2008 Farm Bill: Plant Pest and Disease Management and Disaster Prevention Provision.

Comparative Risk Assessment for the 50 U.S. States

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Section 10201

In May, 2008, *H.R. 6124 Food, Conservation, and Energy Act of 2008*, otherwise known as the Farm Bill, became law. In *Section 10201, Plant Pest and Disease Management and Disaster Prevention*, the Secretary is directed to make available Commodity Credit Corporation (CCC) funds for early detection and rapid response of pest threats. The 5-year Farm Bill specifies that these funds are to be made available incrementally, starting with $12 million in FY09, $45 million in FY10, and $50 million in FY11 and thereafter.

Risk Assessment

The Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine (PPQ), Center for Plant Health Science and Technology (CPHST) has been charged with ranking the relative risk of the 50 states to exotic pest threats based upon risk factors including: i) the number of international ports of entry in the State; (ii) the volume of international passenger and cargo entry into the State; (iii) the geographic location of the State and if the location or types of agricultural commodities produced in the State are conducive to agricultural pest and disease establishment due to the climate, crop diversity, or natural resources (including unique plant species).

Method Overview

The Center for Plant Health Science and Technology routinely conducts risk analyses for imported commodities, organisms, pathways and newly detected pests. The risk assessment for the 50 U.S. states is based on a modified version of the Q-56 commodity risk analysis (USDA APHIS, 2003, Mack, 2002). The Q-56 risk analysis is based upon two risk elements i) Likelihood of Introduction; and ii) Consequences of Introduction. In the Q-56 guidelines, the Likelihood of Introduction is based upon the quantity of imported material and the chance that a pest will escape detection based upon biological characteristics of the pest. The Consequences of Introduction is based upon i) climate host interaction, ii) host range, iii) dispersal potential; iv) economic impact and v) environmental impact. The Q-56 risk analysis was modified to assess the risk of introduction of exotic pests by state, but pest specific criteria were removed. **The modified risk elements were the: i) Likelihood of Introduction; ii) Economic Impact; iii) Environmental Suitability and iv) Natural Resource Impact (Table 1).** The first three risk elements were each given a 30% weight. The Natural Resource Impact, since it was based on a single sub-element was given a 10% weight. Each risk element was composed of a number of sub-elements containing one or more variables.

Likelihood of introduction

The Likelihood of Introduction assesses the potential for a pest to enter a state based upon human mediated transport. The Likelihood of Introduction for each state was based upon i) importation volume; ii) recent pest history; iii) points of entry including the numbers of ports, border crossings and international airports, and iv) geographical location.

Importation volume

Importation volume was given a weight of 61% of the total Likelihood of Introduction. The introduction of exotic pests is tied strongly to the total volumes of imports (Baker et al. 2005, Le Maitre 2004, Mack 2002, Mack 2003, Taylor and Irwin 2004). The following pathways were considered as components of importation volume; agricultural and non-agricultural commodities for each of land, sea and air transportation, and air passengers (Table 1, 1A). Although agricultural commodities are at higher risk (Work et al., 2006) non-agricultural commodities are imported in high volumes. In addition, certain commodities such as tiles, machinery and cars are important pathways (Beckwith, 2004, Toy, 2007). Wood-based crating, dunnage, and pallets have been implicated as a major pathway by which bark- and wood-infesting insects have moved among countries (Pasek et al. 2000). Imports such as tiles, machinery, marble, steel, and ironware have been commonly associated with borer infested wood packaging material (Haack 2006). Passenger transit, including baggage, also accounts for pest introductions (Liebhold et al. 2006, Tatem, 2009). Although, imported plants for propagation are a major pathway for the introduction of plant pests (Reichard and White 2001), they were not considered separately but are considered as agricultural commodities.

In our assessment, we considered agricultural (HS 06-14) and non-agricultural imports by both sea and air from the USA Trade database. We also estimated the total tonnage of imports by land (rail and truck) based on the number of loaded containers using the Bureau of Transportation Statistics (BTS) database. Containers were converted to tons using a container payload of 26.7 tons. Additionally, we also considered agricultural imports using from the Freight Analysis Frame work (FAF) database. FAF captures regional distribution of imports by multiple modes (air/sea/land) more completely than the USA Trade database but provides dated information 2002, compared to 2008 for USA Trade. The pathway volume was converted into a risk value by multiplying the tonnage for each pathway (air/sea/land/all) by the number of actions per ton (also known as approach rate) for each commodity type (agricultural/non-agricultural) based on AQIM data (Table 1A).

