Executive Summary of the Invasive Plant Electronic Discussion

Introduction:

The Invasive Plant Electronic Discussion (IPED) was initiated by the Animal Plant Health Inspection Service within the United States Department of Agriculture (USDA-APHIS). Regulations for imported plants for planting and propagation (7CFR319.37), commonly referred to as Quarantine -37 (Q-37) regulations, are currently being revised by the Commodity Imports Analysis & Operations (CIAO) Branch within Permits, Registrations, Imports & Manuals (PRIM). The IPED website was developed, and hosted by APHIS. Notification of the public discussion was announced in the Federal Register on November 13, 2006. The IPED website was open for comments from November 27, 2006 to February 28, 2007. The primary objective of IPED was to initiate a public discussion on scientific methods used to evaluate the potential invasiveness of imported plants into the USA.

Prior to opening the website in November 2006, several notices were sent to the Weed Science Society of America and the Ecological Society of America as an announcement to their membership. In addition, an email listing was generated for many of the published invasive plant ecologists and scientists, which were then given advance notice of the IPED discussion. The general public and all interested parties could submit comments and attachments, after they registered on the website with their name and email address. Written comments could be submitted as a postal mail option if access to the IPED website was a technical problem.

The IPED discussion was an exchange of ideas and information about methods for screening or developing predictive models for plant invasiveness. There were seven questions listed on the IPED website. Anyone could submit comments and attachments for the posted questions. All comments were monitored for profanity or nonsensical responses, and then posted for next day viewing on the website. The comments are useful in administering the APHIS Noxious Weed Program and the revision of nursery stock quarantine regulations.

Regulatory history

The Animal Plant Health Inspection Service (APHIS) is charged with regulating agricultural trade for imported and exported plant material. In December, 2004 APHIS initiated the process of revising nursery stock regulations by publishing an advanced notice for proposed rulemaking in the Federal Register [69 FR 71736-71744, Docket No. 03-069-1]. The overall revision and implementation of the nursery stock quarantine regulations in 7 CFR part 319 may take as long as ten years to fully complete.

Under the Plant Protection Act (7 U.S.C. 7701-7772 et seq.) the Secretary of Agriculture has delegated the responsibility of regulating “noxious weeds” to APHIS. A noxious weed is “Any plant or plant product that can directly or indirectly injure or cause damage

to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment." In order to determine if a weed meets this definition APHIS conducts a Pest Risk Analysis (PRA) which also includes a risk assessment for invasiveness. The regulatory definition for an invasive species is given in Executive Order 13112 which states an invasive species is: 1) non-native (or alien) to the ecosystem under consideration, and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. If the PRA indicates a potential for invasiveness for a candidate plant species it is then listed on the federal noxious weed list. Proposed revision of the nursery stock quarantine regulations includes a new category of plants whose importation is not authorized pending pest risk analysis that is based on scientific evidence of invasiveness potential.

In 2001 APHIS commissioned the National Research Council to establish the Committee on the Scientific Basis for Predicting the Invasive Potential of Non-indigenous Plants and Plant Pests in the United States to draft a report on invasive plant issues. The objective was to evaluate the state of knowledge about invasive plants, and the scientific ability to predict plant invasiveness. The report, published as a book, states that the best predictor of plant invasiveness is whether the plant has a global history of weediness. The authors concluded that there is no reliable method currently available to accurately predict the potential invasiveness for species, especially if they have an unknown history of weediness. The committee recommended that controlled experiments are needed to screen candidate species with an unknown invasive history. Finally, the committee concluded that predicting plant invasiveness could be improved with experiments designed to quantify exotic plant responses to stochastic environments that they would encounter when imported.

The IPED responses were divided into five categories of professional interest. The commercial categories consisted of people, business, and organizations that supported the sale or provided a service for imported plants. The conservation category consisted of individuals and organization dedicated to land and plant preservation. The general public category consisted of individuals identifying themselves as private citizens and those for which no affiliation could be found. The government category consisted of federal and state employees. Finally the research category consisted of those in academia with no known ties to conservation or commercial organizations.

