Methods to Assess Invasibility of Habitats*. Similar predictive screening models exist to predict the likelihood of certain ecosystems being invaded by non-native species, usually plants. Disturbed ecosystems have been associated with invasibility, for example.[6] These models are not uniformly accepted in detail although the premise that an ecosystem may be more or less inherently vulnerable to invasions has broad consensus support.

- *Notes on the use of the Survey*: The survey developed by the Pathways Work Team solicits justified (through citations in the literature, first hand accounts etc.) expert opinion. Results from individual surveys are essentially subjective. Results from a collection of surveys depend on the variety and number of experts participating as well as the breadth of their collective and individual expertise. There is some reason to believe, however, that the spectrum of information gleaned from a large and diverse enough group of experts is objective in the sense that it is reproducible—the results from a different but similar group of experts would extract the same information. More tests with this tool need to be completed to support this belief, however.

Pathway Risk Assessment Do's and Don'ts

DO NOT summarize risk information about individual species/pathway combinations to assign a single numeric value of risk to a pathway category. Some synthesis of this information is necessary to compare the relative importance of pathway categories, but this process cannot be formulaic and is necessarily subjective.

DO look at information about individual species and pathways in the category and determine the quality of the information source (published records, informed opinion, anecdote, etc.)

DO Use predictive screening where possible but only with a full understanding of the assumptions involved and quality of data used.

[1] See the review article "Reducing the risks of nonindigenous species introduction" by Jennifer L. Ruesnink and Ingrid M. Parker, *Bioscience*, Vo. 45 Issues 7, p. 465 (Jul/Aug 1995) which cites Phillips, J.C. "Wild birds introduced or transplanted in North America" *USDA Technical Bulletin* No. 61. US Department of Agriculture (1928)
[2] See Pathways Diagrams in Report Appendices.
[3]See, for example, "Guidelines for Pathway-Initiated Pest Risk Assessments" .US Department of Agriculture, APHIS, PPQ. (October 17, 2000)
[4]A comprehensive list is contained in "Invasive Species Databases—Proceedings of a Workshop" Charles Valentine Riley Memorial Foundation, 1999. See also http://www.nbii.gov/search/sitemap.html
[5] Rejmánek, M. and Richardson, D.M. "What Attributes Make Some Plant Species More Invasive?" *Ecology*, 77(6) (1996) pp. 1655-1661. See also Reichard, S.H. and Hamilton, C.W. "Predicting Invasions of Woody Plants Introduced into North America" *Conservation Biology*, Vol. 11 No. 1 (1997) pp. 193-203
[6] See Rejmánek, M., Richardson, D.M. and Pyšek, P. "Plant Invasions and Invasibility of Plant Communities" in "Vegetation Ecology" Edited by E.v.d.Maarel, Blackwell Publishing (2005) for a review.

**Managing Uncertainty**

Reduction of uncertainty has always been the central goal of any scientific effort. Uncertainty may result from a range of issues such as follow:

- flaws in methodology (i.e., measurement errors or lack of knowledge of the steps or elements of risk evaluation);
- lack of expertise, coherence or error on part of risk assessor, biological unknowns of the invasive organisms/pathways;
- insufficient information (i.e., lack of accurate/precise knowledge of the input values); or
- political impediments.

What is critical to realize is that uncertainty need not be an impediment to resolution of an issue. The risk perspectives developed are based upon the state of scientific understanding of the pathway at a particular time - - and reflect a state of confidence in that understanding. Culture, organization, educative norms or values may directly impact the level of uncertainty a risk assessor may experience, but the process for pathway risk analysis must 'overcome' these obstacles to create action.

As such, the Pathways Work Team decided the assessment process must characterize the nature of uncertainty each assessor may have (on a per question basis) with a requirement for assessors to devise a strategy to either reduce the uncertainty associated with the question, or a method to assess the pathway, with acceptable levels of uncertainty tolerated.

It is anticipated that individual uncertainty issues will be minimized or ameliorated through the secondary, consensus process whereby broader range (e.g. group) expertise, experience and knowledge will be incorporated into final factor assessment. It is understood that group expertise will replace individual uncertainty factors; and that if there is general consensus of uncertainty on a particular risk factor, the group may elect to raise or lower the risk 'score' of a pathway based upon extrapolated reasoning. Risk assessment is not an absolute, but a relative 'equation'.

Pathway analysis is in a sense, a way of democratizing science; as the end goals are transparency, attention to specific scientific and technological outputs and development of human socio-political (i.e., government) structures. The processes devised must be rigorous, relevant and participatory. It is important evaluators accept that most important decisions are made with a degree of uncertainty; but actions in light of uncertainty are justified by a high level of commitment to set goals, values and actions. Policy decisions are based on what the future should look like for particular groups with an underlying acknowledgement that realities may modify those future goals. Policy sets the direction to take, but science creates and maintains the focus.[5]

[5] Source: Arizona State University Consortium for Science, Policy and Outcomes, College of Liberal Arts and Sciences

## CHAPTER 3 – THE GUIDE VERSION 2

**The Redesign.** The focus groups called for considerable restructuring of the pathway assessment tool. What was recommended was the need to develop a three-tiered methodology that adequately addressed policy direction, risk science and interagency action planning. This methodology had to ensure that the priorities of first, human health, second economy, and then ecology (as defined in National Invasive Species Management Plan) were accommodated.

Within the above recommended framework, the focus groups challenged the Pathways Work Team to also devise a method to determine which individual pathway(s) to first assess. There were concerns over unknown pathways; false perceptions over severity or 'innocuous' nature of pathways; or that the current instrument would result in little differentiation over pathway risk. As such, and after great discussion on weighting particular factors and creating scales of severity, the following phased assessment was proposed to and unanimously approved by the National Invasive Species Council and the Aquatic Nuisance Species Task Force in summer 2006. This document will be in continual evaluation as feedback and trial tests will bring greater sophistication to program processes. In addition, the NISC requested, as part of document approval, the Pathways Work Team devise a full-agency implementation plan and further develop quantitative analysis methodologies.

**Pathway Evaluators:** Pathway prioritization is a task for program experts. It is important to gather together a team of individuals who can appropriately accomplish all facets of risk evaluation. At a minimum, a pathway assessment expert team list should be compiled that includes information as to the experts' name, organization/associations, areas of specialty, published papers, academic background, related work history and contact information.

**The following segment of this report serves a second purpose as an instructional guide for pathway definition, prioritization and risk analysis. Please note, certain information from prior portions of this report will be repeated in the guide for ease of use. Repeated sections are notated.**

THE NATIONAL INVASIVE SPECIES COUNCIL (NISC)

ANS Task Force — Dedicated to the prevention and control of aquatic nuisance species

# Guide to Invasive Species

- Pathway Definition
- Risk Analysis
- Risk Prioritization; *and*

# Policy Planning

Developed jointly by the Aquatic Nuisance Species Task Force (ANSTF) and National Invasive Species Council (NISC) Prevention Committee via the Pathways Work Team

This Guide Only Applies to Unintentional, Man-Made Pathways

Issuance date: July 2006

# Pathways Guide
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## Background

**1. Purpose for and Definition of Invasive Species Pathways Analysis.** The purpose of pathway risk analysis is to provide scientific analyses and policy recommendations in support of U.S. National Invasive Species Council's Management Plan. These analyses and recommendations must comply with the Plan's mandates to:

- ensure Federal efforts are coordinated and effective
- promote action and partnership at local, State, tribal and ecosystem levels
- identify recommendations for international cooperation; and,
- facilitate networks to document, monitor and prioritize invasive species pathways

Though many definitions for invasive species and pathways may exist, we are defining these terms as they relate to Federal regulatory functions. Definitions are recounted, below:

> **Invasive species- -** an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.
>
> **Pathways - -** the means by which species are transported from one location to another. Natural pathways include wind, currents, and other forms of dispersal in which a specific species has developed morphological and behavioral characteristics to employ. Man-made pathways are those pathways which are enhanced or created by human activity. These are characteristically of two types:
>
> - The first type is intentional, which is the result of a deliberate action to translocate an organism.
>
> - The second type of man-made pathways are those pathways which unintentionally move organisms. Examples of unintentional pathways are ballast water discharge (e.g. red-tide organisms), soil associated with the trade of nursery stock (e.g. fire ants), importation of fruits and vegetables (e.g. plant pests), and the international movement of people (e.g. pathogens). In these … the movement of species is an indirect byproduct of our activities.

This guide only addresses analysis of the second type of pathway: unintentional, man-made invasive species pathways; with a section devoted to policy synthesis. For our purposes, analysis and policy synthesis are defined as:

> **Analysis--** the procedure by which we scientifically break down a 'whole' phenomena (i.e., unintentional IS incursions) into its parts or components.
>
> **Policy Synthesis--** the process by which we combine the analysis components into a comprehensive perspective to devise copasetic IS policies and actions on the local, regional, national and international levels.

**2. Pathways Further Defined.** The concept of pathway conceptualization proved challenging, particularly for those new to pathway risk analysis concepts. To assist new users, an overall schematic of pathways and sub-pathways (that is expected to be user-modified) is provided:

# Categorization Of Pathways and Sub-Pathways
# (A continual 'Drill Down' of Pathways to the Lowest Levels)

## Transportation Related Pathways

This category includes all the various pathways related to transportation of people and goods. Subcategories include:

1) Modes of Transportation
2) Military Travel and Transportation of Military Vehicles
3) Items Used in Shipping Process
4) Mail/Internet/Overnight Shipping Companies
5) Travel/Tourism/Recreation /Relocation

See Diagram 1 for more details

## Living Industry Pathways

This category includes all the various pathways associated with living organisms and/or their by-products. Subcategories include:

1) Plant Pathways
2) Food Pathways (market ready or near market ready – transporting animals for consumption)
3) Non-Food Animal Pathways (transporting animals for reasons other than consumption)
4) Non-Living Animal and Plant Related Pathways (animal and plant products)

See Diagram 2 for more details

## Miscellaneous Pathways

**This category includes various pathways that did not fit into the other two categories. Subcategories include:**

**1) Biocontrol**
**2) Release of Animals for Religious, Cultural or Other Reasons**
**3) Other Aquatic Pathways**
**4) Natural Spread of Established Populations of Invasive Species**
**5) Ecosystem Disturbance (long and short term)**

**See Diagram 3 for more details**

**Diagram 1**

## Transportation Related Pathways

**(Includes all the various pathways related to the transportation of people, commodities and goods, including military travel and transportation of military vehicles)**