We ignored the contribution of several other pathways including pedestrians and vehicles at border crossings because they are low tonnage and have shorter range dispersal. We also ignored mail and express couriers because these goods are likely to go to a destination addresses before packages are opened. Overall the maritime cargo for non-agricultural commodities made the greatest contribution (64%) to importation volume because of its high volume 2.4 x 10^8 ton, despite a low approach rate (2.95 actions per ton).

Past pest history

Past pest history was given a 24% weight for the total Likelihood of Introduction. Past pest history is important because it may indicate where future exotic pest incursions or detections will occur. However it is less important than actual trade volumes since trade flow patterns change with international economic conditions. Past pest history was an equal weighting of the number of recent instances of PPQ Emergency Action Notifications (EANs) issued and pest interceptions, by destination state.

Points of entry

The number of points of entry was given a 10% weight for the total Likelihood of Introduction. Although the number of points of entry is not as important an indicator of risk as volume, states with the greater numbers of points of entry will need more resources to intercept or detect the same volume of pests. The number of points of entry was based on the number of maritime ports receiving imports, the number of international airports (those with customs facilities) and the number of border crossings.

Geographical location

The geographic location of a state and its proximity to other countries is also an indication of the likely introduction of exotic pests by both natural and human mediated dispersal. We estimated the number of countries within a 1000 km radius of each state and this variable was given a 5% weight. The choice of 5% weight is based on the fact that natural dispersal accounts for only a small proportion of introductions. Human mediated dispersal is more efficient than natural dispersal, only a fraction of exotic species are able to disperse long distances on air currents and storms that promote long distance dispersal are sporadic events.

Economic impact

The Economic Impact was based upon the cash receipts for agricultural crop sales (USDA-ERS) and the total value of forestry products in each state (USDA-ERS).

Environmental suitability

Environmental Suitability was based upon i) climatic suitability; ii) crop acres; iii) forest acres; and iv) crop diversity. States with favorable or diverse climates, large crop or forest acres and diverse crops have a higher environmental suitability and need greater survey resources to protect against exotic species.

Climatic conditions in a state were estimated using products derived from the North Carolina State APHIS Plant Pest Forecasting (NAPPFAST) system (Magarey et al. 2007, Magarey et al. 2009). Climate conditions were based on a rating of the state's climate using: i) maximum hardiness zone; ii) number of hardiness zones; iii) length of growing season; and iv) moisture during the growing season (USDA-APHIS, 1997). Crop acres were obtained from the National Agricultural Statistics Service 2002 census of agriculture data. Forest data was obtained from the United States Forest Service, Forest Inventory and Analysis National Program Forest Inventory Data Online. Crop diversity was derived using the state total of the number of 116 NASS commodities grown in each state.

Natural Resource Impact

Natural resource impact was based upon the number of threatened and endangered species in each state according to Plants USA.

Analysis

Three of the risk elements: i) Likelihood of Introduction; ii) Economic Impact; and iii) Environmental Suitability were each given a 30% weight. The Natural Resource Impact, since it was based on a single sub-element was given a 10% weight. Within each risk element, the sub-elements were weighted as shown in Table 1. Each sub-element contained one or more risk variables which were weighted equally with the exception of importation volume where the weights were based on actions and tons (Table 1A).

The risk values for each variable was calculated as follows. Each state was assigned a 1-4 risk value for each risk variable with 4 being the highest risk and 1 being the lowest risk. (This allows risk variables with different units to be averaged for each sub-element.) For each variable, if the value for a state was less than the 25% percentile then it was assigned a value of 1. If it was between 25% and 50% then it was assigned a value of 2. If it was between 50 and 75% then it was assigned a value of 3. If it was greater than the 75% variable then it was assigned a value of 4. Exceptions were made for variables with a skewed distribution (due to frequent zero counts), in which case the maximum value was used to scale the data. For climate suitability, the risk values were assigned visually by an observer for each climate variable.

The next step was to calculate average values for each sub-element and risk element. These average values were multiplied by the sub-element and risk element weights shown in Table 1. The final average of the four risk elements was used to rank the states.