Question 1. *What criteria, other than whether the plant has a history of invasiveness elsewhere, are most useful to determine the invasiveness of a plant introduced into the United States for the first time?*

Question one received 35 responses. Of these comments only twelve listed specific criteria that may be useful for predicting invasiveness. Of the total 35 responses, nine were from commercial interests, three from conservation interests, nine from the general public, nine from government, and five from researchers. Only one response from the University of Nebraska offered a brief methodology for developing an efficient screening method for plant invasiveness. Highlights from some of the responses are listed below.

Commercial

- Plant invasiveness can not be predicted prior to it becoming invasive in its new environment.
- Definitions for plant invasiveness are too vague and ultimately difficult to quantify and measure.
- Plant invasiveness is a function of plant properties, environment, and human activity, and these factors should be integrated into a screening system.
- Efforts for preventing entry of invasive plants should be redirected on improved methods of early detection and eradication of any future invasions.
- A holistic screening method is needed to include all invasive variables.
- APHIS should network with taxonomic specialists that have gardening experience at the genus level to assess invasiveness potential.
- Regulations that are too strict or inflexible will lead to smuggling horticultural plants of interest.
- APHIS should develop a list of foreign agencies that issue phytosanitary permits for easy access by commercial interests.
- APHIS should network with horticultural societies, botanic gardens, and nursery associations to form a clearinghouse of invasive plants.
- Many new horticultural specimens are extremely difficult to identify, and may only be identified at the family or genus level.
- Lack of evidence for invasiveness should be included in a screening system.

Conservation

- Validation of the Australian WRA with Florida data shows that 97% of unknown plant species would be correctly accepted as non-invasive, and 67% would be correctly rejected as invasive (98% of all invaders were correctly rejected).
- Screening models should include the question of whether a species was invasive elsewhere in the world, as well as questions concerning whether the climate/soils in the new region would support the species.
- A New Zealand study shows that 20% of their invasive plants do not have a history of invasiveness elsewhere in the world, thus additional variables are needed to predict invasiveness for species with an unknown invasive history.
- The Australian WRA model is available at http://www.daff.gov.au/ba/reviews/weeds/system.
- Biological criteria should include: reproductive and dispersal characteristics, mean seed mass, juvenile period, mean interval between major seed crops, relative growth rate, flowering/fruiting phenology, seed dispersal, and size of native range.
- The Nature Conservancy recommends that APHIS incorporates a modified version of the Australian WRA system into the revised screening process for Q-37 regulations.

General Public

- Potential screening models should have a "false positive" rate, or mistaken exclusion of noninvasive plants, of no more than 1%.
- Horticultural sales in Oregon are $778 million a year. Nursery and landscape industry in the USA employs over 600,000 workers during peak seasons. Grower cash receipts are increasing at approximately $500 million per year. Nursery and greenhouse crops are the top five commodities in 27 states and the top 10 commodities in 42 states.
- Specialty seed suppliers such as Silverhill (South Africa) and Nindethana (Australia) offers seed catalogs for horticultural species, which portends that many listed species may already be present within the USA.

Government

- Invasive criteria should include: easy to propagate, vegetative reproduction, high germination rates, seed dispersal by air, water, animals, or edible fruits.
- Other predictors are self-compatibility, growth form/life history types, root-shoot ratio, and specific leaf area.
- The United States Geological Survey and the USDA- Cooperative State Research, Education, and Extension Service (CSREES) have collaborated on two regional, invasive plant surveys. Websites for these projects are at: www.gri.msstate.edu and www.NIISS.org.
- North Carolina horticultural/landscape industry grosses $8.6 billion per year, and the industry employed 155,000 jobs in 2005.
- The North Carolina Nursery and Landscape Association supports science-based criteria to evaluate plant invasiveness.

Research

- Environmental factors are critical predictors of invasiveness.
- Biological factors include: specific leaf area, root/shoot ratio, self-compatibility, life history, vegetative reproduction, and presence of seed size/shape variability.
- Non-invasive plants generally have low levels of performance plasticity.
- Use of plant should be included in screening process.
- Screening systems should not be configured at the national level, but designed and configured at state or regional levels because tropical plants will not survive in most northern states.
- Decision tree model by Dr. Reichard had 18% false positive results for non-invasive classification tests, while the Australian Weed Risk Assessment model had 10% false positive results for the non-invasive species test. The percentage of species classified for "further evaluation" was 36% and 29% for the Reichard model and WRA model, respectively.
- A tiered system should be used to predict invasiveness, with progressive, science-based filters to classify plants as "acceptable", "need further assessment", or "unacceptable".