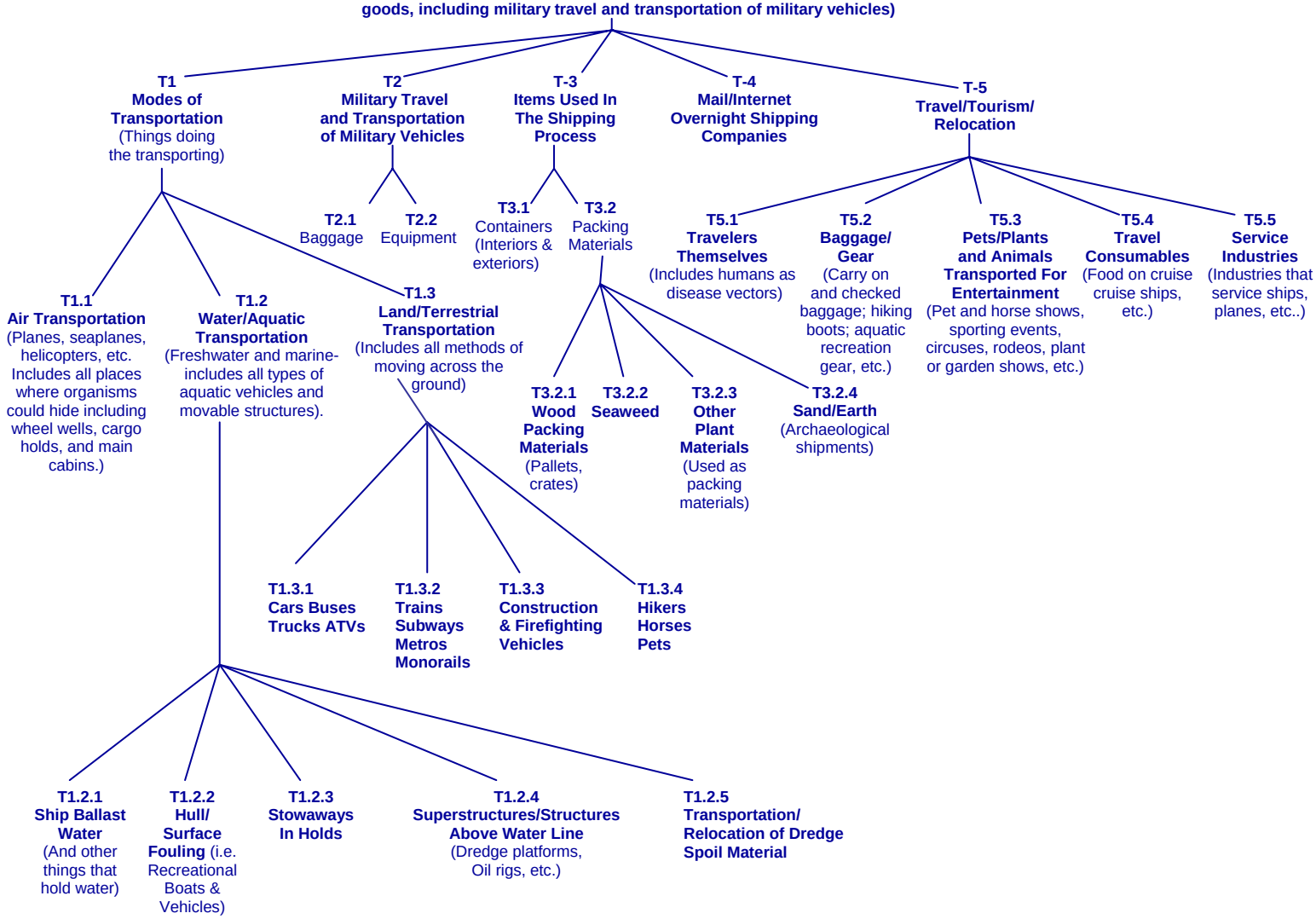
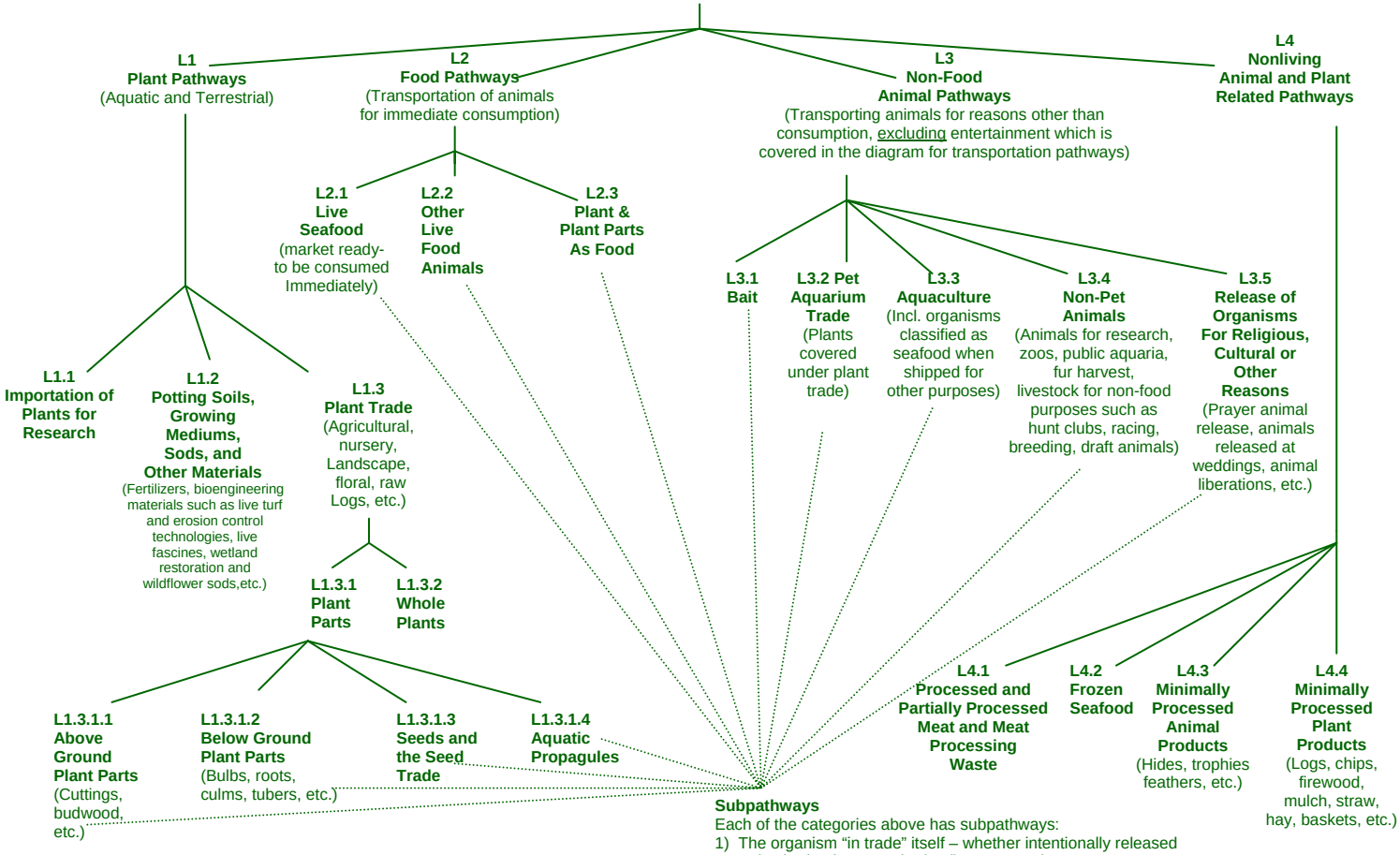


**Diagram 2**

# Living Industry Pathways

**(includes all pathways associated with living organisms and/or their by-products)**




**Subpathways**

Each of the categories above has subpathways:

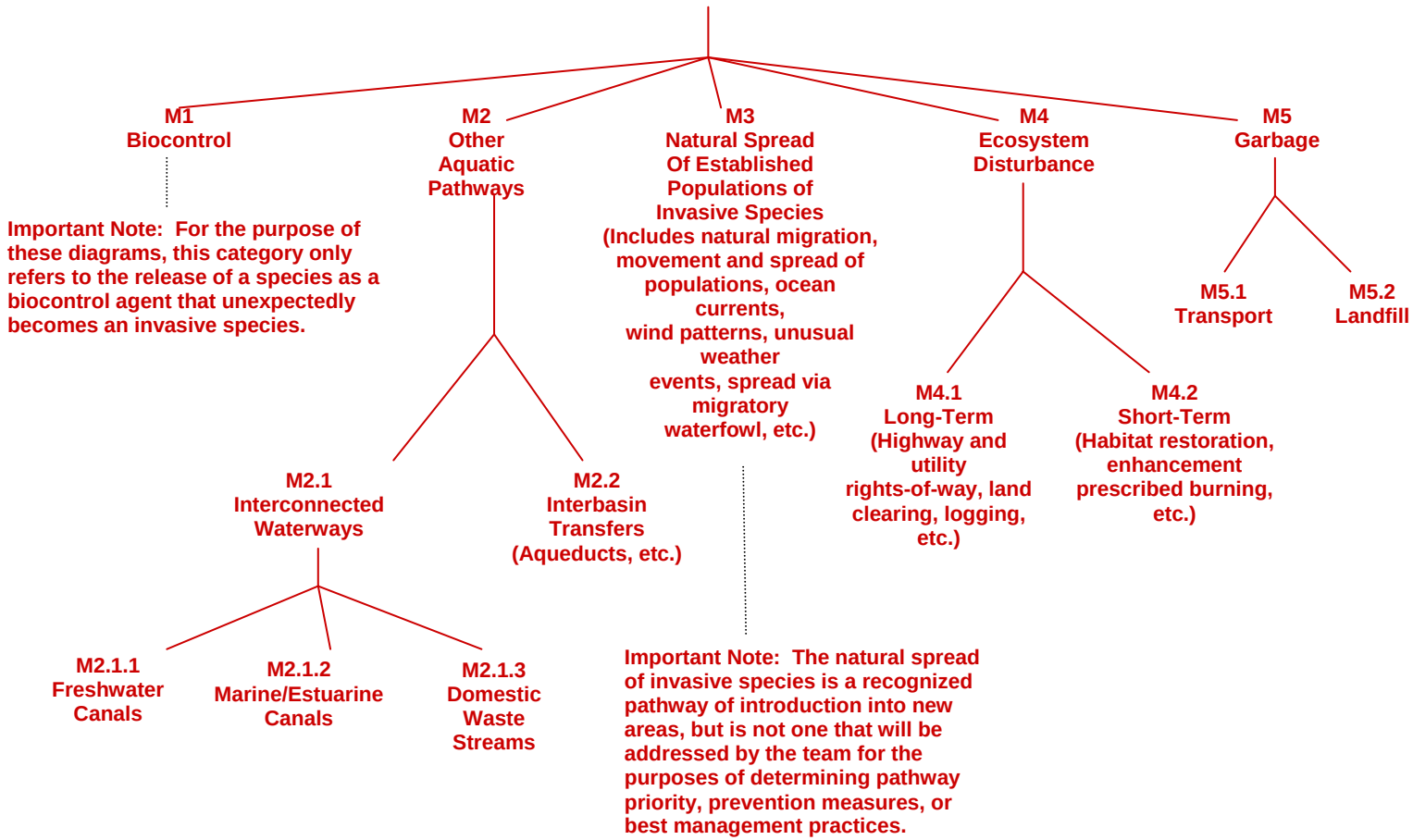
1) The organism "in trade" itself – whether intentionally released (authorized or unauthorized) or escaped
2) Hitchhikers on or in the organism in trade
3) Hitchhikers in water, food, nesting/bedding, or growing medium