Results

In general, the highest risk states are those with large cities and busy ports or airports (Figure 1). They also tend to be located on the Atlantic and Pacific coasts or on the Great Lakes and perhaps share a land border with Canada or Mexico. Medium-high risk states have large or diverse agricultural or forest production. These states were not clustered in any geographic regions. They also tend to have large or diverse agricultural production and moderate or high populations. Next, the medium risk states had moderate agricultural production and low or moderate populations or high ecological impact. These states are predominantly in the Great Plains, Appalachia and the Gulf Coast. Finally, the low risk states generally had either low populations and/or low agricultural production such as those states in the North East, South West or Rocky Mountains.

Interpretation of risk

Since most pest introductions are the result of human activity, pest detection programs needs are expected to vary depending upon the risk rankings (Table 3). For example, states with high imports or passenger volumes should conduct targeted surveys of port environs, importers and redistributors (Self and Kay, 2005). These surveys have typically been conducted as part of the PPQ Targeted Detection Surveys (hotzone) program. In this program, port environs, rail yards and individual premises are targeted based on type of location, sales volumes and past EANs. An example is a survey of tile warehouses that resulted in many new pest detections in the state of Florida (Beckwith, 2004). Since live plants are an important pathway for exotic pests (Reichard and White 2001), the surveys might also need to target importing or distributing nurseries. Another need in the high risk states is to target agricultural and forest surveys in areas proximal to or within metropolitan areas. This is because these crop or forest land within metropolitan areas is the most likely to have newly introduced exotic pests (M. Colunga, Michigan State University, personal communication).

Engaging stakeholders

Despite the use of techniques to target surveys based upon human activity, it is not always possible to detect pests before they escape into agricultural or natural environments. Consequently, there is a need to survey the major agricultural and forest commodities. The CAPS program has established commodity surveys for major commodities such as soybean, oak and small grains. These survey programs allow scouts to look for multiple target pests during a single visit. One current limitation of the current PPQ commodity survey program is that there are millions of acres to survey in the moderate to high risk states. An option that should be deployed in these states is to build cooperative relationships with stakeholders including industry or professional groups (e.g. American Seed Trade Association (ASTA), Nursery associations, Master Gardeners, crop consultants) that allows for expanded data collection efforts. These cooperative programs would allow PPQ to utilize existing observation and diagnostic networks for exotic pest survey. In the lower risk states, surveys might be required to protect interest particular to that state, ecologically sensitive areas or to protect neighboring states.

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References cited

Baker R., R. Cannon, P. Bartlett and I. Barker. 2005. Novel strategies for assessing and managing the risks posed by invasive alien species to global crop production and biodiversity. Annals of Applied Biology 146: 177-191.

Beckwith J. 2004. A survey of tile warehouses in Florida. Gainesville, FL: United States Department of Agriculture, Animal Plant Health Inspection Service, Plant Protection and Quarantine, Cooperative Agriculture Pest Survey.

Haack, R.A. 2006. Exotic bark- and wood-boring Coleoptera in the United States: recent establishments and interceptions. Can. J. For. Res. 36: 269-288.

Le Maitre, D.C., D.M. Richardson, and R.A. Chapman. 2004. Alien plant invasions in South Africa: driving forces and the human dimension. South African Journal of Science 100: 103-112.

Liehbold, A.M., T.T. Work, D.G.McCullough, and J.F. Cavey. 2006. Airline Baggage as a Pathway for Alien Insect Species Invading the United States. American Entomologist. 52:48-54.

Mack, R.N. 2002. Predicting invasions of nonindigenous plants and plant pests. Washington, DC: National Academy Press.

Mack, R.N. 2003. Global plant dispersal, naturalization, and invasion: pathways, modes and circumstances. Pages 3-30 in Ruiz GM, Carlton JT, eds. Invasive species, vectors and management strategies. Washington, D.C.: Island Press.

Magarey, R.D., D.M. Borchert, and J. Schlegal. (2009). Global plant hardiness zones for phytosanitary risk analysis. Scientia Agricola 64:54-59.

Magarey, R.D, G.A. Fowler, D.M. Borchert, T.B. Sutton, M. Colunga-Garcia and J.A. Simpson. 2007. NAPPFAST: An Internet System for the Weather-Based Mapping of Plant Pathogens. Plant Disease 91: 336-345.

