Training and Implementation Guide for Pathway Definition, Risk Analysis and Risk Prioritization

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This guide was developed to address issues pertaining to invasive species. Processes are also relevant to other pest risk management activities.

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

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A Note To Users

This training guide is designed to be continually enhanced and updated based upon user perspectives and revisions. As such, as you use this guide, please make note of any issues, unclear expectations or revisions you believe necessary to enable users to better develop pathway definitions, prioritization and analyses. Suggested changes may be forwarded to the following:

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Invasive Species
Pathways Guide
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PATHWAY ASSESSMENT MANAGEMENT

1. THE PROGRAM

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 (IS)** - 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:

- Intentional pathways - these result from deliberate actions to translocate an organism.
- Unintentional pathways - these are man-made pathways that 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: existing unintentional, man-made invasive species pathways; with a section devoted to policy synthesis. Though guide processes may be used for potential pathway analysis, such analysis must be based upon statistical predictive indicators of past trends - which at this time is not feasible due to lack of consolidated data sources. 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. THE PROCESS OVERVIEW

The process for pathway analysis and prioritization has been ‘broken down’ into five basic steps. These steps are designed to ensure the matching of mission areas with pathways of interest; use of most recent literature and datasets relevant to the pathways; analysis based upon expert opinions; and science-based consensus advisories.

The schematic below provides a visual reference guide; with each step then described in detail.

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**Note:** The purpose of pathway analysis, again, is to develop a science-based risk report that will be used by policy makers to develop local, national and international strategies. The value of the assessment is in terms of scientific discussion and conclusions - - and as such is not solely the results of numerical tabulations.
3. PREPARATION

**Convene a Consensus Analysis Pathways Team (CAPT).** It is recommended that each agency form an Invasive Species (IS) Consensus Analysis Pathways Team (CAPT) to manage the individual and group processes/documentation associated with pathway analyses. It is recommended the CAPT be a permanent standing committee and should be comprised of 3-5 persons (including a chair and recorder). CAPT should first perform the following functions prior to any pathway analyses:

A. Define organizational mission relative to invasive species (IS). The perspective and actions taken by an agency relative to invasive species is dependent upon the mission and its objectives. This definition is critical and serves as the foundation for all pathway activities. An example follows below:

<table>
<thead>
<tr>
<th>Strategic Goals</th>
<th>Mission Areas</th>
<th>IS Functions</th>
<th>Defined IS Role</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal 1:</strong> Safeguard the health of animals, plants and ecosystems in the United States</td>
<td>Animal Care (determines standards of humane care and treatment of animals).</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Goal 2:</strong> Facilitate safe agricultural trade</td>
<td>Biotechnology and Regulatory Services (Ensures safe dev. of genetically engineered organisms)</td>
<td>Indirect</td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Goal 3:</strong> Ensure the effective and efficient management of programs to achieve APHIS’ mission</td>
<td>International Services and Trade Support (Internat’l animal and plant health expertise to enhance safeguarding and trade). Plant Protection and Quarantine (safeguards agriculture and natural resources from the risks assoc with entry, establishment, or spread of animal and plant pests and noxious weeds)</td>
<td>Indirect</td>
<td>Not Applicable</td>
</tr>
<tr>
<td></td>
<td>Veterinary Services (protects and improves the health, quality, and marketability of nation’s animals, animal products and veterinary biologics)</td>
<td>Direct</td>
<td>Safeguards agriculture and natural resources from the risks assoc with entry, establishment, or spread of animal and plant pests (inclusive of invasive species) and noxious weeds</td>
</tr>
<tr>
<td></td>
<td>Wildlife Services (resolve wildlife conflicts/creates balance)</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>

(Note: this is only for example)
The remainder of activities during this phase center upon creating internal infrastructures to accomplish program tasks. As such they include:

B. Develop a general list of qualified group facilitators and recorders
C. Compile general collection of qualitative information sources on IS. Though pathway-specific quantitative benchmarks and datasets are to be researched to assist pathway prioritization, a significant lack of data history causes the use of additional qualitative methods for pathway assessment; specifically, document and scientific studies. Research through such avenues as bibliographic literature searches, scientific journals, et. al., these pathway-specific documents are to be supplied to participants several weeks prior to the “Step 2” to create a common knowledge base for discussion and comparison.
D. Communicate the role of CAPT to appropriate organization personnel
“FIRST-CUT’- MULTIPLE PATHWAYS TRIAGE AND THREAT LEVEL ASSESSMENT

1. OVERARCHING PATHWAY DEFINITION

The next role of CAPT is to elicit from multiple (i.e., 5-8) individual experts, a ‘first-cut’ or general analysis of IS pathways. The ‘first-cut’ analysis is a preliminary ‘triage’ of pathways, wherein decisions are made as to what pathways are relevant to agency mission, what the traditional characteristics of the pathway(s) are; what invasives are traditionally transmitted via these pathways; and finally, what the threat level of invasives transmitted via those pathways represent. For this process, it is suggested the CAPT use the general definitions, lists and charts of pathways provided below. CAPT actions should include the following:

A. Develop list of agency invasive species/pathways experts
B. Provide a definition of agency mission - relative to invasive species - to 5 to 8 individual IS experts (see product from preparation phase).
C. Provide a copy of general pathway charts and listings to individual experts (as next provided in the following 5 graphics):

OVERVIEW OF DIAGRAMS

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)

T1  Modes of Transportation
(Things doing the transporting)

T1.1  Air Transportation
(Planes, seaplanes, helicopters, etc. Includes all places where organisms could hide including wheel wells, cargo holds, and main cabins.)

T1.2  Water/Aquatic Transportation
(Freshwater and marine includes all types of aquatic vehicles and movable structures).

T1.3  Land/Terrestrial Transportation
(Includes all methods of moving across the ground)

T1.3.1  Cars Buses Trucks ATVs

T1.3.2  Trains Subways Metros Monorails

T1.3.3  Construction & Firefighting Vehicles

T1.3.4  Hikers Horses Pets

T2  Items Used In The Shipping Process

T2.1  Baggage

T2.2  Equipment

T2.3  Containers (Interiors & exteriors)

T3  Items Used In The Shipping Process

T3.1  Packing Materials

T3.2  Packing Materials

T3.2.1  Wood Packing Materials (Pallets, crates)

T3.2.2  Seaweed

T3.2.3  Other Plant Materials (Used as packing materials)

T3.2.4  Sand/Earth (Archeological shipments)

T4  Mail/Internet Overnight Shipping Companies

T5  Travel/Tourism/Relocation

T5.1  Travelers Themselves
(Includes humans as disease vectors)

T5.2  Baggage/Gear
(Carry on and checked baggage; hiking boots; aquatic recreation gear, etc.)

T5.3  Pets/Plants and Animals Transported For Entertainment
(Pet and horse shows, sporting events, circuses, rodeos, plant or garden shows, etc.)

T5.4  Travel Consumables
(Food on cruise cruises, etc.)

T5.5  Service Industries
(Industries that service ships, planes, etc.)

T2.1.1  Ship Ballast Water
(And other things that hold water)

T2.2  Hull/Surface Fouling (i.e. Recreational Boats & Vehicles)

T2.3  Stowaways In Holds

T2.4  Superstructures/Structures Above Water Line
(Dredge platforms, Oil rigs, etc.)

T2.5  Transportation/Relocation of Dredge Spoil Material
Diagram 2

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

L1 Plant Pathways
(Aquatic and Terrestrial)

L1.1 Importation of Plants for Research
L1.2 Potting Soils, Growing Mediums, Sods, and Other Materials
(Fertilizers, bioengineering materials such as live turf and erosion control technologies, live fascines, wetland restoration and wildflower sods, etc.)

L1.3.1 Above Ground Plant Parts
(Cuttings, budwood, etc.)
L1.3.1.2 Below Ground Plant Parts
(Bulbs, roots, culms, tubers, etc.)
L1.3.1.3 Seeds and the Seed Trade
L1.3.1.4 Aquatic Propagules

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

L1.3 Plant Trade
(Agricultural, nursery, landscape, floral, raw Logs, etc.)