- Spatial risk models, population models, robustness analysis, decision theory, economic analysis, and ecophysiological models should be components of a tiered screening system.

Question 2. *When there is little or no existing scientific literature or other information describing the invasiveness of a plant species, how much should we extrapolate from information on congeners (other species within the same genus)?*

There were 19 responses to this question, and 18 of these responses suggested that we should not extrapolate invasive information from congeners, or other species within the same genus. A few comments suggested that invasive information about species within a genus may be used to focus more attention on any unknown species. The majority of responses agreed that risk assessment should be done on an individual species basis. The one response that thought extrapolation from congeners was okay argued that plants within a genus may be able to cross pollinate and create hybrids that could be invasive.

Commercial

- Many commercial species have congeners that are invasive, including orchids and honeysuckle. Future regulations based on taxonomic relatedness may negatively impact important commercial species.

Conservation

- A study that validated the Australian Weed Risk Assessment model for Florida species found that 20% of the 49 questions (14 questions) were related to congeneric issues. When the researchers deleted the 14 questions and reran the model the overall results were not different from the full model including the 49 questions. Thus, they found little evidence that information on invasiveness for taxonomically related plants could be extrapolated to other species within a genus with an unknown invasiveness history. Another response cited an article by Rejmanek et al. (2005) that taxonomic relationships within the Pinaceae family were not as reliable a predictor of invasiveness as the biological parameters associated with each species.

Research

- There are no objective standards for defining genera, and many genera have widely different species. Each species should be evaluated on its own potential for invasiveness, even if the majority of its congeners are invasive.

Question 3. *What specific scientific experiments should be conducted to best evaluate a plant's invasive potential, thereby providing conclusive information for a regulatory decision?*

There were fourteen comments to this question, and eight of these comments gave at least one suggestion on the type of experiment needed to evaluate plant invasiveness. In general, the comments ranged from absolutely no testing to paper risk assessments with limited testing to fill in the gaps, or rigorous testing within the different regions of the

USA. Several comments suggested that regional testing centers be established with state universities, or the USDA - Natural Resources Conservation Service so that diverse soil, climate, and biotic environments could be incorporated into the experiments. The EPA sponsors the IR-4 program that develops data to register pesticides for minor crops. Such a program could be used as a model system to develop data on unknown plant species for invasive potential.

Commercial

- APHIS should rely on private collector and horticulturist expertise.
- Experimental testing should be under "real world conditions" across a variety of environmental conditions instead of uniform greenhouse trials.
- Risk assessments should be based on current literature, with limited testing.
- New plant accessions with an unknown invasive history may be classified as 'evaluate further", resulting in experimental testing for many new introductions.

Conservation

- Only plants with "evaluate further" status or contested classification should be tested.
- Experimental testing should be conducted where plants are already present, or in native countries.
- Greenhouse trials may not produce accurate plant growth/reproductive properties.
- Ensuring low risk of propagule escape is critical during experimental testing.
- Most species can be screened with current information collected from all available literature.
- Avian testing should be conducted in aviaries or other animal containment facilities.
- Plants should be tested for their reproductive properties in a variety of soils.
- Testing protocols should be developed for a variety of plant growth forms, and cover a three year growing period.

Government

- A database should be developed for grasses, forbs, vines, ferns, shrubs, trees, etc that includes biological parameters for phenology, morphology, physiology, fecundity, and genetics.
- Biological parameters should include relative growth rate, root/shoot ratio, percent germination, repeated resprouting ability, leaf decomposition rate, seed size, specific leaf area, and nitrogen/water use efficiency
- Phenotypic plasticity is generally higher for invasive versus native species.

Research

- Plants should be tested for their competitive ability and resource use efficiency under low nutrient/water conditions.