Pasek, J.E., H.H. Burdsall Jr., J.F. Cavey, A. Eglitis, R.A. Haack, D.A. Haugen, M. I. Haverty, C.S. Hodges, D.R. Kucera, J.D. Lattin, W.J. Mattson, D.J. Nowak, J.G. O'Brien, R.L. Orr, R.A. Sequeira, E.B. Smalley, B.M. Tkacz, and W.E. Wallner. 2000. Pest risk assessment for importation of solid wood packing materials into the United States. USDA/APHIS-FS, Washington, DC.

Reichard, S.H. and P. White. 2001. Horticulture as a pathway of invasive plant introductions in the United States. Bioscience 51: 103-113.

Self M., and C. Kay. 2005. Development of methodology for targeted post border surveillance for exotic pest incursions: Paper presented at the workshop on post-border surveillance for exotic pests of plants. Canberra, 7 & 8 June 2005.

Tatem, J. 2009. The worldwide airline network and the dispersal of exotic species. Ecography 32: 94-102.

Taylor, B.W. and R.E. Irwin. 2004. Linking economic activities to the distribution of exotic plants. Proceedings of the National Academy of Sciences of the United States of America. 101: 17725-17730.

Toy, S. 2007. Import risk analysis: Vehicle & Machinery. Bisoecuirity New Zealand. Website:www.maf.govt.nz

USDA APHIS U.S. Department of Agriculture Plant Health Inspection Service 2003. Guidelines for plant pest risk analysis of imported commodities. Version 5.1

Plant Protection and Quarantine, Biological and Taxonomic Assessment Team, Riverdale, MD.
Work TT, McCullough DG, Cavey JF, Komsa R. 2005. Arrival rate of nonindigenous insect species into the United States through foreign trade. Biological Invasions 7: 323-332.

Table 1. Risk elements for ranking U.S. states to exotic pest threats

Risk Element Sub-elements	**Weight**	weight	**Variable (Units)**	**Source**
Likelihood of Introduction	**30%**			
Importation volume (Table 1A)		61%	See Table 1A	
Recent pest history		24%	Total EANS from all sources 2006-2007 by destination state	PPQ unpublished data
			Total reportable interceptions by state for 2007.	PPQ PestID (restricted access)
Number of international ports of entry		10%	Number of maritime ports	U.S. Army Corps of Engineers (USACE) Principal Ports file for 2007
			Number of international airports	Federal Aviation Administration (Aeronautical Information Services, ATA-100)
			Number of land border crossings	Bureau of Transportation statistics. (BTS)
Geographic proximity		5%	Number of countries within 1000 km radius	ESRI Geographic data sets.
Economic impact	**30%**			
Economic impact		100%	Crop receipts ($) Forest products sales ($)	USDA-ERS
Environmental suitability	**30%**			
Climate suitability		50%	Maximum hardiness zone Number of hardiness zones Length of growing season (weeks per year) Moisture during growing season (%)	NAPPFAST (Restricted and public products)
Host range		50%	Total acres of commodities	USDA-NASS

Risk Element Sub-elements	Weight weight	Variable (Units)	Source
		Diversity of commodities	
		Forest acres	USFS FIANP http://fia.fs.fed.us/
Natural resource impact	**10%**		
Threatened and endangered plants	100%	Total number of threatened and endangered plant species	http:// plants.usda.gov

* Sub-elements within a risk element were weighted equally, as were multiple variables with an individual sub-element.

Table 1A. Calculations of risk by importation volume and actions based on AQIM

Pathways	Pathway data source	Pathway volume kton[1,3,4]	% Actions Per Ton[1]	% weight
Air				
Cargo –agricultural[2]	USA Trade	696	31.6	2.0
Cargo -non agricultural	USA Trade	6595	18.7	11.1
Air passenger	T-100	41380	4.2	1.6
Maritime				
Cargo – agricultural	USA Trade	19270	2.3	4.0
Cargo - non agricultural	USA Trade	240805	2.95	64.2
ALL				
Cargo –agricultural	Freight Analysis Framework	42817	2.3	8.9
Land				
Southern border	Bureau Transportation Statistics (BTS)	93482	0.09	0/8
Northern border	Bureau Transportation Statistics (BTS)	146621	0.6	7.4

[1] Metric tons

[2] HS codes 06-14 (Plant Products).