L1.3.2 Whole Plants

L1.3.1 Plant Parts

L1.3.1.1 Above Ground Plant Parts

L1.3.1.2 Below Ground Plant Parts

L2 Food Pathways
(Transportation of animals for immediate consumption)

L2.1 Live Seafood
(market ready to be consumed immediately)

L2.2 Other Live Food Animals

L2.3 Plant & Plant Parts As Food

L2.3.1 Bait

L2.3.2 Pet Aquarium Trade
(Plants covered under plant trade)

L3 Non-Food Animal Pathways
(Transporting animals for reasons other than consumption, excluding entertainment which is covered in the diagram for transportation pathways)

L3.1 Aquaculture
(Incl. organisms classified as seafood when shipped for other purposes)

L3.2 Pet Animals
(Animals for research, zoos, public aquaria, fur harvest, livestock for non-food purposes such as hunt clubs, racing, breeding, draft animals)

L3.3 Non-Pet Animals
(Animals for research, zoos, public aquaria, fur harvest, livestock for non-food purposes such as hunt clubs, racing, breeding, draft animals)

L3.4 Minimally Processed Animal Products
(Hides, trophies, feathers, etc.)

L3.5 Release of Organisms For Religious, Cultural or Other Reasons
(Prayer animal release, animals released at weddings, animal liberations, etc.)

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 Plant Products
(Logs, chips, firewood, mulch, straw, hay, baskets, etc.)

L4.4 Minimally Processed Animal Products
(Hides, trophies, feathers, etc.)
Diagram 3

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

M1 Biocontrol

Important Note: For the purpose of these diagrams, this category only refers to the release of a species as a biocontrol agent that unexpectedly becomes an invasive species.

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 (Aqueducts, etc.)

M3 Natural Spread Of Established Populations of Invasive Species
(Includes natural migration, movement and spread of populations, ocean currents, wind patterns, unusual weather events, spread via migratory waterfowl, etc.)

M4 Ecosystem Disturbance

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

M4.2 Short-Term (Habitat restoration, enhancement prescribed burning, etc.)

M5 Garbage

M5.1 Transport

M5.2 Landfill

Important Note: The natural spread of invasive species is a recognized pathway of introduction into new areas, but is not one that will be addressed by the team for the purposes of determining pathway priority, prevention measures, or best management practices.
Pathways Lists 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. DEFINING MULTIPLE PATHWAYS OF INTERESTS

The CAPT ensures general definition of multiple pathways of interest—based on agency mission. Processes are delineated, below:

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

B. **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 briefly define pathway particulars (i.e., start point, mid and endpoints) for clarification.

C. **List Pathways.** Select and list all pathways that are pertinent to the mission.

D. **List Invasives.** Indicate, briefly, what particular invasives are associated with each pathway. Potential invasive species categories include:

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

3. PRELIMINARY MULTI-PATHWAY DESCRIPTIONS

Once the mission, the “universe” of all potential pathways, and the ‘narrowed-down’ list of pathways of agency-interest are complete, the CAPT should then prepare a preliminary or general description for each pathway of agency interest.

A matrix example of these processes is provided on the next page:
<table>
<thead>
<tr>
<th>Agency IS Mission</th>
<th>The “Universe” of ALL Potential Pathways</th>
<th>From the “Universe” of Pathways, Only Those Mission-Related Pathways</th>
<th>Mission Related Preliminary Pathway(s) Description</th>
<th>Invasives Transmitted via Pathway</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Coast Guard protects the public, environment &amp; 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</td>
<td>Water Transportations: T1.1 Air; T1.2 Water/Aquatic; T1.2.1 Ballast Water</td>
<td>T1.2.1 Ballast Water</td>
<td>T1.2.1 Ship Ballast Water/Cargo ship that begins voyage in Kusadasi, with endpoint NYC.</td>
<td>Amphidinium Cholera</td>
</tr>
<tr>
<td></td>
<td>Water Transportations: T1.2.2 Hull/Surface Fouling; T1.2.3 Stowaways; T1.2.4 Superstructures</td>
<td>T1.2.2 Hull/Surface Fouling</td>
<td>T1.2.2 Hull/Surface Fouling. Cruise ship start point Miami, to Jamaica and Return</td>
<td>Zebra Mussles</td>
</tr>
<tr>
<td></td>
<td>Water Transportations: T1.2.5 Transportation/Relocation of Dredge (L) Living Industry</td>
<td>T1.2.5 Dredge Relocation</td>
<td>T1.2.5 Dredge Relocation. Barge traveling from Hawaii to Oregon</td>
<td>Water hyacinth</td>
</tr>
<tr>
<td></td>
<td>(L) Living Industry: L1 Plant Pathways; L1.1 Importation Plants; L1.2 Potting Soils</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(M) Miscellaneous: M1 Biocontrol; M2 Other Aquatic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M2.1 Interconnected Waterways; M2.1.1 Freshwater Canals; M2.1.2 Estuarine Canals; M2.1.3 Domestic Waste Streams; M2.2 Interbasin Transfr</td>
<td></td>
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### 4. PATHWAY THREAT LEVEL DETERMINATION

CAPT next ensures the team assigns an invasive species threat level to each pathway. As determined by National Invasive Species Plan priorities, those pathways which present a threat to human health take priority over those presenting threats to the economy and then ecology. 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.

Further definition of method of assigning IS threat level follows below as:

**Threat Level A - - Human Health.** The pathway currently transmits an invasive species that poses a direct threat to human health. This threat is typified by such emerging infectious diseases
as monkeypox, pandemic influenza, bovine spongiform encephalitis, etc., that may be transmitted
to human population from any nonindigenous invasive source such as plants, animals, prions,
et al. An underlying assumption to this category is that if human health is affected, then
economic ecological factors will be impacted as well. As such, designation at the “A” level, is
inclusive of lower level threat risk levels.

<table>
<thead>
<tr>
<th>Define the impact on Human Health (i.e., rationale for category determination)</th>
</tr>
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</table>

**Threat Level B - Economic Health.** The pathway currently transmits an invasive species that,
via history or current consequences, demonstrates a direct negative impact to U.S. economic
health (i.e., diminishes gross domestic product quotient; lowers market value of goods and/or
services). An underlying assumption to this category is that if economic health of industries is
affected, then ecosystem factors will be impacted as well.

<table>
<thead>
<tr>
<th>Define the impact on Economic Health (i.e., rationale for category determination)</th>
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**Threat Level C - Ecosystem Health.** The pathway currently transmits an invasive species that
pose a threat to ecosystem health via impeding biological integrity, diversity, sustainability, quality
or physical/biological functioning of ecosystems. An underlying assumption to this category is the
invasive does not have a direct impact on human or economic systems.

| Define the impact on Ecosystem Health (i.e., rationale for category
determination) |
<table>
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</tbody>
</table>

What is the final threat level assigned? _____________________________
Select only A, B or C
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.

5. FINALIZING THE “FIRST-CUT” ANALYSIS

Triage, again, is to provide the first prioritization factors or ‘cut’ of which pathway(s) an agency or organization should assess. In that the pathways for IS are complex and numerous, the CAPT should then convene a panel of the 5 to 8 agency IS experts. The purpose of the meeting is to, via consensus, finalize the “first cut” analysis of invasive species (otherwise known as triage). To accomplish the final triage, the CAPT team should:

A. Convene individual IS experts into a PANEL OF EXPERTS for consensus ‘first-cut' analysis of IS pathways – requiring group to discuss opinions and decisions
B. Facilitate a consensus “first-cut” analysis
C. Document the “First-Cut” analysis consensus results, incorporating the individual responses as background documentation.
D. Create a hierarchy or ordered list of IS pathways, based on posed threat determined by ‘First-Cut’, for ‘Second and Third cut’ analysis processes.
E. Establish an analysis timeline for each individual IS pathway deemed relevant to agency mission - - with associated lists of experts, group facilitators and recorders.