**NOTE:** Hitchhikers can include plants, animals, invertebrates, parasites, diseases and pathogens

## Diagram 3

# Miscellaneous Pathways

**(Includes various pathways that did not fit into the Transportation or Living Industry Pathway Categories)**



## Written Pathways and Sub-Pathways
## (Color-Coded to Match Prior Charts)

(T) Transportation

T 1 Modes of Transportation
- T1.1 Air
- T1.2 Water/Aquatic
  - T1.2.1 Ship Ballast Water
  - T1.2.2 Hull/Surface Fouling (i.e., Recreational Boats and Vessels)
  - T1.2.3 Stowaways in Holds
  - T1.2.4 Superstructures/Structures Above Water Line
  - T1.2.5 Transportation/Relocation of Dredge Spoil Material
- T1.3 Land Terrestrial
  - T1.3.1 Cars, Buses, Trucks, ATVs. Trailers for recreational boats
  - T1.3.2 Trains, Subways, Metros, Monorails
  - T1.3.3 Construction/Firefighting Vehicles
  - T1.3.4 Hikers, Horses Pets

T2 Military Travel and Transportation of Military Vehicles
- T2.1 Baggage/Gear
- T2.2 Equipment

T3 Items used in the Shipping Process
- T3.1 Containers
- T3.2 Packing Materials
  - T3.2.1 Wood Packing Materials
  - T3.2.2 Seaweed
  - T3.2.3 Other Plant Materials
  - T3.2.4 Sand/Earth

T4 Mail/Internet Overnight shipping

T5 Travel Tourism/Relocation
- T5.1 Travelers Themselves
- T5.2 Baggage/Gear
- T5.3 Pets/Plants and Animals Transported for Entertainment
- T5.4 Travel Consumables
- T5.5 Service Industries

(L) Living Industry

L1 Plant Pathways
- L1.1 Importation of Plants for Research
- L1.2 Potting Soils, Growing Mediums, Sods and Other Materials
- L1.3 Plant Trade (agricultural nursery, landscape, floral, raw logs)
  - L1.3.1 Plant Parts
    - L1.3.1.1 Above-Ground Plant Parts
    - L1.3.1.2 Below Ground Plant Parts
    - L1.3.1.3 Seeds and the Seed Trade
    - L1.3.1.4 Aquatic Propagules
  - L1.3.2 Whole Plants

L2 Food Pathways
- L2.1 Live Seafood
- L2.2 Other Live Food Animals
- L2.3 Plants and Plant Parts as Food

L3 Non-Food Animal Pathways
- L3.1 Bait
- L3.2 Pet/Aquarium Trade
- L3.3 Aquaculture
- L3.4 Non-Pet Animals
- L3.5 Release of Organisms for Religious, Cultural or Other Reasons

L4 Nonliving Animal and Plant Related Pathways
- L4.1 Processed and Partially Processed Meat and Meat Processing Waste
- L4.2 Frozen Seafood
- L4.3 Minimally Processed Animal Products
- L4.4 Minimally Processed Plant Products

(M) Miscellaneous

M1 Biocontrol

M2 Other Aquatic Pathways
- M2.1 Interconnected Waterways
  - M2.1.1 Freshwater Canals
  - M2.1.2 Marine/Estuarine Canals
  - M2.1.3 Domestic Waste Streams
- M2.2 Interbasin Transfers

M3 Natural Spread of Established Populations

M4 Ecosystem Disturbance

M4.1 Long-Term (highway and utility rights-of-way, clearing, logging)

M4.2 Short Term (habitat restoration, enhancement, prescribed burning)

M5 Garbage
- M5.1 Garbage Transport
- M5.2 Garbage Landfill

## 2. Cumulative Assessment and Risk Information Pyramid (Future Development)

The above structure of pathways and sub-pathways sets a framework for evaluating pathway risk, based on a cumulative, compounding effect of local, to regional, to national and then international assessments. This needed approach, was codified in the proceedings from the IS "Stakeholders, Collecting, Sharing and Using Information" roundtable, held April 26, 2006, in Washington, DC between United States Department of Interior, United States Department of Agriculture, Riley Memorial Foundation, and stakeholders. During this session, the following goal was established:

> *The uninhibited exchange of information, ideas and positions…[to] provide a framework for finding more common ground through collecting, sharing and using information as efforts are made to deal with the ever increasing and often devastating invasive species problem"*

This pathways risk analysis system, to meet this goal and to ensure integration, functions as a shared (i.e., electronic, internet-based) information system. Using a 'cumulative effects' predictive statistical approach, the framework requires collection of IS pathway baseline data at multiple 'field' or operational sites. Local quantitative and qualitative datasets, compiled regionally, nationally, then internationally, will provide a 'real-time' analysis of invasiveness - -via a virtual risk information pyramid. As such, all levels of invasive scientific analyses becomes inextricably linked to local, regional, national and international invasive species policies and actions. In addition, long-term compilation and analysis of these datasets will enable trend analysis and predictive risk assessment.

There are four basic components to this system: 1) standardized data collection and database platforms, 2) algorithmic synthesis and benchmarking of the data, 3) communication of data analysis implications, and 4) research to support, evaluate and continually enhance the system.

Currently, the Pathways Work Team has been charged with developing and accomplishing the four components. No easy task, efforts must be made to ensure quality (i.e., validity and reliability) of the information to ensure credibility of results. As we further develop these information sources, numerous databases exist that provide vital information supportive to pathways analysis. A comprehensive list of available IS databases is contained at the following URL: www.invasivespeciesinfo.gov.

### Preparation For Review

### 3. Internal Infrastructure for Pathway Analysis **(Note: Section reiterated from conference report).**

**A. Pathway Analysis Experts (i.e., Risk Evaluators):** Pathway analysis and prioritization is a challenge to be met by scientific program experts. It is important to gather together a team of individuals whom can appropriately accomplish all quantitative analyses and also be able to provide qualitative opinions. The following process is recommended for the selection of individual or team members for pathway analyses:

- Define academic and experience expertise essential for analysis
- Compile a list of all pertinent agencies, organizations, industries and stakeholders
- Forward letters for IS evaluator participation solicitation to various groups (complying with any Federal Advisory Committee Act provisions). The solicitation should clearly state the pathway and expertise areas being sought.
- Designate evaluators; matching credential and pathways to be assessed
- Designated participants are to provide curricula vita, resumes, any relevant published articles, areas of specialty, academic background, related work history and contact information.

**B. Pathway Assessment Teams/Focus Group.** Pathway analysis can be accomplished by a single expert or focus group of experts. It is advised that focus group procedures be used for more complex pathways and for any pathway that is being assessed at the regional level and above. The questions contained in the assessment tool questions, that later follow, provide a consistent structured protocol for individual assessment that can later be used for consensus analysis and policy synthesis.

**C. Focus Group Facilitation**. Focus group participants are asked to reflect on the questions asked by the moderator; are permitted to hear one another's individual responses and then make additional comments beyond their own original responses. The facilitator(s)' role in these discussions will be to seek consensus between participants on pathway risk prioritization.

**D. Focus Group Construct**. In that pathways are to be succinctly defined and assessed, a single focus group per pathways is deemed sufficient. This is not to say once evaluated, a pathway is always evaluated. In fact, it is expected that pathways will be re-assessed, as needed, due to changing conditions.

**E. Recording Focus Group Data.** The focus group facilitator should assign a non-expert person as the recorder to take notes on all comments and assessments. A major advantage to this is the recorder focuses on observing and taking notes, while the facilitator concentrates on asking questions, facilitating group interaction, following up on ideas, and making smooth transition from issue to issue. These results are then codified in a final overarching assessment by the recorder but without individual names or organizations attributed to specific comments. ***The risk analysis assessment tool must be completed by each individual experts*** for each pathway assessments; regardless if they are the sole evaluator or a co-evaluator for focus group assessment. The recorder is responsible for ensuring individual evaluators 'turn-in' their individual assessments and for compiling overarching consolidated pathway assessment based on group discussion. The analysis process requires record-keeping of comments and opinions to ensure transparency and for review of decision rationale.

**F. Other Qualitative Methods - -Document Studies.** Though quantitative benchmarks and datasets are to be researched to assist pathway prioritization, a significant lack of data history causes use of one other method for pathway assessment - - document and scientific studies. Pathway-specific documents are to be supplied to participants several weeks prior to the conference to provide exemplar pathway cases and to create a common knowledge base for discussion and comparison.

**G. Database Sources for Quantitative Assessment.** The goal of developing quantitative datasets is to give statistical indicators to aid in assessing the likelihood of invasive species entry or occurrence, establishment or spread of a pest or disease within the territory, phytosanitary measures which might be applied, and the associated potential biological and economic consequences or the evaluation of the potential for adverse effects on human or animal health. Assessment should first be rooted in the unmitigated (unmanaged) pest or disease risk but then modified to address mitigation/management practices. Biological, economic or ecosystem consequences should also be addressed, but in terms of merging risk 'science' with policy decisions. Database sources for pathway assessment are numerous. Therefore, prior to any group discussion, individual expert should first compile and document quantitative data sources used for forming expert perspectives.

**[Note: At this time, quantitative data is in support of overall qualitative (i.e., expert) risk assessment. As sophistication in data collection increases, it is expected that quantitative predictive statistics will evolve from 'background' or supportive information, into a portion of the analysis assessment tool that immediately follows.]**

**Risk Analysis Portion**

**4. Multiple Pathway Triage.** Stakeholders posed a critical question during the local assessment process, restated below:

> ***"How do we prioritize resources dedicated to the evaluation of invasive species in light of multiple competing pathway interests, varying definitions of pathways and invasives and yet to be determined pathway risk levels?"***

What appeared to be a simple question was in actuality, a complicated one, expressing the need for a triage process to determine order for multiple pathway risk analysis.

The intent of triage is to prioritize invasive pathways that will require in-depth risk assessment, based upon agency mission and goals. As such, an agency-based group of two or more invasive species 'generalists' are asked accomplish the following steps:

**Step 1: The Mission**. Define agency mission, functions, responsibilities and strategic initiatives relative to IS pathways.

**Step 2. The 'Universe' of Pathways.** Review the general inventory list and diagrams of all invasive species pathways; adding any pathways that may not yet be listed (see prior pages 23-28). As part of this exercise it is advisable to <u>briefly</u> define pathway particulars (i.e., start point, mid and endpoints) for clarification.