[3] Air passengers were converted to tons by assuming that each passenger with baggage plus person and personal possessions represented 0.1 ton.

[4] Containers were converted to tons by multiplying by 26.7 t based on the basis of 40'GP container at an industry website http://www.bslcontainers.com/products00.php. .

Table 2. Relative risk of U.S. states to exotic pest threats.

	High			Low
1	California	Arizona	Kansas	Kentucky
2	Texas	Oregon	Mississippi	Vermont
3	Florida	Minnesota	Colorado	Maine
4	Washington	Arkansas	Idaho	South Dakota
5	Illinois	South Carolina	Hawaii	Utah
6	Georgia	New Mexico	Maryland	Montana
7	North Carolina	Indiana	North Dakota	Massachusetts
8	Michigan	Virginia	Iowa	Nevada
9	Louisiana	Missouri	Oklahoma	Delaware
10	Pennsylvania	Nebraska	Wisconsin	Connecticut
11	New York	Alabama	Tennessee	Rhode Island
12	Ohio	New Jersey	Alaska	West Virginia
13				New Hampshire
14				Wyoming

Table 3. Comparison of recommended survey activities for U.S. states or areas by level of relative risk

Activity	High	Low
Targeted surveys of port/airport surveillance environs	XXX*	
Targeted surveys of importing/distributing warehouses	XXX	X
Targeted surveys of cropland/forest land in metropolitan areas	XXX	
Commodity surveys	XXX	X
Cooperative sampling with industry groups	XXX	X
Cooperative sampling with professional groups	X	XXX
Surveys targeting specific pests	X	XXX

* XXX = High need for activity, XX = Moderate need for activity, X = Low need for activity

Table 4. Risk rankings for states by alphabetical order

State		Intro. Likelihood	Economic Impact	Environ. Suitability	Natural Resource	Average	Rank
AK	Alaska	2.42	1.00	2.50	4.00	2.18	36
AL	Alabama	2.62	2.00	3.33	1.00	2.49	23
AR	Arkansas	1.22	3.00	3.67	4.00	2.77	16
AZ	Arizona	2.35	3.00	3.33	3.00	2.91	13
CA	California	3.78	4.00	3.83	4.00	3.88	1
CO	Colorado	1.37	3.00	2.50	3.00	2.36	27
CT	Connecticut	2.17	1.00	1.50	2.00	1.60	46
DE	Delaware	2.10	1.00	1.67	2.00	1.63	45
FL	Florida	3.87	4.00	3.50	4.00	3.81	3
GA	Georgia	3.71	3.00	3.50	4.00	3.46	6
HI	Hawaii	2.90	1.00	2.50	4.00	2.32	29
IA	Iowa	1.10	4.00	1.67	2.00	2.23	32
ID	Idaho	1.60	3.00	2.50	2.00	2.33	28
IL	Illinois	3.63	4.00	3.17	3.00	3.54	5
IN	Indiana	1.37	4.00	2.50	3.00	2.66	19
KS	Kansas	1.22	4.00	2.67	1.00	2.47	25
KY	Kentucky	1.29	2.00	2.33	3.00	1.99	37
LA	Louisiana	3.21	3.00	3.33	3.00	3.16	9
MA	Massachusetts	3.08	1.00	1.83	1.00	1.88	43
MD	Maryland	2.71	2.00	2.00	3.00	2.31	30
ME	Maine	2.46	1.00	2.33	2.00	1.94	39
MI	Michigan	3.75	3.00	3.33	2.00	3.22	8
MN	Minnesota	2.86	4.00	2.17	1.00	2.81	15
MO	Missouri	1.43	3.00	3.17	3.00	2.58	21
MS	Mississippi	1.81	2.00	3.33	3.00	2.44	26
MT	Montana	1.78	2.00	2.17	1.00	1.89	42
NC	North Carolina	2.17	4.00	3.83	4.00	3.40	7
ND	North Dakota	1.79	4.00	1.50	1.00	2.29	31
NE	Nebraska	1.74	4.00	2.33	1.00	2.52	22
NH	New Hampshire	1.01	1.00	1.67	1.00	1.20	49
NJ	New Jersey	3.60	2.00	2.00	2.00	2.48	24
NM	New Mexico	2.42	2.00	3.17	4.00	2.68	18
NV	Nevada	1.40	1.00	2.17	3.00	1.67	44
NY	New York	3.67	2.00	3.17	3.00	2.95	11
OH	Ohio	2.93	4.00	2.17	2.00	2.93	12
OK	Oklahoma	1.25	2.00	3.50	2.00	2.23	33
OR	Oregon	2.14	3.00	3.17	4.00	2.89	14
PA	Pennsylvania	3.69	3.00	2.50	2.00	2.96	10
RI	Rhode Island	2.27	1.00	1.00	1.00	1.38	47
SC	South Carolina	3.26	2.00	2.67	3.00	2.68	17
SD	South Dakota	1.59	3.00	1.50	1.00	1.93	40