- Previous plant invasiveness analysis, based on meta-datasets, is generally based on observational data. Plant plasticity to resources is a critical biological parameter.
- Plants should be tested for susceptibility to insects and diseases that are native to the USA. Also, plants should be tested for competitive ability against native species.
- Plants should be tested for beneficial properties.
- Experimental testing should be multi-year, and standardized across testing centers, which may include NRCS, botanic gardens, or universities.
- Experimental tests should include avian transport, soil types, moisture and fertility gradients, and hybridization potential.
- Experimental screening for plants with an unknown invasive history could be modeled after the EPA system for registering pesticides, where chemical companies are responsible for generating data for a risk assessment.

Question 4. *How should the results of the experiments from question #3 be interpreted?*

There were a total of eight comments to this question. Several responses stated that it would be "impossible" to develop scientific experiments to predict plant invasiveness.

Commercial

- There is no reliable science-based method that could accurately predict plant invasiveness at the national level.
- It is very difficult to prove that a plant is not invasive. Regulations should be flexible enough to allow importation of plants with a wide range of properties.
- None of the definitions have precise terms, and are value-based.
- Regulations should be "open minded and guided by as much information as possible".

Conservation

- Experimental data should be incorporated into a screening system such as the Australian WRA to produce a final risk assessment.
- Species with unknown invasiveness properties should be experimentally tested at the request of the importer, followed by a final risk assessment.
- APHIS should periodically monitor imported plants for invasiveness.

Government

- Experimental data should be interpreted at the eco-region level within the USA. Species may be invasive if environmental conditions are suitable.

Research

- Invasiveness should have three classes: high, medium, and low risk potential.
- High and medium risk plants should not be imported, and low risk plants should be sold under specified limits per year for designated climates.

Question 5. *If field trials are necessary to determine the invasive potential of a plant, under what conditions should the research be conducted to prevent the escape of the plant into the environment?*

Question five received nine responses. Five of the nine responses were from commercial interests, two from conservation interests, and two from government interest. Highlights from some of the responses are listed below.

Commercial

- Plant candidates should be screened for sensitivity to generalist insects and diseases within the USA to determine potential for natural control mechanisms if imported.
- Enlist hobbyist or specialist growers to determine potential invasiveness.
- Field trials are the only way to determine tendencies for plant invasiveness.
- Climate matching should be considered because it is impossible to conduct field trials in all the different climate regimes in the United States.
- It is impossible and impractical for APHIS to predict invasiveness over the entire United States. APHIS should consider increasing public awareness about invasive species.
- Ultimate prevention is impossible unless a plant has no reproductive potential. County-level is the only way to have effective screening through field trials.

Conservation

- The plots and surrounding areas should be monitored to ensure control of delayed germination from dormant seed banks.
- Animal/wind seed dispersal, cross pollination with nearby taxonomically related plants, and non-sexual, propagule dispersal should be the three main escape vectors for developing prevention, control, and monitoring protocols. Otherwise, plots could be fumigated or deep plowed.
- Experimental tests should be conducted with dedicated facilities to ensure adequate monitoring, and such facilities should be at least regionally based.
- Protocols for field studies should be modified for plant type and seed dispersal patterns.
- Protocols should follow Canadian guidelines developed for genetically modified plants.
- Experimental gardens should have barriers above and below ground, and screens should not prevent potential pollinators.

Government

- APHIS offered a one-page set of standard operating procedures for preventing propagules escape from invasive weed experimental plots established within the USA (https://qp01.aphis.usda.gov/QuickPlace/iped/Main.nsf/h_Toc/47B91A2AC603E03405256708001672 01/?OpenDocument).

- Experimental field gardens be enclosed with screening, and/or prevent animal/wind dispersal of fruits and seeds.
- Seed production could be prohibited by clipping mature flowers, or using hormone sprays.
- Seed escape could be prohibited by netting individual flowers or seed cluster.
- Field trials should be conducted over the long-term to detect any time lag factors that may affect plant invasiveness
- Field trials could be conducted at the 27 USDA-Natural Resources Conservation Service Plant Materials Centers distributed across the USA to provide data for intended usage and adaptation to regional climate, soil and biotic factors.
- Excess preventative measures for flowering may alter normal growth patterns for unknown plants.
- Most states have cooperative extension facilities that could be used to screen for plant invasiveness in controlled field trials.