**Step 3: List Pathways.** Select and list all pathways that are pertinent to the mission.

**Step 4: List Invasives.** Indicate, briefly, what particular invasives are associated with each pathway. A list of potential invasive species categories is provided below:

- All hitchhiking organisms
- All aquatic organisms
- Fouling organisms (e.g., organisms that attach to boats, pilings, platforms, etc.)
- Arthropods (e.g., insects, arachnids, crustaceans, etc.)
- Mollusks (e.g., giant African snails, zebra mussels, etc.)
- Plants and plant propagules (e.g., water hyacinth, Russian knapweed, etc.)
- Plant pathogens (e.g., sudden oak death, etc.)
- Phytoplankton (e.g., Amphidinium, dinoflagellates, etc.)
- Vertebrates (e.g., snakeheads, gavials, rats, brown tree snakes, etc.)
- Human and animal parasites (e.g., liver flukes, etc.)
- Human and animal pathogens (e.g.,salmonella, West Nile virus, foot and mouth disease, SARS, etc.)

**Step 5**: **Assign Initial Threat Level.** Assign each listed pathway to a single threat level, based on invasives transmitted. The threat levels are defined as:

**Threat Level A** - - the pathway currently transmits an invasive species that poses a direct threat to human health (which infers economic and ecological as well)

**Threat Level B** - - the pathway currently transmits an invasive species that poses a direct threat to economic systems (which infers ecological as well)

**Threat Level C** - - the pathway currently transmits an invasive species that poses a direct threat solely to ecological climes

**Note: Why only one level?** By definition, for our purposes, an invasive species must be harmful and as such will 'fall' within one of the above three categories. Though new exotics may be continually entering the country via these selfsame pathways - - if they do not pose a harmful threat, they do not meet our definition of invasiveness. In addition, these threat levels are hierarchical in basis. The intent is for a determination of threat level 'A' to be inclusive of 'B' and 'C' levels of harm. Threat level 'B' means level 'C' of harm is included. Threat level 'C' is a 'stand-alone'. So, though an invasive may pose a threat on one or more levels, it is the 'top inclusive' or most pernicious category that is assigned.

Triage, again, is to provide the first prioritization factor or 'cut' of which pathway(s) an agency or organization should assess.

As a frame of reference, ballast water carrying cholera that dumps directly into drinking water would be a threat level of A. Whereas that same water, if dumped into a stream that is not used for any human or business purposes (i.e., where cholera contamination would not impact health or economics), then the threat level could be C - - or could even possibly result in the determination that in the particular circumstance (or receiving point), it would not even be considered invasive; using the key definitive element of harm.

**A sample of the triage process follows on the next page.**

**Triage Process Chart**
(Note: this is only for example)

| 1. Agency IS Mission, Strategic Priority | 2. All Pathways | 3. All Mission-Related Pathways for Risk Analysis | 3. Mission Related Pathway(s) Description | 4. Invasives Transmitted via Pathway | 5. Threat Level |
|---|---|---|---|---|---|
| U.S. Coast Guard protects the public, environment & U.S. economic interests in ports, waterways, along the coast, on international waters, or in any maritime region. Invasive Species strategic priorities includes ballast water, hull/surface, superstructure dredge | T 1 Transportation<br>T1.1 Air<br>T1.2 Water/Aquatic<br>T1.2.1 Ballast Water<br>T1.2.2 Hull/Surface<br>T1/2.3 Stowaways<br>T1.2.4 Superstructures<br>T1.2.5 Transportation/ Relocation of Dredge<br><br>**(L) Living Industry**<br>L1 Plant Pathways<br>L1.1 Importation Plants<br>L1.2 Potting Soils<br><br>(M) Miscellaneous<br>M1 Biocontrol<br>M2 Other Aquatic<br>M2.1 Interconnected Waterways<br>M2.1.1 Freshwater Canals<br>M2.1.2 Estuarine Canals<br>M2.1.3 Domestic Waste Streams<br>M2.2 Interbasin Transfr | T1.2.1 Ballast Water | T1.2.1 Ship Ballast Water-Cargo ship that begins voyage in Kusadasi, with endpoint NYC. | Amphidinium Cholera | **A Human Health**<br><br>**First Priority** |
| | | T1.2.2 Hull/Surface | T1.2.2 Hull/Surface Fouling. Cruise ship start point Miami, to Jamaica and Return | Zebra Mussels | **B Econo-my**<br><br>**Second Priority** |
| | | T1.2.5 Dredge Relocation | T1.2.5 Dredge Relocation Barge traveling from Hawaii to Oregon | Water hyacinth | **C Ecology**<br><br>**Third Priority** |

The result of this triage is a prioritized list for pathways risk assessment. In this case, Ship Ballast Water is first, followed by Hull Fouling, then Dredge relocation.

**5. Single Pathway Risk Assessment.** The next stage of assessment is science-based risk analysis. There are four steps to Pathway Risk Assessment: (1) detailed pathway definition, (2) pathway scope definition; (3) pathway risk level assessment; and (4) pathway risk score assignment.

The assessment is to first be completed by the pathway expert(s), independently, based on his/her agency, organization or scientific perspective. Even if a focus group is to be used for developing a second, consensus perspective, the individual expert evaluations are essential to develop a 'cumulative knowledge' framework for regional, national and international decision-making. ***All expert assessors must complete an individual assessment which remains part of the permanent record. The validity of the instrument is directly dependent upon the expertise of those completing the assessment***. When focus groups are used, an over-arching consensus assessment will also be prepared- - and completed by the facilitator and recorder of the focus group based on consensus discussions.

Assessment steps follow:

**Step 1: In-depth Pathway Definition**. At this stage, it is critical to fully DEFINE, but not yet analyze, the characteristics of the pathway. Pathway definition should include the following:

a) Define the start point of the pathway, including all physical, geographical, ecological, etc., characteristics relevant to pathway invasiveness (i.e., ship starting at shipyard loading dock in Charleston, North Carolina where wood packing material originating from the U.S. is being used to transport motor parts).
b) Define any intermediary stop points (i.e., ship docks in New York City but crates remain on hold. Ship then travels to Miami, Florida)
c) Define endpoint of the pathway (i.e., crates are off-loaded at Miami port. Wood packing material is destroyed via wood chipper; motor parts are fumigated then delivered via truck to stores).

Pathway definitions should be brief narratives or lists that give succinct facts (not opinion) regarding pathway characteristics. Defined characteristics for this pathway are:

**Pathway Title** _____

| | Ecosystem | Co-Mingling Factors | Nature of Conveyance | Handling/Treatment Protocols | Official Control Procedures | Other (Define) |
|---|---|---|---|---|---|---|
| Start Point | | | | | | |
| Mid Point(s) | | | | | | |
| End Point | | | | | | |

**Step 2: Detailed Description of Transmitted Invasives.** Specifically define the taxonomy and biological invasive characteristics that should be considered for this specific pathway. Examples include:

> **Description: *Caulerpa taxifolia:*** Green algae with feather-like branches, leaf is 5-65 cm in length, tropical in origin, found in Caribbean Sea and Indian Ocean, hybrid form found in Mediterranean Sea is much larger (plants up to 10 ft.), and can survive out of water for up to 10 days. It can survive in a wide variety of habitats, including sandy bottoms, rocky outcroppings, mud, and natural meadows.
>
> **Description: *Agrilus planipennis. (Emerald Ash Borer)*** The beetle appears to have a one year life cycle in North America. Mating occurs during the first 7-10 days after emergence. Each female lays an average of 77 eggs in bark crevices from late May through July, and these hatch in 7 to 9 days. Larvae tunnel in the cambial layer, feeding on the phloem and outer sapwood, and move into the sapwood as they increase in size. Larva feed aggressively until cooler fall temperatures arrive, and then over winter in the tree. Pupation occurs in late April to June.

(Note: Invasive Species listings may be found at www.invasivespeciesinfo.gov. The Pathways Work Team is creating a multiple database matrix for comprehensive analysis across multiple pathways and invasives)

**Step 3: Pathway Scope Determination.** The next step is to define the scope of the pathway using one of the categories, below. The underlying assumption to this step is: the broader the pathway (i.e., in terms of distance and ecoregions potentially contaminated), the greater the threat the pathway may pose. These devised categories are not absolutes but represent a general framework for assignment of scope complexities. Expertise, knowledge and discretion should be used in assigning scope level as there may be nuances regarding a particular invasive species or pathway that will warrant varying the scope category as defined. Ecoregion definitions, ultimately, are the responsibility of the assessing team - - though a general map to assist in these definitions is provided. Specific pathways and associated invasive species may even call for redefinition of ecoregions. Any redefinition should be documented as part of the assessment process to provide basis for transparency in decision making.

Assign the pathway scope using one of the following categories:

> **Level 0- - Single Event.** This is a single invasive species outbreak in a state, territory or tribal land within a single ecosystem with no movement of the invasive via a pathway. It may also represent more than one type of invasive species outbreak, but again, with no movement outside of a single ecosystem that is contained within a single state, territory or tribal land boundary.
>
> **Level I** - - **Multiple Event**. This is a multiple event where one or more outbreaks of a single invasive species crosses two ecosystems within a single state, territory or tribal boundary or where the single invasive species crosses one or more ecoregions that crosses boundaries between two different states, territories or tribal land boundaries. It may also represent more than one type of invasive species outbreak, but again, with movement only between two distinct ecosystems within a single boundary land area; or movement between two different state, territory or tribal land boundaries.

**Level II**- - **Regional Event**. This is a regional event where two or more outbreaks of a single invasive species invades three or more ecosystems within a single state, territory or tribal land boundary or where the single invasive species invades three or more ecoregions that cross boundaries between three or more different state, territory or tribal lands. It may also represent more than one type of invasive species outbreak, but again, with movement only between three distinct ecosystems within three boundary land areas; or movement between three different state, territory or tribal land boundaries.

**Level III** - - **Multiregional** - - This level represents multi-regional, multiple events where three or more outbreaks of a single invasive species invades four or more ecosystems within multiple state, territory or tribal land boundaries or where the single invasive species invades four or more ecoregions that cross boundaries between four or more different state, territory or tribal lands. It may also represent more than one type of invasive species outbreak, but again, with movement only between four distinct ecosystems within four boundary land areas; or movement between four different state, territory or tribal land boundaries.

**Level IV** - - **National** - - This is a national level event where invasion impacts national resources and priorities. It is characterized by four or more outbreaks of a single invasive species that invades five or more ecosystems within multiple state, territory or tribal land boundaries or where the single invasive species invades five or more ecoregions that cross boundaries between five or more different state, territory or tribal lands. It may also represent more than one type of invasive species outbreak, but again, with movement between five distinct ecosystems within five boundary land areas; or movement between five different state, territory or tribal land boundaries.

**Level V** - - **International** - - An international level event is characterized by pathway movement of a single or multiple invasive species between the continental United States (CONUS) boundaries (for these purposes, Hawaii would be considered international; tribal lands considered CONUS ), its territories and foreign countries. This pathway may range from single start and endpoint, to multiple 'intermediary stop points' of an invasive species pathway from initial to final destination.