State		Intro. Likelihood	Economic Impact	Environ. Suitability	Natural Resource	Average	Rank
TN	Tennessee	1.53	2.00	2.50	4.00	2.21	35
TX	Texas	3.78	4.00	3.67	4.00	3.83	2
UT	Utah	2.47	1.00	1.83	3.00	1.89	41
VA	Virginia	3.21	2.00	3.17	1.00	2.61	20
VT	Vermont	2.51	1.00	1.67	4.00	1.95	38
WA	Washington	3.81	4.00	3.33	4.00	3.74	4
WI	Wisconsin	2.05	3.00	1.67	2.00	2.21	34
WV	West Virginia	1.01	1.00	1.83	1.00	1.25	48
WY	Wyoming	0.98	1.00	1.17	2.00	1.14	50

Table 5. Risk rankings for states by rank order.

	State	Intro. Likelihood	Economic Impact	Environ. suitability	Natural Resource	Average	Rank
CA	California	3.78	4.00	3.83	4.00	3.88	1
TX	Texas	3.78	4.00	3.67	4.00	3.83	2
FL	Florida	3.87	4.00	3.50	4.00	3.81	3
WA	Washington	3.81	4.00	3.33	4.00	3.74	4
IL	Illinois	3.63	4.00	3.17	3.00	3.54	5
GA	Georgia	3.71	3.00	3.50	4.00	3.46	6
NC	North Carolina	2.17	4.00	3.83	4.00	3.40	7
MI	Michigan	3.75	3.00	3.33	2.00	3.22	8
LA	Louisiana	3.21	3.00	3.33	3.00	3.16	9
PA	Pennsylvania	3.69	3.00	2.50	2.00	2.96	10
NY	New York	3.67	2.00	3.17	3.00	2.95	11
OH	Ohio	2.93	4.00	2.17	2.00	2.93	12
AZ	Arizona	2.35	3.00	3.33	3.00	2.91	13
OR	Oregon	2.14	3.00	3.17	4.00	2.89	14
MN	Minnesota	2.86	4.00	2.17	1.00	2.81	15
AR	Arkansas	1.22	3.00	3.67	4.00	2.77	16
SC	South Carolina	3.26	2.00	2.67	3.00	2.68	17
NM	New Mexico	2.42	2.00	3.17	4.00	2.68	18
IN	Indiana	1.37	4.00	2.50	3.00	2.66	19
VA	Virginia	3.21	2.00	3.17	1.00	2.61	20
MO	Missouri	1.43	3.00	3.17	3.00	2.58	21
NE	Nebraska	1.74	4.00	2.33	1.00	2.52	22
AL	Alabama	2.62	2.00	3.33	1.00	2.49	23
NJ	New Jersey	3.60	2.00	2.00	2.00	2.48	24
KS	Kansas	1.22	4.00	2.67	1.00	2.47	25
MS	Mississippi	1.81	2.00	3.33	3.00	2.44	26
CO	Colorado	1.37	3.00	2.50	3.00	2.36	27
ID	Idaho	1.60	3.00	2.50	2.00	2.33	28
HI	Hawaii	2.90	1.00	2.50	4.00	2.32	29
MD	Maryland	2.71	2.00	2.00	3.00	2.31	30
ND	North Dakota	1.79	4.00	1.50	1.00	2.29	31
IA	Iowa	1.10	4.00	1.67	2.00	2.23	32
OK	Oklahoma	1.25	2.00	3.50	2.00	2.23	33
WI	Wisconsin	2.05	3.00	1.67	2.00	2.21	34
TN	Tennessee	1.53	2.00	2.50	4.00	2.21	35
AK	Alaska	2.42	1.00	2.50	4.00	2.18	36
KY	Kentucky	1.29	2.00	2.33	3.00	1.99	37
VT	Vermont	2.51	1.00	1.67	4.00	1.95	38
ME	Maine	2.46	1.00	2.33	2.00	1.94	39
SD	South Dakota	1.59	3.00	1.50	1.00	1.93	40
UT	Utah	2.47	1.00	1.83	3.00	1.89	41