A matrix-sample of the finalized ‘first-cut analysis follows on the next page:
**FIRST CUT ANALYSIS**

|----------------------------------------|--------------------------|-----------------------------------------------|------------------------------------|-----------------|
| 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  
T1.1 Air  
T1.2 Water/Aquatic  
T1.2.1 Ballast Water  
T1.2.2 Hull/Surface  
T1/2.3 Stowaways  
T1.2.4 Superstructures  
T1.2.5 Transportation/Relocation of Dredge  
(L) Living Industry  
L1 Plant Pathways  
L1.1 Importation Plants  
L1.2 Potting Soils  
(M) Miscellaneous  
M1 Biocontrol  
M2 Other Aquatic  
M2.1 Interconnected Waterways  
M2.1.1 Freshwater Canals  
M2.1.2 Estuarine Canals  
M2.1.3 Domestic Waste Streams  
M2.2 Interbasin Transfr | T1.2.1 Ballast Water  
T1.2.2 Hull/Surface  
T1.2.5 Dredge Relocation | T1.2.1 Ship Ballast Water  
Cargo ship that begins voyage in Kusadasi, with endpoint NYC.  
T1.2.2 Hull/Surface Fouling  
Cruise ship start point Miami, to Jamaica and Return  
T1.2.5 Dredge Relocation  
Barge traveling from Hawaii to Oregon | Amphidinium Cholera  
Zebra Mussels  
Water hyacinth | A Human Health  
B Economy  
C Ecology | First Priority  
Second Priority  
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.
SECOND-CUT’” ANALYSIS – SINGLE PATHWAY DEFINITION, COUPLING WITH INCLUSIVE IS LISTING AND ECOSYSTEM SCOPE

1. DETAILED SINGLE PATHWAY DESCRIPTION

Based on the ‘first-cut’ analysis, agencies now have a roughly prioritized list of pathways upon which to work. Second-cut analysis is the process for the analysis of individual, single pathways. In that pathways can be simple or complex, it is essential to further define the single pathway being analyzed. Examples follow:

Example A. This is a single segment pathway, wherein a rail car carries oranges from Jacksonville, Florida to Atlanta Georgia rail station. The rail station then transmits boxed, fumigated fruit directly to city markets. There is currently a fruit fly quarantine in place in Florida. Related invasives include fruit fly and citrus canker. However, due to endpoint destination ecosystem, no threat occurs UNLESS there is co-mingling of product with shipments destined for California citrus growing regions. For Department of Agriculture, the first-cut analysis indicates it is an invasive pathway of agency concern, the related invasives impact would be on economy.

Example B. This is a three-segment pathway that begins with table grapes from Paris that are cold-treated during cargo shipment. The shipment is then unloaded in the Port of New York, into two rail cars that will unload the product in Chicago, and Los Angeles. Associated invasives are fruit flies. The rail shipments will go from rail car, to market and then human consumption in both cities.

Example C: This is a two segment pathway where pink hibiscus, plants for planting are harvested from Puerto Rico growers, transmitted via airplane to Miami Airport; transferred to outbound plane for Indianapolis; then disseminated to retail nurseries. Associated invasive is pink hibiscus mealybug.

What is important to realize, is that based upon the pathway segment under discussion, the pathway may be local, regional or national in perspective or impact. Pathway definition includes factors such as the pathway beginning/mid/end points; receiving, transiting and ending ecoregions; pathway segments; pathway vectoring agents (sometimes called sub-pathways) that may harbor pests/diseases; and all associated invasives. A matrix of further examples follows:

<table>
<thead>
<tr>
<th>Nbr #</th>
<th>Pathway Name</th>
<th>Threat Level</th>
<th>Pathway Start Point(s)</th>
<th>Pathway Mid Point(s)</th>
<th>Pathway End Point</th>
<th>Dissemination Points</th>
<th>Related Invasives</th>
</tr>
</thead>
</table>
| T3.2.1| Wood Packing Materials| B            | Ciudad Juarez, MX. Via Railcar transport of heavy equipment | Transits through El Paso but bypasses inspection points | Tillamook Oregon | A. Commercial lumber operations in forest  
B. City hardware store-retail | Asian Long Horn Beetle |
|       |                       |              | Great Plains            | Ecoregion Type(s)    | Ecoregion Type(s) | Ecoregion Type(s)    | Preferred Ecoregion Type(s) |
|       |                       |              |                         | Great Plains         | NW Forested Mtns  | NW Forested Mtns-confined non-ag area | A. Forest Areas-Receptive  
B. City—low receptivity |
<p>| T1.2.1| Ship Ballast Water    | A            | Naples -Cargo Ship (Cholera) | Lisbon, Portugal      | Bar Harbor Maine | City Harbor          | zebra mussels cholera    |</p>
<table>
<thead>
<tr>
<th>Ecoregion Type(s)</th>
<th>Ecoregion Type(s)</th>
<th>Ecoregion Type(s)</th>
<th>Ecoregion Type(s)</th>
<th>Preferred Ecoregion Type(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mediterranean Sea</td>
<td>Mediterranean Sea</td>
<td>Grand Banks</td>
<td>Grand Banks</td>
<td>Marine-salt water</td>
</tr>
<tr>
<td>Perth, Australia</td>
<td>None</td>
<td>Raleigh, NC</td>
<td>NC State Botany</td>
<td>Marsh grasses are</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>invasive water</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>hyacinth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Soil is a vectoring</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>agent or sub-pathway</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>for other invasives</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecoregion Type(s)</td>
<td>Ecoregion Type(s)</td>
<td>Ecoregion Type(s)</td>
<td>Ecoregion Type(s)</td>
<td>Preferred Ecoregion Type(s)</td>
</tr>
<tr>
<td>Mangroves</td>
<td>N/A</td>
<td>Temperate</td>
<td>Temperate</td>
<td>Marine Ecosystem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Coniferous Forest</td>
<td>Coniferous Forest</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Temperate grasslands</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– controlled lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>low receptivity</td>
</tr>
</tbody>
</table>

2. DETAILED INVASIVE DEFINITIONS

It is critical to ‘marry-up’ the specific invasive(s) and its (their) threat to the related pathway. It is at this point that the ‘science’ of the individual invasive(s) becomes important. Though abbreviated in the exemplar chart s, it is also imperative to 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.

Detailed invasive definitions are contained on www.invasivespeciesinfo.gov

3. PATHWAY ECOSYSTEM THREAT/SCOPE LEVEL DETERMINATION

As noted above, ecosystem consideration is an important aspect of pathway analysis. As such, it is essential to review and, if necessary, revise the first general assessment of pathway threat level and
ecosystem scope determination made in the ‘First-Cut’ analysis that may result from redefinition. Exemplar ecosystem charts and listings are provided below (sources: Commission for Environmental Cooperation and World Wildlife Federation). Please note, the above pathway ecosystem designations and ecoregion charts are just examples. Ecoregion charts may be modified, developed anew by the teams, etc. What is required, however, is documentation of ecoregion determinations.

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 ecosystems 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. Ecosystem 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 ecosystems. Any redefinition should be documented as part of the assessment process to provide basis for transparency in decision making. As such, the CAPT must ensure the assignment of ecosystem threat or scope for each pathway 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 ecosystems 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 ecosystems 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 ecosystems 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 ecosystems 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:

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________

4. **EXEMPLAR ECOSYSTEM CHARTS.**

The following are exemplar ecosystem charts and listings for reference. However, different ones may be used, based upon the preferences of expert opinions.

**North American Ecoregion Map**
World Ecoregion Map

Terrestrial Major Habitat Types

- Tropical & Subtropical Moist Broadleaf Forests
- Tropical & Subtropical Dry Broadleaf Forests
- Tropical & Subtropical Coniferous Forests
- Temperate Broadleaf & Mixed Forests
- Temperate Coniferous Forests
- Boreal Forests / Taiga
- Tropical & Subtropical Grasslands, Savannas & Shrublands
- Temperate Grasslands, Savannas & Shrublands
- Flooded Grasslands & Savannas
- Montane Grasslands & Shrublands
- Tundra
- Mediterranean Forests, Woodlands & Scrub
- Deserts & Xeric Shrublands
- Mangroves