**Assigned Pathway Scope Level: _____. Please indicate rational for scope decision and attach map/schematic of eco-regions assigned to pathway**:

_____

_____

_____

_____

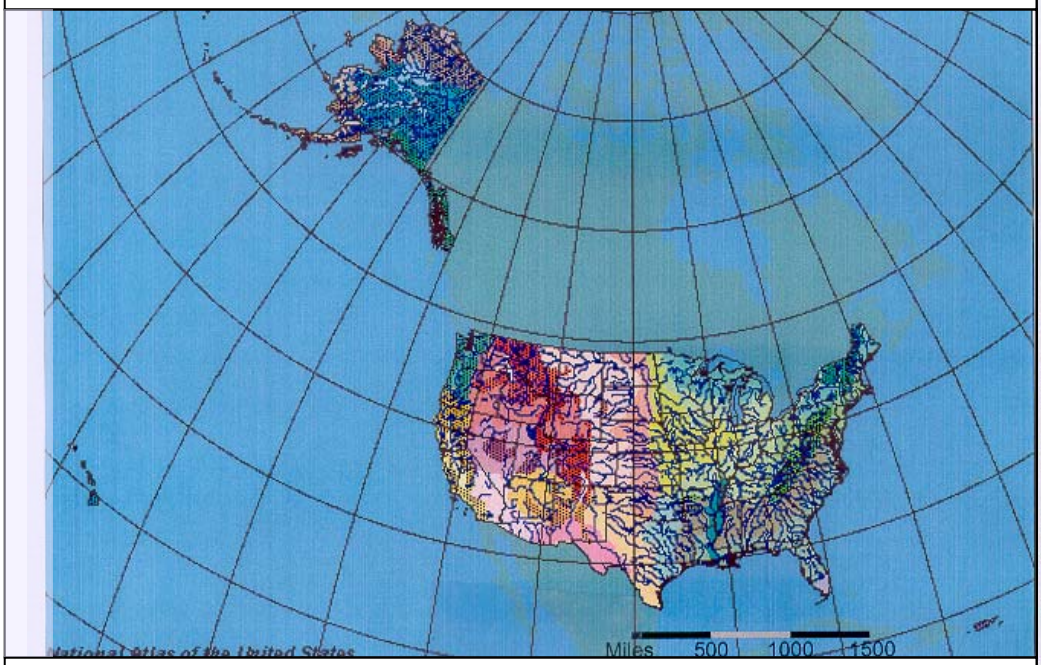
For the purposes of example and reference, the Pathways Work Team has provided the following graphic depiction of pathway related ecoregions- - produced by the U.S. Geological Survey via the website: www.nationalatlas.gov. This is solely a point of reference. Devised categories are not absolutes but represent a general framework. Ecoregion definitions are the responsibility of the assessment team. Any redefinition should be documented as part of the assessment process.

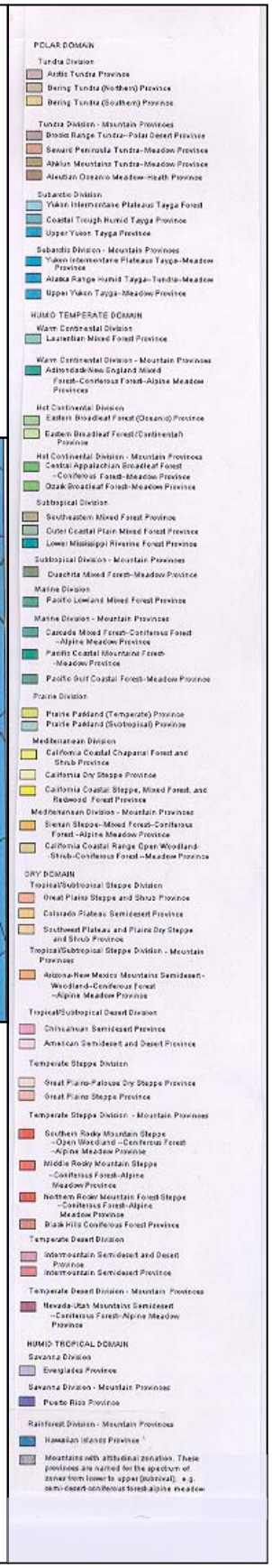
# Invasive Species Pathway Scope Ecoregion Map

**Level 0- - Single Event.** This is a single invasive species outbreak in a state, territory or tribal land within a single ecosystem with no movement of the invasive via a pathway. It may also represent more than one type of invasive species outbreak, but again, with no movement outside of a single ecosystem that is contained within a single state, territory or tribal land boundary.

**Level I** - - **Multiple Event**. This is a multiple event where one or more outbreaks of a single invasive species crosses two ecosystems within a single state, territory or tribal boundary or where the single invasive species crosses one or more ecoregions that crosses boundaries between two different state, territory or tribal lands. It may also represent more than one type of invasive species outbreak, but again, with movement only between two distinct ecosystems within a single boundary land area; or movement between two different state, territory or tribal land boundaries.

**Level II**- - **Regional Event**. This is a regional event where two or more outbreaks of a single invasive species invades three or more ecosystems within a single state, territory or tribal land boundary or where the single invasive species invades three or more ecoregions that cross boundaries between three or more different state, territory or tribal lands. It may also represent more than one type of invasive species outbreak, but again, with movement only between three distinct ecosystems within three boundary land areas; or movement between three different state, territory or tribal land boundaries.




**Level III** - - **Multiregional** - - This is a multi-regional, multiple events where three or more outbreaks of a single invasive species invades four or more ecosystems within multiple state, territory or tribal land boundaries or where the single invasive species invades four or more ecoregions that cross boundaries between four or more different state, territory or tribal lands. It may also represent more than one type of invasive species outbreak, but again, with movement only between four distinct ecosystems within four boundary land areas; or movement between four different state, territory or tribal land boundaries.

**Level IV** - - **National** - - This is a national level event where invasion impacts national resources and priorities. It is characterized by four or more outbreaks of a single invasive species that invades five or more ecosystems within multiple state, territory or tribal land boundaries or where the single invasive species invades five or more ecoregions that cross boundaries between five or more different state, territory or tribal lands. It may also represent more than one type of invasive species outbreak, but again, with movement between five distinct ecosystems within five boundary land areas; or movement between five different state, territory or tribal land boundaries.

**Level V** - - **International** - - An international level event is characterized by pathway movement of a single or multiple invasive species between the continental United States (CONUS) boundaries (for these purposes, Hawaii would be considered international; tribal lands considered CONUS ), its territories and foreign countries. This pathway may range from single start and endpoint, to multiple 'intermediary stop points' of an invasive species pathway from initial to final destination.

**Step 4: Pathway Risk Level Analysis (Question-Based)**
Step 4 is the portion of pathway assessment where risk experts perform science-based risk analysis of invasive species via common criterion. This assessment represents the 'third cut' in prioritizing pathways. Expert opinions are to be supported by quantitative datasets, expert literature and scientific expertise. Pathway complexities and characteristics are in constant change and flux - -motivated by shifting trade and market patterns. As such, though future pathway risk assessments will strive for greater quantifiable or formulaic assessments, expert opinion will remain a key source of pathway risk determinations. Risk decisions are guided by response to the following set of pre-determined analysis questions. Prior to proceeding, the following is an important issue regarding assessment:

**Uncertainty Factor**. During this process, evaluators must accept the existence of varying degrees of uncertainty. It is expected for all reviewers, even in light of the uncertainty, to come to a single/consensus whole number score for each question. If uncertainty exists, the basis for that uncertainty must be defined. Pathway analysts must give character to the uncertainty, using such rationale as exampled below:

Uncertainty exists due to:

- flaws in methodology (i.e., measurement errors or lack of knowledge of the steps or elements of risk evaluation)
- lack of expertise, coherence or error on part of risk assessor, biological unknowns of the invasive organisms/pathways
- insufficient information (i.e., lack of accurate or precise knowledge of the input values), or
- political impediments

Each question (again, a single/consensus response in whole numbers) must be answered. The questions are geared to address such issues as probability of introduction, probability of establishment, history of invasiveness, available mitigation methods and invasive impacts. Issues regarding action planning, policy and political implications for the invasives are not part of this scientific risk assessment phase but rather will be covered in the last portion, Invasive Species response, action planning and communication.

**The segment of this chapter that serves as guided questions for pathways risk analysis begins on the next page for ease of use.**

**Question 1: What is the pathway's history for frequency of introducing invasive species?**
(*Frame of Reference: Extremely high frequency ranking is defined, in relative terms, as introducing numerous invasives (i.e., 10 or more) that have had either human health pandemic implications resulting in deaths, have caused serious economic impacts on (i.e., failure of) major industries or have introduced invasives that negatively impacted 5 or more ecological niches).*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** |
|---|---|---|
| Level 0 | No Risk | **Rationale** |
| Level 1 | Extremely Low Level of Risk | |
| Level 2 | Moderately Low Level of Risk | |
| Level 3 | Medium Level of Risk | |
| Level 4 | Moderately High Level of Risk | |
| Level 5 | Extremely High Level of Risk | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** |
|---|---|---|
| Flaws in methodology | | **Rationale** |
| Lack of expertise | | |
| Lack of issue coherence | | |
| Biological unknowns | | |
| Insufficient information | | |
| Political impediments | | |
| Other-Define | | |

**Question 2: What level (0-5) of viable invasive species does this pathway typically transport?**
*(Frame of Reference: Extremely High (i.e., ranking of 5) infers a pathway capable of transferring 100 or more viable invasives species in a single event).*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** |
|---|---|---|
| Level 0 | No Risk | **Rationale** |
| Level 1 | Extremely Low Level of Risk | |
| Level 2 | Moderately Low Level of Risk | |
| Level 3 | Medium Level of Risk | |
| Level 4 | Moderately High Level of Risk | |
| Level 5 | Extremely High Level of Risk | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

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|---|---|---|
| Flaws in methodology | | **Rationale** |
| Lack of expertise | | |
| Lack of issue coherence | | |
| Biological unknowns | | |
| Insufficient information | | |
| Political impediments | | |
| Other-Define | | |

**Question 3: What level (0-5) quantifies the number of viable specimens per invasive species transmitted via that pathway?** *(Frame of Reference: Extremely High infers the pathway transmits numerous [i.e. 100 plus) viable populations that can readily be established. Extremely low infers that only 1-2 specimens capable of establishment/reproduction are transmitted. No risk implies no survival.*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** |
|---|---|---|
| Level 0 | No Risk | **Rationale** |
| Level 1 | Extremely Low Level of Risk | |
| Level 2 | Moderately Low Level of Risk | |
| Level 3 | Medium Level of Risk | |
| Level 4 | Moderately High Level of Risk | |
| Level 5 | Extremely High Level of Risk | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** |
|---|---|---|
| Flaws in methodology | | **Rationale** |
| Lack of expertise | | |
| Lack of issue coherence | | |
| Biological unknowns | | |
| Insufficient information | | |
| Political impediments | | |
| Other-Define | | |