Question 6. *What models or techniques are being used by the nursery industry, weed scientists, seed companies, botanical gardens, and others to screen plants that have not yet been widely introduced into the United States for invasiveness? What species have been rejected for introduction as a result of the use of these evaluation methods?*

Question six received nine responses. Several comments mentioned the Australian WRA, ARS research techniques, or nursery protocols, or even individual hobbyists procedures for testing for invasiveness. Except for the comment from USDA-NRCS, there were no comments with detailed explanations for nursery testing techniques for plant invasiveness. The comment from NRCS included a seven-page attachment entitled "Environmental Evaluation Process" form that their National Plant Materials Program uses for all plant selections. They evaluate all species for invasiveness, along with suitability assessments for their soil erosion, reclamation, and soil conservation programs. The NRCS plant invasiveness evaluation form is located at: https://qp01.aphis.usda.gov/QuickPlace/iped/Main.nsf/h_Toc/47B91A2AC603E0340525670800167201/?OpenDocument) under Question 6, comment 10. Highlights from some of the responses are listed below.

Commercial

- Many horticultural societies have small memberships, and imported seed lots for individuals would be in small quantities.
- A mechanism for sharing invasive plant information between hobbyists, nurseries, botanic gardens, and private growers needs to be developed.
- Individual hobbyists have extensive experience with uncommon ornamental plants and APHIS should develop a clearinghouse program to use these experts as a resource.
- A nursery screening technique includes literature searches and observation over multiple seasons and climates. Well-documented evidence of invasive tendencies and species with large numbers of persistent volunteer seedlings are considered high risk.

- Many plant accessions have demanding plant growth requirements that preclude them from high risk of invasiveness.
- The horticultural industry has dramatically increased its awareness and concern for invasive plants, and has contributed funding for research involving plant invasiveness. An ARS scientist has collaborated with the Chicago Botanic Garden to develop a regional screening model for plant invasiveness.
- APHIS may want to create incentives to encourage horticulturist to report suspected invasive tendencies in their plants.

Conservation

- The Nature Conservancy proposed that APHIS adopt the Australian WRA model into the revised Q-37 regulations for imported plants.
- The Australian WRA model has been validated under a wide range of geographic and environmental conditions, and was found to have high accuracy in predicting true plant invaders.

Government

- APHIS mentioned that the Australian WRA systems lacks a major component of risk analysis, the "likelihood of introduction", which is required by IPPC agreements.

Question 7. *Do you have any comments on the subject of evaluating plants for invasiveness that were not addressed by the previous six questions?*

Question Seven had thirty seven responses. Eighteen of these responses were from commercial interests, four from conservation interests, five from the general public, five from government interest, and five from research interests. Question seven was a "catch-all" question for any generic comments related to screening methods for invasiveness. The first five comments further defined the term "invasive species", as applied to regulatory issues. In general, regulatory definitions include assessments for injury to human health, ecosystem damage, or animal/wildlife injuries. Also regulatory and ecological definitions may not contain the same underlying criteria for assessing invasiveness. Highlights from some of the responses are listed below.

Commercial

- The discussion started by asking how APHIS defines "invasive".
- Executive Order 13112 uses vague terminology such as "could cause harm to the environment" or "not native to the ecosystem", which is problematic for writing defensible regulations for screening plants for invasiveness.
- Many plant species cannot be accurately indentified without flowers, which limit plant exploration and collection to flowering times, or expensive DNA analysis.
- A horticultural company suggested that a coarse screening model would be the best regulatory approach due to uncertainty in the science behind predicting invasiveness. Also, more funds and manpower should be devoted to early

detection and rapid response for the few plants that become invasive after importation.