- Marine Ecoregions
- Freshwater Ecoregions
- No Data
- International Boundaries
- Disputed Boundaries, Lines of Control, or alignment unconfirmed
  (Boundaries based on UN sources)
<table>
<thead>
<tr>
<th>ECOREGIONS</th>
<th>WITHIN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TERRESTRIAL ECOREGIONS</strong></td>
<td></td>
</tr>
<tr>
<td>Tropical and Subtropical Moist</td>
<td></td>
</tr>
<tr>
<td>Broadleaf Forests</td>
<td></td>
</tr>
<tr>
<td><strong>Afrotropical</strong></td>
<td></td>
</tr>
<tr>
<td>(1) Guinean Moist Forests</td>
<td>Benin, Côte d'Ivoire, Ghana, Guinea, Liberia, Sierra Leone, Togo</td>
</tr>
<tr>
<td>(2) Congolian Coastal Forests</td>
<td>Angola, Cameroon, Democratic Republic of Congo, Equatorial Guinea, Gabon, Nigeria, São Tomé &amp; Príncipe, Republic of Congo</td>
</tr>
<tr>
<td>(3) Cameroon Highlands Forests</td>
<td>Cameroon, Equatorial Guinea, Nigeria</td>
</tr>
<tr>
<td>(4) Northeastern Congo Basin Moist Forests</td>
<td>Central African Republic, Democratic Republic of Congo</td>
</tr>
<tr>
<td>(5) Central Congo Basin Moist Forests</td>
<td>Democratic Republic of Congo</td>
</tr>
<tr>
<td>(6) Western Congo Basin Moist Forests</td>
<td>Cameroon, Central African Republic, Democratic Republic of Congo, Gabon, Republic of Congo</td>
</tr>
<tr>
<td>(7) Albertine Rift Montane Forests</td>
<td>Burundi, Democratic Republic of Congo, Rwanda, Tanzania, Uganda</td>
</tr>
<tr>
<td>(8) East African Coastal Forests</td>
<td>Kenya, Somalia, Tanzania</td>
</tr>
<tr>
<td>(9) Eastern Arc</td>
<td></td>
</tr>
<tr>
<td>(10) Madagascar Montane Forests</td>
<td></td>
</tr>
<tr>
<td>and Shrublands</td>
<td></td>
</tr>
<tr>
<td>(11) Seychelles and Mascarenes Moist Forests</td>
<td>Mauritius, Reunion (France), Seychelles</td>
</tr>
<tr>
<td>Australasia</td>
<td></td>
</tr>
<tr>
<td>(12) Sulawesi Moist Forests</td>
<td>Indonesia</td>
</tr>
<tr>
<td>(13) Moluccas Moist Forests</td>
<td>Indonesia</td>
</tr>
<tr>
<td>(14) Southern New Guinea Lowland</td>
<td>Indonesia, Papua New Guinea</td>
</tr>
<tr>
<td>Montane Forests</td>
<td></td>
</tr>
<tr>
<td>(15) New Guinea Montane Forests</td>
<td>Indonesia, Papua New Guinea</td>
</tr>
<tr>
<td>(16) Solomons-Vanuatu-Bismarck</td>
<td>Papua New Guinea</td>
</tr>
<tr>
<td>Moist Forests</td>
<td></td>
</tr>
<tr>
<td>(17) Queensland Tropical Forests</td>
<td>Indonesia, Solomon Islands, Vanuatu</td>
</tr>
<tr>
<td>(18) New Caledonia Moist Forests</td>
<td></td>
</tr>
<tr>
<td>(19) Lord Howe-Norfolk Islands Forests</td>
<td>Australia</td>
</tr>
<tr>
<td>(20) Southwestern Ghats Moist Forests</td>
<td>India</td>
</tr>
<tr>
<td>(21) Sri Lankan Moist Forests</td>
<td>Sri Lanka</td>
</tr>
<tr>
<td>(22) Northern Indochina Subtropical Moist Forests</td>
<td>China, Laos, Myanmar, Thailand, Vietnam</td>
</tr>
<tr>
<td>(23) Southeast China Moist Forests</td>
<td></td>
</tr>
<tr>
<td>(24) Taiwan Montane Forests</td>
<td></td>
</tr>
<tr>
<td>(25) Annamite Range Moist Forests</td>
<td></td>
</tr>
<tr>
<td>(26) Sumatran Islands Lowland and Montane Forests</td>
<td>Indonesia</td>
</tr>
<tr>
<td>(27) Philippines Moist Forests</td>
<td></td>
</tr>
<tr>
<td>(28) Palawan Moist Forests</td>
<td></td>
</tr>
<tr>
<td>(29) Kayah-Karen / Tenasserim Moist Forests</td>
<td>Malaysia, Myanmar, Thailand</td>
</tr>
<tr>
<td>(30) Peninsular Malaysian Lowland and Mountain Forests</td>
<td>Indonesia, Malaysia, Singapore, Thailand</td>
</tr>
<tr>
<td>(31) Borneo Lowland and Montane Forests</td>
<td>Brunei, Indonesia, Malaysia</td>
</tr>
<tr>
<td>(32) Nansei Shoto Archipelago Forests</td>
<td>Japan</td>
</tr>
<tr>
<td>(33) Eastern Deccan Plateau Moist Forests</td>
<td>India</td>
</tr>
<tr>
<td>(34) Naga-Manupuri-Chin Hills Moist Forests</td>
<td>Bangladesh, India, Myanmar</td>
</tr>
<tr>
<td>(35) Cardamom Mountains Moist Forests</td>
<td>Cambodia, Thailand</td>
</tr>
<tr>
<td>(36) Western Java Mountain Forests</td>
<td>Indonesia</td>
</tr>
<tr>
<td>(37) Greater Antillean Moist Forests</td>
<td>Cuba, Dominican Republic, Haiti, Jamaica, Puerto Rico (United States)</td>
</tr>
</tbody>
</table>

**Indo-Malayan**

**Neotropical**
(38) **Talamancan and Isthmian Pacific Forests** - Costa Rica, Panama

(39) **Chocó-Darién Moist Forests** - Colombia, Ecuador, Panama

(40) **Northern Andean Montane Forests** - Colombia, Ecuador, Venezuela, Peru

(41) **Coastal Venezuela Montane Forests** - Venezuela

(42) **Guianan Moist Forests** - Brazil, French Guiana (France), Guyana, Suriname, Venezuela

(43) **Napo Moist Forests** - Colombia, Ecuador, Peru

(44) **Río Negro-Juruá Moist Forests** - Brazil, Colombia, Peru, Venezuela

(45) **Guayanan Highlands Forests** - Brazil, Colombia, Guayana, Suriname, Venezuela

(46) **Central Andean Yungas** - Argentina, Bolivia, Peru

(47) **Southwestern Amazonian Moist Forests** - Bolivia, Brazil, Peru

(48) **Atlantic Forests** - Argentina, Brazil, Paraguay

(49) **South Pacific Islands Forests** - American Samoa (United States), Cook Islands (New Zealand), Fiji, French Polynesia (France), Niue (New Zealand), Samoa, Tonga, Wallis and Futuna Islands (France)

(50) **Hawaii Moist Forests** - Hawaii (United States)

(51) **Madagascar Dry Forests** - Madagascar

(52) **Nusu Tenggara Dry Forests** - Indonesia

(53) **New Caledonia Dry Forests** - New Caledonia (France)

(54) **Indochina Dry Forests** - Cambodia, Laos, Thailand, Vietnam

(55) **Chhota Nagpur Dry Forests** - India

(56) **Mexican Dry Forests** - Guatemala, Mexico

(57) **Tumbesian-Andean Valleys Dry Forests** - Colombia, Ecuador, Peru

(58) **Chiquitano Dry Forests** - Bolivia, Brazil

(59) **Atlantic Dry Forests** - Brazil

(60) **Hawaii's Dry Forests** - Hawaii (United States)

(61) **Sierra Madre Oriental and Occidental Pine-Oak Forests** - Mexico, United States

(62) **Greater Antillean Pine Forests** - Cuba, Dominican Republic, Haiti

(63) **Mesoamerican Pine-Oak Forests** - El Salvador, Guatemala, Honduras, Mexico, Nicaragua

(64) **Eastern Australia Temperate Forests** - Australia

(65) **Tasmanian Temperate Rain Forests** - Australia

(66) **New Zealand Temperate Forests** - New Zealand

(67) **Eastern Himalayan Broadleaf and Conifer Forests** - Bhutan, China, India, Myanmar, Nepal

(68) **Western Himalayan Temperate Forests** - Afghanistan, India, Nepal, Pakistan

(69) **Appalachian and Mixed Mesophytic Forests** - United States

(70) **Southwest China Temperate Forests** - China

(71) **Russian Far East Temperate Forests** - Russia

(72) **Pacific Temperate Rainforests** - Canada, United States

(73) **Klamath-Siskiyou Coniferous Forests** - United States

(74) **Sierra Nevada Coniferous Forests** - United States

(75) **Southeastern Coniferous and Broadleaf Forests** - United States

(76) **Valdavian Neotropical Forests** - United States
Temperate Rainforests / Juan Fernandez
Islands - Argentina, Chile

Palearctic
(77) European-Mediterranean
Montane Mixed Forests - Albania, Algeria, Andorra, Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, France, Germany, Greece, Italy, Liechtenstein, Macedonia, Morocco, Poland, Romania, Russia, Slovakia, Slovenia
(78) Caucasus-Anatolian-Hyrcanian
Temperate Forests - Armenia, Azerbaijan, Bulgaria, Georgia, Iran, Russia, Turkey, Turkmenistan
(79) Altai-Sayan
Montane Forests - China, Kazakhstan, Mongolia, Russia
(80) Hengduan Shan
Coniferous Forests - China