	State	Intro. Likelihood	Economic Impact	Environ. suitability	Natural Resource	Average	Rank
MT	Montana	1.78	2.00	2.17	1.00	1.89	42
MA	Massachusetts	3.08	1.00	1.83	1.00	1.88	43
NV	Nevada	1.40	1.00	2.17	3.00	1.67	44
DE	Delaware	2.10	1.00	1.67	2.00	1.63	45
CT	Connecticut	2.17	1.00	1.50	2.00	1.60	46
RI	Rhode Island	2.27	1.00	1.00	1.00	1.38	47
WV	West Virginia	1.01	1.00	1.83	1.00	1.25	48
NH	New Hampshire	1.01	1.00	1.67	1.00	1.20	49
WY	Wyoming	0.98	1.00	1.17	2.00	1.14	50

Figure 1. Relative risk of U.S. states to exotic pest threats.

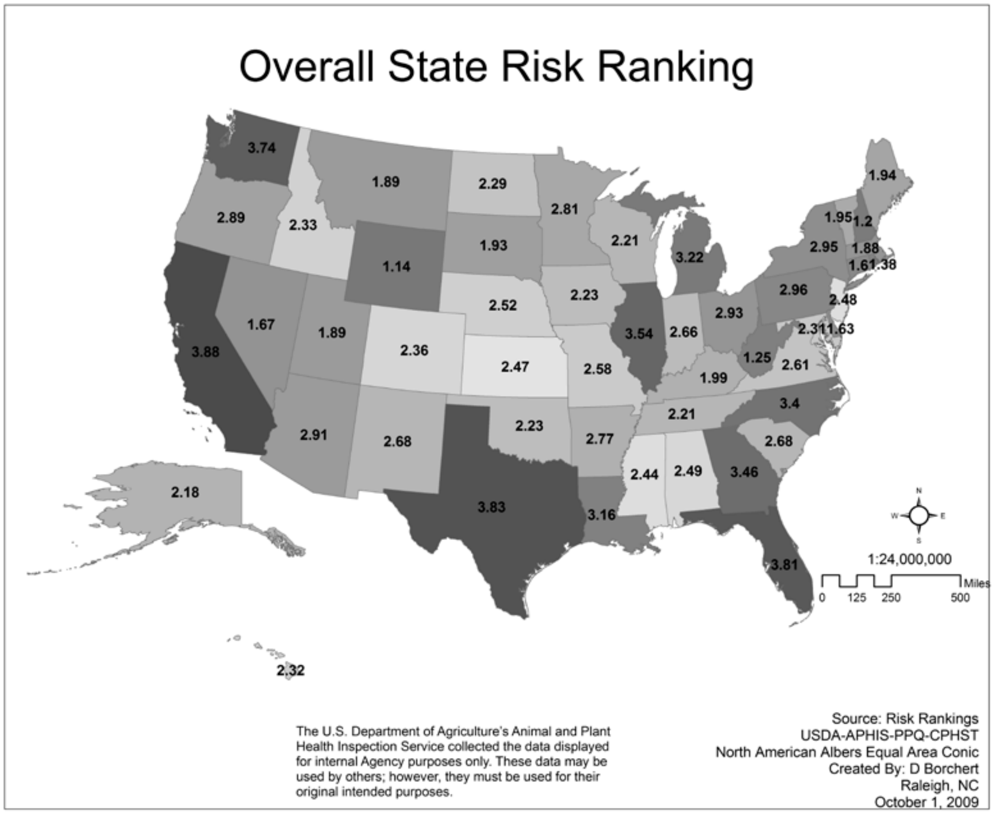

Figure 1.1 Relative risk of U.S. states to exotic pest threats in grayscale.