**Question 4: Based on the specific invasive species transmitted via this pathway, what is the relative level of risk (0-5) of establishment based upon the receiving endpoint (s) of the pathway (i.e., does the pathway introduce organisms into hospitable environments?** *Frame of Reference: Zero (0) risk is when environmental factors preclude IS establishment. Level 5 = exact ecosystem match with IS' natural habitat; plentiful food sources, no predators or ecosystem controls).*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** |
|---|---|---|
| Level 0 | No Risk | **Rationale** |
| Level 1 | Extremely Low Level of Risk | |
| Level 2 | Moderately Low Level of Risk | |
| Level 3 | Medium Level of Risk | |
| Level 4 | Moderately High Level of Risk | |
| Level 5 | Extremely High Level of Risk | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** |
|---|---|---|
| Flaws in methodology | | **Rationale** |
| Lack of expertise | | |
| Lack of issue coherence | | |
| Biological unknowns | | |
| Insufficient information | | |
| Political impediments | | |
| Other-Define | | |

**Question 5: What is level or amount of invasive species environments harbored by the pathway that would enhance viability of and opportunity for transmission of invasive species?** *(Frame of Reference: Is there pathway substrate, trade material, or cargo? Does this volume represent high, medium or low level of incoming material for the pathway assessed?)*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** |
|---|---|---|
| Level 0 | No Risk | **Rationale** |
| Level 1 | Extremely Low Level of Risk | |
| Level 2 | Moderately Low Level of Risk | |
| Level 3 | Medium Level of Risk | |
| Level 4 | Moderately High Level of Risk | |
| Level 5 | Extremely High Level of Risk | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** |
|---|---|---|
| Flaws in methodology | | **Rationale** |
| Lack of expertise | | |
| Lack of issue coherence | | |
| Biological unknowns | | |
| Insufficient information | | |
| Political impediments | | |
| Other-Define | | |

**Question 6: What is the level of invasive opportunities (1-5) posed by this pathway due to the number of potential invasive species entry points (i.e., single or multiple destination/transfer points)?** *(Frame of Reference: Level 5 infers multiple entry points (4 or more) that expand across CONUS; Level 1 assessment infers single, localized entry point with minimal opportunity for invasion.)*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** |
|---|---|---|
| Level 0 | No Risk | **Rationale** |
| Level 1 | Extremely Low Level of Risk | |
| Level 2 | Moderately Low Level of Risk | |
| Level 3 | Medium Level of Risk | |
| Level 4 | Moderately High Level of Risk | |
| Level 5 | Extremely High Level of Risk | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** |
|---|---|---|
| Flaws in methodology | | **Rationale** |
| Lack of expertise | | |
| Lack of issue coherence | | |
| Biological unknowns | | |
| Insufficient information | | |
| Political impediments | | |
| Other-Define | | |

**Question 7: How hospitable to invasive organisms is the pathway?** *(Frame of Reference: Zero (0) level indicates all IS are dead upon arrival; 3 = most (60% ) of the IS that entered the pathway are still reproductively viable; 5 = 100% IS are thriving in transit and have expanded populations, colonies or enhanced invasiveness capabilities).*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** |
|---|---|---|
| Level 0 | No Risk | **Rationale** |
| Level 1 | Extremely Low Level of Risk | |
| Level 2 | Moderately Low Level of Risk | |
| Level 3 | Medium Level of Risk | |
| Level 4 | Moderately High Level of Risk | |
| Level 5 | Extremely High Level of Risk | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** |
|---|---|---|
| Flaws in methodology | | **Rationale** |
| Lack of expertise | | |
| Lack of issue coherence | | |
| Biological unknowns | | |
| Insufficient information | | |
| Political impediments | | |
| Other-Define | | |

**Question 8: What is the level of opportunity (0-5) for the pathway to facilitate spread to uncontaminated shipments during transport or during storage before/after transport (i.e., are shipments commingled and is cross-contamination a possibility)?** *(Frame of Reference: Level 5 equals 100% likelihood of co-mingled/cross-contamination to uncontaminated, hospitable shipments during transport or via pre/post transport/storage. Level 5 = absolute dispersion of IS to all shipments)*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** |
|---|---|---|
| Level 0 | No Risk | **Rationale** |
| Level 1 | Extremely Low Level of Risk | |
| Level 2 | Moderately Low Level of Risk | |
| Level 3 | Medium Level of Risk | |
| Level 4 | Moderately High Level of Risk | |
| Level 5 | Extremely High Level of Risk | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** |
|---|---|---|
| Flaws in methodology | | **Rationale** |
| Lack of expertise | | |
| Lack of issue coherence | | |
| Biological unknowns | | |
| Insufficient information | | |
| Political impediments | | |
| Other-Define | | |

**Question 9: What is the level of prescreening effectiveness (e.g. detection) of invasive species prior to or during transport via this pathway?** *(Frame of Reference: A rating of zero (0) indicates that virtually all invasives are detected and mitigated prior to or during transit. A rating of 5 indicates that there are no detection or mitigation methods for the invasives prior to or during transit)*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** |
|---|---|---|
| Level 0 | No Risk | **Rationale** |
| Level 1 | Extremely Low Level of Risk | |
| Level 2 | Moderately Low Level of Risk | |
| Level 3 | Medium Level of Risk | |
| Level 4 | Moderately High Level of Risk | |
| Level 5 | Extremely High Level of Risk | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** |
|---|---|---|
| Flaws in methodology | | **Rationale** |
| Lack of expertise | | |
| Lack of issue coherence | | |
| Biological unknowns | | |
| Insufficient information | | |
| Political impediments | | |
| Other-Define | | |

**Question 10: What is the level of difficulty (0-5) in detecting the invasive species once introduced?** *(Frame of reference: A rating of zero (0) indicates that all invasives are detected immediately at the pathway endpoint. A rating of 5 indicates that the invasive species is/are so difficult to detect, there is a 100% likelihood they will be disseminated throughout the nation and become permanently established without detection)*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** |
|---|---|---|
| Level 0 | No Risk | **Rationale** |
| Level 1 | Extremely Low Level of Risk | |
| Level 2 | Moderately Low Level of Risk | |
| Level 3 | Medium Level of Risk | |
| Level 4 | Moderately High Level of Risk | |
| Level 5 | Extremely High Level of Risk | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** |
|---|---|---|
| Flaws in methodology | | **Rationale** |
| Lack of expertise | | |
| Lack of issue coherence | | |
| Biological unknowns | | |
| Insufficient information | | |
| Political impediments | | |
| Other-Define | | |

**Question 11: What is the assessment level (0-5) of the pathway's characteristics that would enable it to transport 'generalist' invasives that are capable of surviving in multiple habitats?** *(Frame of Reference: An assessment of zero (0) indicates the pathway does not transmit any generalists. An assessment of 5 indicates the majority of invasives transmitted by this pathway are generalists with at least 3 or more populations capable of surviving in any of the pathway endpoints.)*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** | |
|---|---|---|---|
| Level 0 | No Risk | **Rationale** | |
| Level 1 | Extremely Low Level of Risk | | |
| Level 2 | Moderately Low Level of Risk | | |
| Level 3 | Medium Level of Risk | | |
| Level 4 | Moderately High Level of Risk | | |
| Level 5 | Extremely High Level of Risk | | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** | |
|---|---|---|---|
| Flaws in methodology | | **Rationale** | |
| Lack of expertise | | | |
| Lack of issue coherence | | | |
| Biological unknowns | | | |
| Insufficient information | | | |
| Political impediments | | | |
| Other-Define | | | |

**Question 12: What is the level of risk for natural spread (rating of 0-5) posed by the invasive species transmitted via this pathway?** *(Frame of Reference: A rating of zero (0) indicates the pathway transmits invasives with low reproductive rates or one that are fragile in any ecosystem other than that of origination. A ranking of 5 indicates the pathway transmits multiple (i.e. 10 or more)IS that are highly mobile; spread by wind, water; have fast/high reproductive rates in multiple ecosystems)*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** | |
|---|---|---|---|
| Level 0 | No Risk | **Rationale** | |
| Level 1 | Extremely Low Level of Risk | | |
| Level 2 | Moderately Low Level of Risk | | |
| Level 3 | Medium Level of Risk | | |
| Level 4 | Moderately High Level of Risk | | |
| Level 5 | Extremely High Level of Risk | | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** | |
|---|---|---|---|
| Flaws in methodology | | **Rationale** | |
| Lack of expertise | | | |
| Lack of issue coherence | | | |
| Biological unknowns | | | |
| Insufficient information | | | |
| Political impediments | | | |
| Other-Define | | | |

**Question 13: What is the level or risk of human/human activity (0-5) in spreading the invasives transmitted via this pathway?** (Frame of Reference: A rating of zero (0) indicates that humans or human activities do not spread the invasive species. A rating of 5 indicates humans or human activities are the primary agent for the rapid spread of pandemic IS such as with influenza).

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** | |
|---|---|---|---|
| Level 0 | No Risk | **Rationale** | |
| Level 1 | Extremely Low Level of Risk | | |
| Level 2 | Moderately Low Level of Risk | | |
| Level 3 | Medium Level of Risk | | |
| Level 4 | Moderately High Level of Risk | | |
| Level 5 | Extremely High Level of Risk | | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** | |
|---|---|---|---|
| Flaws in methodology | | **Rationale** | |
| Lack of expertise | | | |
| Lack of coherence on issue | | | |
| Biological unknowns | | | |
| Insufficient information | | | |
| Political impediments | | | |
| Other-Define | | | |

**Question 14: What is the level of risk (0-5) of the pathway introducing an invasive that is known to be invasive but not yet in the U.S.?** (Frame of Reference: Zero (0) =the pathway transmits no new IS, or IS that are already distributed throughout the endpoint ecoregion;3 rating = the pathway transmits invasives that are in some, not all, U.S ecoregions, but are not yet present in the pathway endpoint ecosystem. Level 5 = the pathway transmits viable IS into pristine eco-systems.