Boreal Forests / Taiga

Nearctic
(81) Muskwa / Slave Lake Boreal Forests - Canada
(82) Canadian Boreal Forests - Canada
(83) Ural Mountains
Taiga - Russia
(84) Eastern Siberian
Taiga - Russia
(85) Kamchatka Taiga and Grasslands - Russia

Subtropical
Grasslands, Savannas and Shrublands
Afrotropical
(86) Horn of Africa
Acacia Savannas - Eritrea, Ethiopia, Kenya, Somalia, Sudan
(87) East African
Acacia Savannas - Ethiopia, Kenya, Sudan, Tanzania, Uganda
(88) Central and Eastern Miombo Woodlands - Angola, Botswana, Burundi, Democratic Republic of Congo, Malawi, Mozambique, Namibia, Tanzania, Zambia, Zimbabwe
(89) Sudanian Savannas - Cameroon, Central African Republic, Chad, Nigeria, Democratic Republic of Congo, Eritrea, Ethiopia, Kenya, Nigeria, Sudan, Uganda

Australasia
(90) Northern Australia and Trans-Fly Savannas - Australia, Indonesia, Papua New Guinea

Indo-Malayan
(91) Terai-Duar Savannas and Grasslands - Bangladesh, Bhutan, India, Nepal

Neotropical
(92) Llanos Savannas - Colombia, Venezuela
(93) Cerrado Woodlands and Savannas - Bolivia, Brazil, Paraguay

Temperate Grasslands, Savannas and Shrublands
Nearctic
(94) Northern Prairie - Canada, United States

Neotropical
(95) Patagonian Steppe - Argentina, Chile

Afrotropical
(102) Ethiopian Highlands - Eritrea, Ethiopia, Sudan
(103) Southern Rift Montane Woodlands - Malawi, Mozambique, Tanzania, Zambia

Australasia
(106) Central Range

Afrotropical
(107) Sudd-Sahelian Flooded Grasslands and Savannas

Indo-Malayan
(99) Rann of Kutch Flooded Grasslands - India, Pakistan
(100) Everglades Flooded Grasslands - United States
(101) Pantanal Flooded Savannas - Bolivia, Brazil, Paraguay

Montane Grasslands and Shrublands

Afrotropical
(102) Ethiopian Highlands - Eritrea, Ethiopia, Sudan
(103) Southern Rift Montane Woodlands - Malawi, Mozambique, Tanzania, Zambia

Australasia
(106) Central Range
Subalpine Grasslands - Indonesia, Papua New Guinea

Indo-Malayan
(107) Kinabalu Montane Scrub - Malaysia

Neotropical
(108) Northern Andean Paramo - Colombia, Ecuador, Peru, Venezuela
(109) Central Andean Dry Puna - Argentina, Bolivia, Chile, Peru

Palearctic
(110) Tibetan Plateau Steppe - Afghanistan, China, India, Pakistan, Tajikistan
(111) Middle Asian Montane Steppe and Woodlands - Afghanistan, China, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
(112) Eastern Himalayan Alpine Meadows - Bhutan, China, India, Myanmar, Nepal

Tundra
Nearctic
(113) Alaskan North Slope Coastal Tundra - Canada, United States
(114) Canadian Low Arctic Tundra - Canada

Palearctic
(115) Fenno-Scandinia Alpine Tundra and Taiga - Finland, Norway, Russia, Sweden
(116) Taimyr and Siberian Coastal Tundra - Russia
(117) Chukote Coastal Tundra - Russia

Mediterranean Forests, Woodlands and Scrub
Afrotropical
(118) Fynbos - South Africa

Australasia
(119) Southwestern Australia Forests and Scrub - Australia
(120) Southern Australia Mallee and Woodlands - Australia

Nearctic
(121) California Chaparral and Woodlands - Mexico, United States

Neotropical
(122) Chilean Matorral - Chile

Palearctic
(123) Mediterranean Forests, Woodlands and Scrub - Albania, Algeria, Bosnia and Herzegovina, Bulgaria, Canary Islands (Spain), Croatia, Cyprus, Egypt, France, Gibraltar (United Kingdom), Greece, Iraq, Israel, Italy, Jordan, Lebanon, Libya, Macedonia, Madeira Islands (Portugal), Malta, Monaco, Morocco, Portugal, San Marino, Slovenia, Spain, Syria, Tunisia, Turkey, Western Sahara (Morocco), Yugoslavia

Deserts and Xeric Shrublands
Afrotropical
(124) Namib-Karoo-Kaokoveld Deserts - Angola, Namibia, South Africa

(125) Madagascar Spiny Thicket - Madagascar
(126) Socotra Island Desert - Yemen
(127) Arabian Highland Woodlands and Shrublands - Oman, Saudi Arabia, United Arab Emirates, Yemen

Australasia
(128) Carnavon Xeric Scrub - Australia
(129) Great Sandy-Tanami Deserts - Australia

Nearctic
(130) Sonoran-Baja Deserts - Mexico, United States
(131) Chihuahuan-Tehuacán Deserts - Mexico, United States

Neotropical
(132) Galápagos Islands Scrub - Ecuador
(133) Atacama-Sechura Deserts - Chile, Peru

Palearctic
(134) Central Asian Deserts - Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan

Mangroves
Afrotropical
(135) Gulf of Guinea Mangroves - Angola, Cameroon, Democratic Republic of Congo, Equatorial Guinea, Gabon, Ghana, Nigeria
(136) East African Mangroves - Kenya, Mozambique, Somalia, Tanzania
(137) Madagascar Mangroves - Madagascar

Australasia
(138) New Guinea Mangroves - Indonesia, Papua New Guinea

Indo-Malayan
(139) Sundarbans Mangroves - Bangladesh, India
(140) Greater Sundas Mangroves - Brunei, Indonesia, Malaysia

Neotropical
(141) Guianan-Amazon
**Mangroves** - Brazil, French Guiana (France), Suriname, Trinidad and Tobago, Venezuela

**Panama Bight Mangroves** - Colombia, Ecuador, Panama, Peru

**FRESHWATER ECOREGIONS**

**Large Rivers**

*Afrotropical*

- Congo River and Flooded Forests - Angola, Democratic Republic of Congo, Republic of Congo

*Indo-Malayan*

- Mekong River - Cambodia, China, Laos, Myanmar, Thailand, Vietnam

*Nearctic*

- Colorado River - Mexico, United States

*Neotropical*

- Amazon River and Flooded Forests - Brazil, Colombia, Peru

*Palearctic*

- Yangtze River and Lakes - China

**Large River Headwaters**

*Afrotropical*

- Congo Basin Piedmont Rivers and Streams - Angola, Cameroon, Central African Republic, Democratic Republic of Congo, Gabon, Republic of Congo, Sudan

*Nearctic*

- Mississippi Piedmont Rivers and Streams - United States

**Streams** - United States

*Neotropical*

- Upper Amazon Rivers and Streams - Bolivia, Brazil, Colombia, Ecuador, French Guiana (France), Guyana, Peru, Suriname, Venezuela

- Upper Paraná Rivers and Streams - Argentina, Brazil, Paraguay

- Brazilian Shield Amazonian Rivers and Streams - Bolivia, Brazil, Paraguay

- Large River Deltas

*Afrotropical*

- Niger River Delta - Nigeria

*Indo-Malayan*

- Indus River Delta - India, Pakistan

*Palearctic*

- Volga River Delta - Kazakhstan, Russia

- Mesopotamian Delta and Marshes - Iran, Iraq, Kuwait

- Danube River Delta - Bulgaria, Moldova, Romania, Ukraine, Yugoslavia

- Lena River Delta - Russia

**Small Rivers**

*Afrotropical*

- Upper Guinea Rivers and Streams - Côte D'Ivoire, Guinea, Liberia, Sierra Leone

- Madagascar Freshwater - Madagascar

- Gulf of Guinea Rivers and Streams - Angola, Cameroon, Democratic Republic of Congo, Equatorial Guinea, Gabon, Nigeria, Republic of Congo

**Streams** - South Africa

*Australasia*

- New Guinea Rivers and Streams - Indonesia, Papua New Guinea

- New Caledonia Rivers and Streams - New Caledonia (France)

- Kimberley Rivers and Streams - Australia

**Southwest Australia Rivers and Streams** - Australia

*Eastern Australia Rivers and Streams* - Australia

*Indo-Malayan*

- Xi Jiang Rivers and Streams - China, Vietnam

- Western Ghats Rivers and Streams - India

- Sundaland Rivers and Swamps - Brunei, Malaysia, Indonesia, Singapore

**Nearctic**

- Southeastern Rivers and Streams - United States

*Pacific Northwest Coastal Rivers and Streams* - United States

- Gulf of Alaska Coastal Rivers and Streams - Canada, United States

**Neotropical**

- Guianan Freshwater - Brazil, French Guiana (France), Guyana, Suriname, Venezuela