- There are many pathways for plants to be accidentally introduced by individuals, or agricultural products such as contaminated feeds or hay, thus screening imported plants will not stop this type of introduction.
- Screening methods should include the economic benefits as well as potential risk of invasiveness to provide a balanced assessment for imported plants.
- Plant enthusiasts argue that collectors and botanic gardens act as conservators for rare plants, and preserve diversity of gene pools for many endangered species.
- A response questioned how imported plants could be assessed and categorized as "Not Authorized Pending Pest Risk Analysis" if scientists have not agreed to the overall mechanisms that cause plant to be invasive.
- The American Nursery and Landscape Association commented that regulations based on zero risk would be an impossible goal. Also, excessive regulations would drive plant introductions underground, which nullifies the screening process.
- APHIS should produce documents reporting the number of ornamentals that have become invasive and caused damage within the USA, or prove the assumed premise that imported plants pose a significant risk of invasiveness.
- The intended use and amount of plant material imported should be assessed so that use categories would allow small plant enthusiasts and collectors flexibility in obtaining permits for low use plant species.
- APHIS should implement a voluntary system for all commercial parties involved with screening imported plants.
- Expensive screening procedures would eliminate smaller plant societies, hobbyists, collectors, and botanic gardens that tend to run on shoestring budgets.
- Foreign phytosanitary certificates should be eliminated due to limited plant identification expertise. All inspections should be done at port of entry within the USA.
- Regulations will affect the efficiency of introducing plants.
- Accurate identification of uncommon ornamentals, hybrids, cultivars or plant varieties by botanists with knowledge at the genus or species level is still a very common problem. The USDA has no global database for rare plants, or ornamental plants bred as cultivars or varieties.
- Many trees, shrubs, forbs and grasses used for city and park landscapes have the growth characteristics of invasive plants, in that the plants can endure harsh growing conditions. Beneficial uses of plants should be included in risk assessments.
- Screening methods should be flexible to include new scientific evidence for invasiveness, motivates innovative solutions, allows regulatory appeals, and creates a decentralized clearinghouse for plant invasiveness.
- A response stated that the cost of assessing the invasive potential of imported plants should be borne by the commercial parties interested in importing that species.

- The "overwhelming majority" of horticultural plants have not been invasive, and many invasive plants have been introduced accidentally. The horticultural industry strives both to protect the environment for detrimental plants and to improve the environment by introducing useful plants.
- Several comments suggested that plant invasiveness is a function of environmental conditions (climate, soil, native biota), so regulations should be based on regional environmental conditions. Also, regulations may be slow and cumbersome relative to the commercial trade expectations.
- The climates of Florida and Hawaii are so conductive for aggressive plant growth that regulations based at the national level would be overly restrictive for most species.
- Stringent regulations will lead to illegal importation of plants.

Conservation

- Refine the Australian WRA process to reduce the number of plants falling into the "further evaluation" category, and reduce the number of false positives.
- The Nature Conservancy supports the definition of the US federal agencies executive order of an invasive species.
- A recent economic publication of the Australian WRA shows that their imported plant prevention program would paid for itself within 10 years, and save up to $1.8 billion over 50 years.
- The Nature Conservancy argues that the planned implementation of the Q-37 revisions over a ten-year period is too long, and requests an expedited process.
- Validate the Australian WRA model with independent datasets for trees, shrubs, vines, forbs, ferns, and grasses.
- Federal and state agencies, horticultural societies, weed societies, and botanic gardens should form partnerships to collect invasive plant information.
- Create an international database for invasive plant information that is accessible for risk assessments.

General Public

- Australian regulatory climate is much more inclined to limit imported species and prevent another invasive plant than the USA regulatory climate.
- Citizen scientists should have an organized, website to report findings for volunteer field surveys, such as Invasive Plant Atlas of New England (IPANE).
- When an invasive species displaces a native species, is that evidence of "injury to the environment"?

Government

- USDA-APHIS-PPQ offered invasive plant definitions for Executive Order 13112, along with several international regulatory definitions and a published set of ecological definitions.
- The Massachusetts Aquatic Invasive Program offered a working draft of their "Species Evaluation Questionnaire".

Research

- Biotechnology research could be used to reduce plant fertility, or produce sterile hybrids, thus dramatically reduce the potential for invasiveness.
- Regulatory costs and intellectual property costs may limit the use of GMO sterilization methods for many proposed plant imports.
- There is a lack of science that proves or disproves whether a plant is invasive. List of potential invasive plants should include the input from many specialists from around the United States.
- New Zealand requires expensive fees to conduct a risk analysis for a proposed plant species for importation. Such fees can run from $21,029 to $45,563 per species.