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** | |
|---|---|---|---|
| Level 0 | No Risk | **Rationale** | |
| Level 1 | Extremely Low Level of Risk | | |
| Level 2 | Moderately Low Level of Risk | | |
| Level 3 | Medium Level of Risk | | |
| Level 4 | Moderately High Level of Risk | | |
| Level 5 | Extremely High Level of Risk | | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** | |
|---|---|---|---|
| Flaws in methodology | | **Rationale** | |
| Lack of expertise | | | |
| Lack of issue coherence | | | |
| Biological unknowns | | | |
| Insufficient information | | | |
| Political impediments | | | |
| Other-Define | | | |

**Question 15: What is the level (0-5) of available control options for the invasives transmitted via this pathway?** *(Frame of Reference: A rating of zero (0) indicates there are comprehensive control options that mitigate all invasives transmitted via the pathway. A rating of 5 indicates there are no control options for the invasives transmitted via the pathway.)*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** | |
|---|---|---|---|
| Level 0 | No Risk | **Rationale** | |
| Level 1 | Extremely Low Level of Risk | | |
| Level 2 | Moderately Low Level of Risk | | |
| Level 3 | Medium Level of Risk | | |
| Level 4 | Moderately High Level of Risk | | |
| Level 5 | Extremely High Level of Risk | | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** | |
|---|---|---|---|
| Flaws in methodology | | **Rationale** | |
| Lack of expertise | | | |
| Lack of issue coherence | | | |
| Biological unknowns | | | |
| Insufficient information | | | |
| Political impediments | | | |
| Other-Define | | | |

**Question 16: What is the assessment of economic cost (0-5) of control options for invasive species transmitted via this pathway?** *(Frame of Reference: A rating of zero (0) indicates control options are a part of routine operations and therefore no additional funding is required. A rating of 5 indicates control options are so expensive, it requires the petitioning of external agency/multi-source emergency funding mechanisms to control/eradicate.)*

| **Level Nbr** | **Level Descriptor** | **Level Determination (i.e., 0,1,2,3,4, or 5) (Assign a whole number):** | |
|---|---|---|---|
| Level 0 | No Risk | **Rationale** | |
| Level 1 | Extremely Low Level of Risk | | |
| Level 2 | Moderately Low Level of Risk | | |
| Level 3 | Medium Level of Risk | | |
| Level 4 | Moderately High Level of Risk | | |
| Level 5 | Extremely High Level of Risk | | |

Is there uncertainty regarding this rating? If so, please complete the chart below:

| **Basis of Uncertainty** | **Check All Relevant** | **Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)** | |
|---|---|---|---|
| Flaws in methodology | | **Rationale** | |
| Lack of expertise | | | |
| Lack of issue coherence | | | |
| Biological unknowns | | | |
| Insufficient information | | | |
| Political impediments | | | |
| Other-Define | | | |

## 5. Calculating Risk Individual/Consensus Score

After each single question is provided a score, this portion of pathway assessment requires the awarding of a final, overall assessment number (i.e., 0-5). No partial numbers are to be awarded. The process for awarding the single risk score follows:

| | | |
|---|---|---|
| A. | Tally overall pathway risk rating (Single/Consensus rating 0-5 expressed in whole number. Is the average of all per question ratings) | |
| B. | Tally overall uncertainty ratings (Single/Consensus rating 0-5) expressed in whole number. Is the average of all per question uncertainty ratings) | |
| C. | Tally Final Pathway Risk Rating. Usually this score should be the same as rating in #A - -but not necessarily. Based on uncertainty ratings, it is expected that overall assessment number may change. This score is subjective in that it represents a compromise or adjusted rating reflective of the best determination after consideration of uncertainty. Again, it is a whole number) | |

**Rationale for Final Risk Ratings should be codified in brief narrative format: (i.e., score was adjusted to a lower level due to new treatments capabilities that will ensure total eradication; the score was adjusted to a higher level due to the evolution or detection of new species variant that is immune to current mitigation methods or detection procedures).**

**Rationale is below for final risk rating:** _____

_____

_____

_____

_____

_____

**6. Invasiveness Scale (1-75)**

Based on the above analyses, there are now 3 major factors upon which to assign a pathway ranking: impact category, pathway scope and pathway risk. Using the charts below as an example, you may next assign a risk prioritization (on scale of 1-100) for the pathway.

***Factor Assignments***

Example 1: Ballast Water

| **Impact Category** | **Pathway Scope** | **Pathway Risk Level** |
|---|---|---|
| A Human | V | 4 |

Example 2: Wood Packing Material

| **Impact Category** | **Pathway Scope** | **Pathway Risk Level** |
|---|---|---|
| B Economy | V | 3 |

Using the Scale of Invasiveness chart contained on the next page, after assigning an invasiveness scale number, the above pathways would be assessed as below. (This scale assists in further stratifying and prioritizing invasive pathways and will serve greater purpose for cumulative assessments on invasiveness.)

**********

***Factor Assignments Converted to Invasive Score***

Ex 1: Ballast Water

| **Impact Category** | **Pathway Scope** | **Pathway Risk Level** |
|---|---|---|
| A – Human | V | 4 |

Equates to Risk Ranking of **99**

Ex 2: Wood Packing

| **Impact Category** | **Pathway Scope** | **Pathway Risk Level** |
|---|---|---|
| B – Economy | V | 3 |

Equates to Risk Ranking of **73**

See Next Page for Chart

Scale of Invasivness

**Procedure for Scale Assignment**

1. Assign Risk Impact Category (Row A, B, or C)
2. Assign Pathway Scope Level (Column Numeral V, IV, II, II or I)
3. Assign Pathway Risk Level (i.e., Risk Score of 5, 4, 3, 2 or 1)
4. Assign Corresponding Numerical Rank Order (i.e., integer between the numbers 26-75)

(This guide is not designed to assess any pathway receiving a score below 26.)

| | | | | | |
|---|---|---|---|---|---|
| **A Level: Human Health Impact** | 100. V – 5<br>99. V – 4<br>98. V – 3<br>97. V – 2<br>96. V - 1 | 95. IV – 5<br>94. IV – 4<br>93. IV – 3<br>92. IV – 2<br>91. IV – 1 | 90. III – 5<br>89. III – 4<br>88. III – 3<br>87. III – 2<br>86. III – 1 | 85. II – 5<br>84. II – 4<br>83. II – 3<br>82. II – 2<br>81. II - 1 | 80. I – 5<br>79. I – 4<br>78. I – 3<br>77. I – 2<br>76. I – 1 |
| **B Level: Economic Impact** | 75. V – 5<br>74. V – 4<br>73. V – 3<br>72. V – 2<br>71. V - 1 | 70. IV – 5<br>69. IV – 4<br>68. IV – 3<br>67. IV – 2<br>66. IV – 1 | 65. III – 5<br>64. III – 4<br>63. III – 3<br>62. III – 2<br>61. III – 1 | 60. II – 5<br>59. II – 4<br>58. II – 3<br>57. II – 2<br>56. II - 1 | 55. I – 5<br>54. I – 4<br>53. I – 3<br>52. I – 2<br>51. I – 1 |
| **C Level: Ecological Impact** | 50. V – 5<br>49. V – 4<br>48. V – 3<br>47. V – 2<br>46. V – 1 | 45. IV – 5<br>44. IV – 4<br>43. IV – 3<br>42. IV – 2<br>41. IV – 1 | 40. III – 5<br>39. III – 4<br>38. III – 3<br>37. III – 2<br>36. III – 1 | 35. II – 5<br>34. II – 4<br>33. II – 3<br>32. II – 2<br>31. II - 1 | 30. I – 5<br>29. I – 4<br>28. I – 3<br>27. I – 2<br>26. I – 1 |
| **Outlier Range for Invasives with no harmful impact to human health, economy or ecology** | 25. X<br>24. X<br>23. X<br>22. X<br>21. X | 20. X<br>19. X<br>18. X<br>17. X<br>16. X | 15. X<br>14. X<br>13. X<br>12. X<br>11. X | 10. X<br>9. X<br>8. X<br>7. X<br>6. X | 5. X<br>4. X<br>3. X<br>2. X<br>1. X |

**NOTE**

Scope values of X indicate either an event so small not to warrant a 'local' (i.e., category I) determination; or they represent the incursion of an invasive that does not harm human health, the economy or any ecosystems.

However, events in these areas are valid. They may provide indicators for IS observations or may be used to provide corollary, comparative data for invasive assessment.

## 7. Situational Modifiers of Pathway Risk Ranking (Merging Science and Public Policy)

As previously indicated, there are certain factors which should be considered and then used to adjust the above rankings. The intent of the system is to provide a method of stratifying risk based upon national priorities (i.e., human, then economical and finally ecological impact), pathway scope and pathway risk factors. These are all qualitative measures for socio-political-economic systems. As such, the method must be sufficiently flexible to modify these rankings based upon other relevant factors. These relevant factors include the following:

1. Does the pathway transport invasives that are known to cause impact to human infrastructures (i.e., plant that lowers property values)?
2. Does the pathway transport invasives known to cause impacts to biologic/primary productivity/living industries (i.e., ecotourism, birding, aquatic recreation)?
3. Does the Pathway transport invasives that are known to have political or public sensitivity beyond that scientifically associated with the pathway (i.e., sensationalism of 'killer bees', endangered species)?

For instance, in the second example, the ranking was as below:

Example 2: Wood Packing Material = Risk Ranking of 73

| **Impact Category** | **Pathway Scope** | **Pathway Risk Level** |
|---|---|---|
| B – Economy | V | 3 |

However, if it is found that a new human health invasive is being transmitted through similar foreign pathways that intersect with this particular U.S. pathway, it might be advisable to reevaluate the impact category to the "A" level. The final risk ranking would then be reevaluated as 98 - -at the top of the list.

**End Results.** The end results of the definition and prioritization of the pathway(s) is not solely a number, but all of the research, expert insights, recommendations and comments that led up to final evaluation. As such, the main value of the assessment is not just a number, but the collective comments and perspectives of multiple experts from a myriad of organization and academic disciplines and perspectives. All of this information will be provided in consolidated format to assist policy makers with approaches and responses to issues regarding Invasvie Species. The next Chapter deals more directly with policy implementation relative to unintentional human introduction of invasive species

This ends Chapter 3- Invasive Species Pathways Guide

**Comments regarding this guide**
**may be forwarded to National Invasive Species Council**
**Prevention Committee Pathways Working Team**
**via e-mail to: penny.e.kriesch@aphis.usda.gov**

## CHAPTER 4 - POLICY AND PROGRAM IMPLEMENTATION

### From Science to Pathway Policy

In the process of developing the pathway diagrams, assessment tool, and assessment methodology, the Pathways Work Team struggled with several issues relevant to scientific data and public policy. Key concepts include the following:

- Invasive Species prevention is inherently an international activity that impacts market competitiveness. As such, policy decisions are to be based on what the future should look like for particular groups; with consideration of current situations and trends. Policy makers must devise plans for pathway management, resource leveraging, policy development, budget decisions and technology transfer/development.

- Pathway ranking combines community, government and corporate interests. The process for evaluating pathway risks is as important as assessment tools and criteria. The outcome of process is the predictive characterization and control of pathway risks. Policy decides the direction to take, but science maintains the focus. [7]

The team was, again, challenged with developing rationale and approaches for collaborative risk evaluation and process implementation in various agencies. These follow.

### Collaborative Risk Evaluation

Collaborative risk evaluation creates common 'ground' for characterizing local, regional, national then international perspectives on pathway risk. Specifically the following goals are accomplished via this method:

**(1) Common Value of Human Health First, Economy then Ecology**. Regardless of various agency/industry mission or priorities, this method of pathway prioritization creates a common value: human health is the most salient concern, followed by economy, then ecology.

**(2) Mission Based Priorities**. Managing and prioritizing pathways has to be inextricably linked to organization mission and goals. This pathway prioritization method is a tool to assist agencies in defining and addressing invasive species issues - - and is not a 'stand alone' arbitrary exercise.