- Greater Antillean Freshwater - Cuba,
Dominican Republic, Haiti, Puerto Rico (United States)

**Palearctic**
(180) **Balkan Rivers and Streams** - Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Turkey, Yugoslavia
(181) **Russian Far East Rivers and Wetlands** - China, Mongolia, Russia

**Large Lakes**

**Afrotropical**
(182) **Rift Valley Lakes** - Burundi, Democratic Republic of Congo, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda, Zambia

**Neotropical**
(183) **High Andean Lakes** - Argentina, Bolivia, Chile, Peru

**Palearctic**
(184) **Lake Baikal** - Russia
(185) **Lake Biwa** - Japan

**Small Lakes**

**Afrotropical**
(186) **Cameroon Crater Lakes** - Cameroon

**Australasia**
(187) **Lakes Kutubu and Sentani** - Indonesia, Papua New Guinea
(188) **Central Sulawesi Lakes** - Indonesia

**Indo-Malayan**
(189) **Philippines Freshwater** - Philippines
(190) **Lake Inle** - Myanmar
(191) **Yunnan Lakes and Streams** - China

**Neotropical**
(192) **Mexican Highland Lakes** - Mexico

**Xeric Basins**

**Australasia**

(193) **Central Australian Freshwater**
- Australia

**Nearctic**
(194) **Chihuahuan Freshwater** - Mexico, United States

**Palearctic**
(195) **Anatolian Freshwater** - Syria, Turkey

**MARINE ECOREGIONS**

**Polar Seas**

**Antarctic**
(196) **Antarctic Peninsula & Weddell Sea** - Antarctica Peninsula & Weddell Sea

**Arctic**
(197) **Bering Sea** - Canada, Russia, United States

**Temperate Shelves and Seas**

**Mediterranean**
(198) **Barents-Kara Sea** - Norway, Russia

**Temperate Upwelling**

**North Temperate Indo-Pacific**
(200) **Northeast Atlantic Shelf Marine** - Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Netherlands, Norway, Poland, Russia, Sweden, United Kingdom
(201) **Grand Banks** - Canada, St. Pierre and Miquelon (France), United States

**Chesapeake Bay**
- United States

**North Temperate Indo-Pacific**
(202) **Southern Australian Marine** - Australia
(203) **Yellow Sea** - China, North Korea, South Korea
(204) **Okhotsk Sea** - Japan, Russia

**Southern Ocean**
(205) **Patagonian Southwest Atlantic** - Argentina, Brazil, Chile, Uruguay

**Temperate Upwelling**

**North Temperate Indo-Pacific**
(206) **Southern California Current** - Canada, Mexico, United States

**Temperate Atlantic**
(207) **New Zealand Marine** - New Zealand

**Vaguest**

**Patagonian Southwest Atlantic** - Argentina, Brazil, Chile, Uruguay

**Temperate Temperate**

**North Temperate Indo-Pacific**
(208) **Benguela Current** - Namibia, South Africa

**South Temperate Indo-Pacific**
(209) **Agulhas Current** - Mozambique, South Africa

**Tropical Upwelling**

**Central Indo-Pacific**
(210) **Humboldt Current** - Chile, Ecuador, Peru

**Eastern Indo-Pacific**
(211) **Australasian Current** - Mozambique, South Africa

**Tropical Upwelling**

**Central Indo-Pacific**
(212) **Western Australian Marine** - Australia

**Eastern Indo-Pacific**
(213) **Panama Bight** - Colombia, Ecuador, Panama

**Galápagos Marine** - Ecuador

**Eastern Tropical Atlantic**
(216) Canary Current - Canary Islands (Spain), Gambia, Guinea-Bissau, Mauritania, Morocco, Senegal, Western Sahara (Morocco)

**Tropical Coral**

**Central Indo-Pacific**
(217) Nansei Shoto - Japan
(218) Sulu-Sulawesi Seas - Indonesia, Malaysia, Philippines
(219) Bismarck-Solomon Seas - Indonesia, Papua New Guinea, Solomon Islands
(220) Banda-Flores Sea - Indonesia
(221) New Caledonia Barrier Reef - New Caledonia (France)
(222) Great Barrier Reef - Australia
(223) Lord Howe-Norfolk Islands Marine - Australia
(224) Palau Marine - Palau
(225) Andaman Sea - Andaman and Nicobar Islands (India), Indonesia, Malaysia, Myanmar, Thailand

**Eastern Indo-Pacific**
(226) Tahitian Marine - Cook Islands (New Zealand), French Polynesia (France)
(227) Hawaiian Marine - Hawaii (United States)
(228) Rapa Nui - Chile
(229) Fiji Barrier Reef - Fiji

**Western Indo-Pacific**
(230) Maldives, Chagos, Lakshadweep Atolls - Chagos Archipelago (United Kingdom), India, Maldives, Sri Lanka
(231) Red Sea - Djibouti, Egypt, Eritrea, Israel, Jordan, Saudi Arabia, Sudan, Yemen
(232) Arabian Sea - Djibouti, Iran, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, United Arab Emirates, Yemen
(233) East African Marine - Kenya, Mozambique, Somalia, Tanzania

**Western Tropical Atlantic**
(235) Mesoamerican Reef - Belize, Guatemala, Honduras, Mexico
(236) Greater Antillean Marine - Bahamas, Cayman Islands (United Kingdom), Cuba, Dominican Republic, Haiti, Jamaica, Puerto Rico (United States), Turks and Caicos Islands (United Kingdom), United States
(237) Southern Caribbean Sea - Aruba (Netherlands), Columbia, Netherlands Antilles (Netherlands), Panama, Trinidad and Tobago, Venezuela
(238) Northeast Brazil Shelf Marine - Brazil
5. FINALIZING THE ‘SECOND-CUT’ ANALYSIS.

The second-cut analysis, should therefore have provided detailed, pathway description, full listing and defined properties of all invasive species associated with the specific pathway; and, most importantly, definition of the scope of the pathway.

After completion of ‘second cut’ analysis, CAPT is to forward results and expert lists to:

National Invasive Species Council
Prevention Committee
ATTN: Richard Orr
Assistant Director for International Policy and Prevention
U.S. Department of Interior (OS/SIO//NISC)
1849 C Street, NW
Washington, DC 20240
“THIRD-CUT’ ANALYSIS - - SINGLE PATHWAY
RISK ANALYSIS
VIA EXPERT CONSENSUS

1. INDIVIDUAL TO FOCUS GROUP - - EXPERT ANALYSIS

Similar in process to the ‘First-Cut’ analysis, the CAPT is to oversee the risk evaluation of a single pathway, first, by individual experts, then via a consensus meeting. In step 5, using products developed in steps 1-4, the CAPT completes the following:

A. Selects 5 to 8 IS risk evaluators, with experience pertinent to the single, defined pathway to be analyzed. 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. At a minimum, a pathway assessment expert team list should be compiled that includes information as to the expert(s)’ name, organization/association, areas of specialty, published papers, academic background, related work history and contact information. The following process is recommended for the selection of individual or team members for pathway analyses:

   A. Define academic and experience expertise essential for analysis
   B. Compile a list of all pertinent agencies, organizations, industries and stakeholders
   C. 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.
   D. Designate evaluators; matching credential and pathways to be assessed
   E. Designated participants are to provide curricula vita, resumes, any relevant published articles, areas of specialty, academic background, related work history and contact information.

B. Forwards information packages to individual risk evaluators that includes pathway definition, pathway threat level determination and rationale, pathway ecosystem scope determination and rationale, related literature and study searches, related quantitative datasets/databases, risk questionnaire contained later in this guide. 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.

C. CAPT, finally, receives completed risk assessments from individual IS experts.

2. PROCESSES FOR RISK ANALYSIS

Though pathway analysis can be accomplished by a single expert, 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 risk questions, that later follow, provide a consistent structured protocol for individual assessment that can later be used for consensus analysis and policy synthesis.

CAPT, during focus group processes, must ensure the following:

A. Provides information packages to focus group risk evaluators that includes pathway definition, pathway threat level determination and rationale, pathway ecosystem scope determination and rationale, related literature and study searches, related quantitative datasets/databases, AND all individual expert risk questionnaire assessments.

B. Construct focus groups. 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

C. Facilitate Focus Groups. Focus group participants are to be 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. Record 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.

E. Ensure access to 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.

F. Ensure consensus completion of pathway risk analysis. This portion of pathway assessment requires risk experts perform science-based risk analysis of invasive species via common criterion. 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.

3. RISK ANALYSIS VIA SURVEY QUESTIONNAIRE

CAPT is to ensure each question is answered (again, a single/consensus response in whole numbers). 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.

Critical to these processes, also, is the documentation of decision uncertainties. 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 flaws in methodology, 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.

Completing the Risk Questions. The following section contains the risk assessment portion of pathways prioritization. Expert(s) are to review the questions, determine the level of risk posed by the pathway and assign a single, whole number between 1-10 to each question.
Question 1: What is the level of risk of this pathway introducing invasive species on a frequent basis? (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; moderate is 5 or more that have caused serious economic impacts on (i.e., failure of) major industries; low is 2 or more introduced invasives that negatively impacted 2 or more ecological niches).

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<tr>
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Question 2: What is the level (0-5) of risk of this pathway transmitting a large number of different viable invasive species? (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).

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Question 3: What is the level of risk (0-5) of this pathway transmitting a large number of viable individuals per invasive species? (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. Zero is ‘no risk’ infers no specimen survival.

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Rationale
Question 4: Based on the specific invasive species transmitted via this pathway, what is the relative level of risk (0-5) of this pathway introducing invasive species into hospitable ecosystems or habitats? Frame of Reference: Level 5 = exact ecosystem match with IS’ natural habitat; plentiful food sources, no predators or ecosystem controls. Zero (0) risk is when environmental factors preclude IS establishment.

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Question 5: To what degree does the pathway’s own ecosystem enhance the viability of and opportunity for transmission of invasive species? (Frame of Reference: Level 5 equals 100% likelihood of invasive species survival due to hospitable pathway ecosystem. Level 1 equates to pathway that by nature (i.e., travel through arctic climes) will result in invasive mitigation.

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Question 6: What is the level of risk (0-5) of this pathway introducing invasive species at multiple entry points? (Frame of Reference: Level 5 infers multiple entry points (4 or more) that expand across CONUS; Level 1 infers single, localized entry point.)

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Question 7: What is the level of risk (0-5) of this pathway for transmitting invasives, based on standard treatment measures? (Frame of Reference: Zero (0) level indicates all IS are dead upon arrival; 3 = most (60%) of the IS are still reproductively viable; 5 = 100% IS are alive, have expanded populations, colonies or enhanced invasiveness capabilities).

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Question 8: What is the level of risk of this pathway to assist spread of invasive species to uncontaminated shipments during transport or storage? (Frame of Reference: High reflects a pathway that comingles multi-source vectoring agents with multiple dissemination points (i.e., multi-source, co-mingled wood packing materials in cargo hold with multiple dissemination points. Low equates to no cross-contamination or spread)

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Rationale
Question 9: What is the level of risk (0-5) of this pathway for transmitting invasives, based on current screening techniques? (Frame of Reference: A rating of zero (0) indicates that virtually all invasives are detected prior to or during transit. A rating of 5 indicates that there are no detection methods for the invasives prior to or during transit)

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Question 10: What is the level of risk of the pathway transporting an invasive species that is difficult to detect once in the ‘receiving point’ ecosystem? (Frame of reference: Zero (0) indicates that all invasives are detected immediately at the pathway endpoint. A rating of 5 indicates the species is/are so difficult to detect, there is a 100% likelihood they will be disseminated without detection)

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Question 11: What is the level of risk of this pathway transmitting invasive species that are capable of surviving in multiple habitats (i.e., are generalists)? *(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.)*

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Rationale
Question 12: What is the level of risk of this pathway transmitting invasive species into ecosystems conducive to natural spread? (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) invasives that are highly mobile; spread by wind, water; have high reproductive rates in multiple ecosystems)

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Question 13: What is the level of risk of this pathway transmitting invasive species that are further spread by human activities? (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.)

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46
Question 14: What is the level of risk (0-5) of the pathway introducing invasive species that are known to be invasive in similar ecosystems but are not yet in the U.S.? (Frame of Reference: Zero (0) = the pathway transmits no compatible IS; 3 rating = transmits invasives that are in some, not all, U.S. ecoregions, but are not yet present in the pathway endpoint ecosystem. Level 5 infers the pathway transmits viable IS into pristine ecosystems).

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Question 15: What is the level of risk of this pathway transmitting invasive species that are novel and have limited scientific data upon which to develop control methods? (Frame of Reference: Zero (0) indicates there are comprehensive control options to mitigate all invasives transmitted. Level 5 indicates there are no existing control options.)

<table>
<thead>
<tr>
<th>Level Nbr</th>
<th>Level Descriptor</th>
<th>Level Determination (i.e., 0,1,2,3,4,5,6,7,8,9 or 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 0</td>
<td>No Risk</td>
<td></td>
</tr>
<tr>
<td>Level 1-2</td>
<td>Extremely Low Level of Risk</td>
<td>Assign a whole number:</td>
</tr>
<tr>
<td>Level 3-4</td>
<td>Moderately Low Level of Risk</td>
<td></td>
</tr>
<tr>
<td>Level 5-6</td>
<td>Medium Level of Risk</td>
<td></td>
</tr>
<tr>
<td>Level 7-8</td>
<td>Moderately High Level of Risk</td>
<td></td>
</tr>
<tr>
<td>Level 9-10</td>
<td>Extremely High Level of Risk</td>
<td></td>
</tr>
</tbody>
</table>

Rationale

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

<table>
<thead>
<tr>
<th>Basis of Uncertainty</th>
<th>Check All Relevant</th>
<th>Uncertainty level (Assign whole nbr from 0-5 where 1= slightly uncertain; 5= highly uncertain)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaws in methodology</td>
<td></td>
<td>Rationale</td>
</tr>
<tr>
<td>Lack of expertise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of issue coherence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biological unknowns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insufficient information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Political impediments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other-Define</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Question 16: What is the level of risk of this pathway transmitting an invasive species in which existing control options are too expensive to implement? (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)

<table>
<thead>
<tr>
<th>Level Nbr</th>
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<th>Level Determination (i.e., 0,1,2,3,4,5,6,7,8,9 or 10) (Assign a whole number):</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>Level 1-2</td>
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<td>Level 9-10</td>
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</tr>
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Is there uncertainty regarding this rating? If so, please complete the chart below:

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<td></td>
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<td></td>
</tr>
<tr>
<td>Other-Define</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 (is the average of all per question ratings)

B. Review uncertainty ratings

C. Assign Final Pathway Risk Rating. Usually this score should be the same as the 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: ______________________________________
_______________________________________________________________________
_______________________________________________________________________
_______________________________________________________________________
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_______________________________________________________________________
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_______________________________________________________________________
_______________________________________________________________________
4. PATHWAY ASSIGNMENT TO SCALE OF INVASIVENESS

Based on the prior analyses, there are now 3 major factors upon which to assign a pathway to a scale of invasiveness: impact category (i.e., human health, economy or ecosystem impact), pathway ecosystem scope (i.e., from local to international range); and pathway risk. Using the charts below as an example, you may next assign a risk prioritization (on scale of 1-200) for the pathway. Example of these determinations follow:

Example 1: Ballast Water

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Pathway Scope</th>
<th>Pathway Risk Level</th>
<th>Risk Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – Human</td>
<td>V</td>
<td>4</td>
<td>194</td>
</tr>
</tbody>
</table>

Example 2: Wood Packing Material

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Pathway Scope</th>
<th>Pathway Risk Level</th>
<th>Risk Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>B – Economy</td>
<td>V</td>
<td>8</td>
<td>148</td>
</tr>
</tbody>
</table>

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.)