**(3) Ecoregion Integration.** Using an ecoregion approach enables ecological issues to be imbued in the process, while giving latitude in definition of pathways based upon actual impact as opposed to regional governmental boundaries.

### Policy Implementation Plan

***The Plan***. An implementation plan, succinctly stated, are those events and activities that occur which include both the effort to administer the impacts on people, processes, programs and events. his encompasses not only the behavior of the administrative body that has

[7] Source: Arizona State University Consortium for Science, Policy and Outcomes, College of Liberal Arts and Sciences

responsibility for the program and compliance of groups, but also the web of direct and indirect political, economic and social forces that bear on the behavior of all those involved and ultimately impacts the program. [8]

**Implement Plan Perspectives and Components.** There are three perspectives which must be accommodated for in this implementation process: the central policy maker (i.e., ISAC), the peripheral field implementation officials (NISC infrastructure) and policy target groups (agencies, industry and stakeholders). It is the collective function of these three components to: (1) collaboratively develop policies and decisions; (2) ensure compliance with those decisions; (3) assess actual impacts of policies on target groups (intended/unintended; actual/perceived); and, (4) revise IS program based on objective attainment.

**Evaluating Implementation Plan**. The first question the Pathways Team must respond to, for program implementation, is "Are/Did we accomplish our goals? Factors covering the efficiency of implementation includes the following:

- extent of changes required and compliance levels;
- clarification of governmental authorities relative to objectives and resources,
- hierarchical integration and arrangements within and among implementing institutions
- decision methods of participating agencies,
- agency commitment to IS objectives,
- vested stakeholder access and support
- technology impacts,
- impediments to implementation (i.e., competing interests, policies, organization checks and balances, socio-political opposition, multiple decision clearance points)
- leadership of implementing officials
- actual vs perceived; intended vs unintended impacts

**Plan Framework.** There are several frameworks that may be used for implementation. However, due to the evolving nature of the assessment process, the Pathways Team recommends the use of an adaptive, phased-in approach for program implementation called cumulative incrementalism. This strategy calls for negotiated implementation and mutual adjustments among multiple participants. It is an evolutionary process of experimentation, goal definition, redefinition and tiered implementation strategies to best suit the particular circumstances of implementing parties. This framework looks for gradual improvement in goal definition, constituency development and enhanced administrative procedures. Gradually, the program in brought into greater accord - -without sacrificing current day operations.

**Standards of Excellence.** The second question regarding implementation is "How well did we accomplish our goals?" Due to program variances and the across multiple organization lines and use of cumulative incrementalism approach, several, progressive levels of standards for effectiveness (i.e., excellence) will be developed throughout lifecycle of the project.

**Implementation Evaluators.** Evaluation will be an ongoing effort. In lieu of an independent team, evaluation will be made from those involved in the program from all aspects [the bottom up (target groups); top-down (NISC) and vested program participants (policy coordinators or

[8] This andall following information on implementation taken from Mazmanian, Daniel A. and Sabatier, Paul A. 1989. *Implementation and Public Policy*. University Press of America, Inc. Lanham, MD: Scott, Foresman and Co.

stakeholders). A desired outcome of this approach to evaluation, in addition to program feedback, is the development of advocacy groups or coalitions for program implementation.

**Implementation Plan**. The full implementation plan is in Appendix E of this guide

**NISC Facilitated Pathway Analysis, Collaboration and Program Implementation**

NISC, responsible for the field or operating level implementation of IS programs, has the three following primary goals relative to pathways:

1. **Assessment Collaboration.** Once each agency has gone through the first 'triage' of pathway prioritization, these results are to be shared with the National Invasive Species Council (NISC). NISC will then inform the various agencies as to which pathways they share similar priorities. This 'matching' will enable NISC to provide a framework for regional, national, and international strategic groupings of organizations and experts for matrixed, systemic pathway prioritization, analysis, and resource sharing. In that the matching is for collaborative purposes, only, it will not impede or infringe upon individual agency decisions or mission regarding IS activities. In this NISC role, will also define international implementation methods and collaboration points.

2. **Data Clearinghouse.** A long term goal is for NISC to serve as the central clearinghouse for an online library of benchmarked pathway risk analyses and datasets.

3. **Program Evaluator**. Finally, NISC will serve as evaluator of the efficacy IS pathway analysis and policy development, nationwide.

**ISAC Facilitated International Pathway Analysis and Policy Consultations**

The Invasive Species Advisory Council, through NISC, is currently working on a proposal for the North American Plant Protection Organization Invasive Species Panel to explore the potential for developing an international resource management approach for invasive species pathway identification, prioritization, risk-based analysis and collaborative policy decision-making. The ultimate goal is to provide a NAPPO regional standards or guidelines on pathway evaluation.

**[This Space Reserved for**
**Regional Resource Management Proposal to**
**North American Plant Protection Organization]**

**Future Pathway Assessment Activities**

There is still much to accomplish in the arena of pathway assessments- -particularly in the development of datasets, databases, quantitative data integration and predictive statistical algorithms. As such and for the near future, this document will be in a continual development phase as we enhance our sophistication in the predication, detection, mitigation and control of invasive species.

## APPENDIX A: Sponsorship

This conference was co-sponsored by the U.S. Department of Interior, National Invasive Species Council, Prevention Committee, Pathways Working Group and the U.S. Department of Agriculture, Animal Plant Health and Inspection Service, Plant Protection and Quarantine. An immeasurable amount of gratitude is expressed to the following cooperators, advisors, and experts that so diligently dedicated their resources for invasive species pathways activities:

Aquatic Nuisance Species Task Force
Chamber of Shipping of America
Chippewa Ottawa Resource Authority
Colorado State University
Ecological Society of America
Environment Protection Agency
Florida Department of Agriculture &Consumer Services
Florida Gulf Coast University
International Joint Commission
International Union of Concerned Scientists
Louisiana State University
Maine Lakes Conservancy Institute
Minnesota Crop Improvement Association
National Aeronautics Space Administration
National Aquaculture Association
National Association State Departments of Agriculture
National Fish and Wildlife Foundation
Native American Fish and Wildlife Society
North American Brown Tree Snake Control Team, Texas A&M University
North American Weed Management Association
North Carolina Department of Agriculture and Consumer Services
Northeast Midwest Institute
Ocean Conservancy
Office of Secretary of Defense- Armed Forces Pest Management Board
Oregon Department of Agriculture
Oregon State University
Pacific Wildlife Research, Inc.
Pet Industry Joint Advisory Council
Smithsonian Environmental Research Center
Taylor Shellfish Farms
The Nature Conservancy
University of Florida
University of Georgia
U.S. Coast Guard
U.S. Geological Survey
U.S. Department of Agriculture
U.S. Department of Commerce
U.S. Department of Health and Human Services
U.S. Department of Homeland Security
U.S. Department of Interior
U.S. Department of State
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**APPENDIX C: Conference Background Research Materials List:**

1. HAACK 2001 Intercepted Scolytidae (Coleoptera) at U.S. ports of entry: 1985–2000
2. APHIS Intercept 1 yr dunnage SWPM counts
3. APHIS intercept tiles SWPM counts
4. F.J. GAY 1969 Article - - Species Introduced by Man
5. APHIS PIN 309 Ad Hoc Report Results on Air Transport
6. Quarantine Risk Associated with Air Acrgo Contains by P.D> Gadgil, LS bulman and K.L. Glassey, July 2002
7. Insect Survival in jet Aircraft by W. N. Sullivan, 1958
8. MIA cargo aircraft risk analysis
9. MIA cargo aircraft establishment
10. MIA cargo aircraft inspections analysis
11. MIA optimizing cargo inspections
12. Canadian Technical Report of Fisheries and Aquatic Sciences 2268 dated 1999 by Michel Harvey, Michel Gilbert, Danile Gauthier and Donald M. Reid
13. Genetic Identification and Implications of Another Invasive Species of Dreissenid Mussel in the Great Lakes by Bernie May and J. Ellen Marsden 1992
14. Mid-ocean exchange of container vessel ballast water. 2: Effects of vessel type in the transport of diatoms and dinoflagelaltes from Manzanillo, Mexico, to Hong Kong, China by Dickman dated 1999
15. Ballast-mediated animal introductions in the Laurentian Great Lakes: retrospective and prospective analyses by Igor A. Grigorovich, Robert I. Colautti, Edward L. Mills, Kristen Holeck, Albert G. Ballert, and Hugh J. MacIsaac 2003
16. Identifying hazards in complex ecological systems. Part 1: fault-tree analysis for biological invasions Keith R. Hayes 2002
17. Global hot spots of biological invasions: evaluating options for ballast-water management, John M. Drake and David M. Lodge 2004

## APPENDIX D: Conference Agenda

Agenda
National Invasive Species Council
Pathway Assessment Conference
(Air Transport, Ballast Water, Wood Packing Material)
USDA APHIS Oklahoma Memorial Conference Center
Riverdale, Maryland, June 21-22, 2005

Day One – June 21, 2005

| | | |
|---|---|---|
| 8:30 | Coffee | |
| 9:00 | Welcome | Penny Kriesch, USDA APHIS-NISC Prevention Cmte |
| 9:10 | National Invasive Species Program | Richard Orr, Assistant Director for International Policy/Prevention, National Invasive Species Council, (NISC) U.S. Department of Interior |
| 9:30 | Pathways Analysis Project | Hilda Diaz-Soltero, Senior USDA Invasive Species Coordinator USDA Liaison, NISC |
| 10:00 | Instructions to Work Groups | Facilitation Team (Penny Kriesch) |
| 10:15 | Break | Adjourn to Work Groups |
| 10:30 | Individual Focus Groups | Conference-Rooms A/B/C |
| 12:00 | Training- Invasive Species | Jeffrey P. Fisher, PhD, International Trade and Trends U.S. Department of State, Bureau of Oceans and International Environmental & Scientific Affairs |
| Lunch | | |
| 1:30 | Focus Groups (In-Room break) | Conference-Rooms A/B/C |
| 3:30 | Reconvene in Large Group Issues, Challenges, Next Steps | Pathway Focus Group Leads Conference Center Main Room |
| 4:00 | Adjourn | |

Day Two – June 22, 2005

| | | |
|---|---|---|
| 8:30 | Coffee | |
| 9:00 | Invasive Species: Data Mining | Susan Cohen, PhD, USDA APHIS Policy/Program Dev |
| 9:15 | Work Group Break-Outs | Conference-Rooms A/B/C |
| 12:00 | Training Video | Al Tasker, USDA APHIS, Noxious Weed Coordinator |
| 1:30 | Focus Groups (In-Room Break) | Conference-Rooms A/B/C |
| 2:30 | Focus Group Report Outs | Pathway Focus Group Leads- Conference Center Main Room |
| 3:30 | The Next Challenges for Pathway Prioritization | Faith Campbell The Nature Conservancy |
| 3:45 | Thanks and Adjourn | Penny Kriesch |

**APPENDIX E -** Reserved for Program Implementation Plan

**APPENDIX F –** Reserved For Future Development of Predictive Algorithms and Integrated Database Design