Ex 1: Ballast Water

<table>
<thead>
<tr>
<th>Impact Category</th>
<th>Pathway Scope</th>
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<td>194</td>
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</table>

Ex 2: Wood Packing

<table>
<thead>
<tr>
<th>Impact Category</th>
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<tbody>
<tr>
<td>B – Economy</td>
<td>V</td>
<td>8</td>
<td>148</td>
</tr>
</tbody>
</table>

See Next Page for Invasiveness Scale
**Procedure for Scale Assignment**

1. Assign Risk Impact Category (Row A, B, or C)
2. Assign Pathway Scope Level (Column Numerals V, IV, II, I or I)
3. Assign Pathway Risk Level (i.e., Risk Score of 1, 2, 3, 4, 5, 6, 7, 8, 9 OR 10)
4. Assign Corresponding Numerical Rank Order (i.e., integer between the numbers 50-200)

(This guide is not designed to assess any pathway receiving a score below 50)

**A Level:** Human Health Impact

|-----|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|

**B Level:** Economic Impact

|-----|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|

**C Level:** Ecological Impact

|-----|-------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|

**Outlier Range for Invasives with no harmful impact to human health, economy or ecology**

<table>
<thead>
<tr>
<th></th>
<th>50. X</th>
<th>49. X</th>
<th>48. X</th>
<th>47. X</th>
<th>46. X</th>
<th>45. X</th>
<th>44. X</th>
<th>43. X</th>
<th>42. X</th>
<th>41. X</th>
</tr>
</thead>
</table>

**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.
5. FINALIZING THE ‘THIRD-CUT’ ANALYSIS

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 Invasive Species.
THE RISK ANALYSIS REPORT

1. REPORT COMPONENTS.

The ‘bulk’ of the report-out should have been accomplished via the previous steps. However, in review the components should be as follows:

- Agency-based multiple pathways list
- Multiple pathways threat list
- Experts List
- Single pathway(s) detailed consensus description
- Pathway consensus ecosystem scope determination
- Pathway-specific consensus invasives listings and definition
- Pathway Risk consensus survey questionnaire responses
- Pathway Risk scale consensus decision
- Specific recommendations or issues regarding uncertainty

As indicated, this report, in its entirety, will be provided to pathway decision/policy makers.

FROM SCIENCE TO PATHWAY POLICY

1. SITUATIONAL MODIFIERS

A critical of developing pathway prioritization is development of consensus scientific perspective to enable policy makers to effect quality decisions, networks, collaborations and allocations relative to invasive species management. Key factors 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.  

- Are there non-risk situational issues relative to invasive species that policy makers must take into account in the decision process? Such issues include:

  - Does the pathway transport invasives that are known to cause impact to human infrastructures (i.e., plant that lowers property values)?
  - Does the pathway transport invasives known to cause impacts to biologic/primary productivity/living industries (i.e., ecotourism, birding, aquatic recreation)?
  - 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)?

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2 Source: Arizona State University Consortium for Science, Policy and Outcomes, College of Liberal Arts and Sciences
Often there are no clear-cut responses to issues. However, creating a foundation of sound science will help ensure the best possible decisions, based on current knowledge, can be effected.

2. NISC, ISAC AND PATHWAY ANALYSIS

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

- **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.

- **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.

- **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 proposing international resource management approaches for invasive species pathways. The ultimate goal is to provide a NAPPO regional standards or guidelines on pathway evaluation.

3. INTERNATIONAL RESOURCE MANAGEMENT PROPOSAL

Based on discussions of the Pathways work team and readings in S. Andresen, & W. Ostreng, ed, *International Resource Management*, Belhaven Press, New York, 1989; and Dickson, David, *The New Politics of Science*, University of Chicago Press, Chicago, 1997, the Pathway Work Team Chair provided a proposal to NISC for international resource management. It is hoped with this will enable the collaborative development of pathway analysis methods and procedures on a global basis. The proposal follows below:
White paper: ³

A proposal to the North American Plant Protection Organization to enjoin with the U.S. National Invasive Species Council’s development and implementation of an international resource management approach for invasive species pathway identification, prioritization, risk-based analysis and collaborative policy decision-making.

³ Draft dated 5-6-06 pkriesch
The Proposal: The National Invasive Species Council (NISC), through its work with Aquatic Nuisance Species Task Force (ANSTF) and NISC Prevention Committee Pathways Work Team, has developed (and is further refining) a methodology for pathway identification, prioritization and risk-based analysis of unintentional invasive species introductions. The methodology combines the principles of scientific expertise and transparency with democratic policy development. The intent is to ultimately create a system using an international resource management approach (i.e., inter-agency and inter-governmental) for the definition, risk analysis and management of invasive species. We are requesting the North American Plant Protection Organization review current processes proposal and enjoin in the further development and implementation of this approach with all participant members.

Background Leading to Proposal. In June 2002, the U.S. Invasive Species Advisory Council to the President, through the National Invasive Species Council, established a discreet set of tasks for the prevention, interdiction and eradication of Invasive Species (IS) nationwide. This was put into effect via the National Invasive Species Management Plan. Comprehensive, the Plan addressed all aspects of IS challenges throughout the U.S. This proposal centers upon the tasks which called for U.S. Federal, state governments, private industry and academia to accomplish the following:

1. Devise a common methodology to interdict pathways that are recognized as significant sources for the unintentional introduction of invasive species;
2. Implement a process for identifying high priority invasive species that are likely to be introduced unintentionally and for which effective mitigation tools are needed;
3. Implement a system for evaluating invasive species pathways and ranking those pathways that it believes are the most significant; and
4. Define the most useful tools, methods, and monitoring systems for identifying pathways, including emerging or changing pathways, and for intervening and stopping introductions most efficiently.

The Proposal Specifics. The proposal blends qualitative expertise, academic research and quantitative data analysis via a democratic process to reach consensus analysis and decisions regarding pathway definition, risk levels and action planning.

1. Triage: Stage one requests participating entities respond (from their individual perspectives) to the basic question: “How do we prioritize resources dedicated to the mitigation of unintentional introduction of invasive species in light of multiple competing pathway interests and yet-to-be-determined pathway risk levels?” This is done via a two-fold process. First, participating entities are requested to review pathway schematics to determine the IS pathways for which they have a vested interest. Second, they are asked to prioritize those pathways based on existing academic knowledge of the threats the pathways pose to human health, economy and ecological threats

2. Scope: Stage two addresses the definition of the scope (i.e., breadth of potential contamination) of the pathway via definition of pathway characteristics, ecological clime contact points and invasiveness potential. Again, analysis is from the individual entity perspective and results in a ‘rough cut’ distribution of severity of all pertinent pathways.

3. Individual Entity to Consensus Risk Assessment. Individual entities are then asked to complete a risk assessment of the pathway, using a series of guide questions and available datasets, to support the determinations. These independent assessments are then used in
inter-agency/government/academia focus groups to create a single consensus risk decision for the pathway.

4. **Situational Modifiers.** Sound science was used for determining the IS risk analysis. But stage 4 permits the blending of science with situational (or socially-based) modifiers. These modifiers give opportunity to ensure the ultimate decision makers are aware of and given opportunity to address non-scientific, relevant social issues that may impact policy action. Such issues include the following:

- human infrastructures (property values);
- biologic/primary productivity/living industries (ecotourism);
- political/public sensitivities (sensationalism, i.e., ‘killer bees’)
- uncertainty factors (i.e., incomplete science affecting analysis, etc.)

**Proposal’s Visioned Outcomes.** The outcome of the process is a common, global definition and perspective of particular IS pathways and they risks that they pose relative to specific invasives. The intent is for this to be a ‘fluid, evolving’ process wherein pathways will be continually re-evaluated due to changing risk. The analysis should serve as common ground for all entities to then decide on common areas of interest, areas of needed expertise, areas of potential collaboration and cooperation, gaps in existing regulatory oversight and sharing of research, datasets and ideas for IS management

**NAPPO Involvement.** NAPPO involvement is requested as this stage, prior to solidifying final methods, to devise, accommodate and incorporate aspects relevant to international collaboration that may not have been evident in domestic analyses. NAPPO participation would require the below:

1. Proposal Infrastructure: Designation of Pathways ‘team captains’ in Canada and Mexico to participate in IS Pathways analysis, prioritization and planning implementation
3. Data Analysis: Participation in the development of methods and systems to used to create North American benchmark datasets relative to IS introductions/spread. This would include use of predictive statistical modeling for anticipatory response
4. Training: Cooperation in bilingual training delivery to vested stakeholders in IS pathways analysis and risk management
5. Policy: Development of international consensus for transparent, science-based NAPPO IS policies
6. Cadre: Establishment of international nodes of IS expertise
7. Quality: Establishment of uniform, quality standards for IS analysis
8. Communication: Creation of IS communication network

**Future Vision:** The vision of this proposal is to develop a method for continual interagency, inter-governmental, science-based collaboration and policy planning for predicting invasiveness and developing North American regional position and management plan. It is anticipated this would lead to better management of resources, the ability to create short and long term regional targets, action planning with consideration of political and situational elements. Ultimately, it could serve as a democratic strategy for furthering IS science and policies relevant to regional trade activities.
This training guide is in still in draft form. 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