Establishment Potential Surface for *Ips typographus*

Data format: Raster Dataset - ESRI GRID

File or table name: Establishment

Coordinate system: Albers Conical Equal Area

Theme keywords: Forest Pathogen, Forest Pest, Exotic, Invasive Species, European spruce bark beetle, *Ips typographus*, Establishment

Abstract: The Establishment Potential Surface for *Ips typographus* was produced for the conterminous United States in 1 square kilometer (km²) units by the U.S. Forest Service, Forest Health Technology Enterprise Team's (FHTET) Invasive Species Steering Committee.

FGDC and ESRI Metadata:

Metadata elements shown with blue text are defined in the Federal Geographic Data Committee's (FGDC) *Content Standard for Digital Geospatial Metadata (CSDGM)*. Elements shown with green text are defined in the *ESRI Profile of the CSDGM.* Elements shown with a green asterisk (*) will be automatically updated by ArcCatalog. ArcCatalog adds hints indicating which FGDC elements are mandatory; these are shown with gray text.

Identification Information:

Citation:
Citation information:
Originators: Forest Health Technology Team (FHTET) USDA Forest Service

Title:
Establishment Potential Surface for *Ips typographus*
***File or table name:** estab8a (GRID)
***File or table name: establishment7.mdx**
Tool name: Ips_models

Model Name: Susceptibility2

Publication date: 6/20/2006
***Geospatial data presentation form:** raster digital data

Series information:
Series name: Version 2.0
Issue identification: 6/20/2006
Publication information:
Publication place: Fort Collins, Colorado
Publisher: Marla C. Downing

Online linkage: http://www.fs.fed.us/foresthealth/technology/invasives_ipstypographus_riskmaps.shtml

Larger work citation:
Citation information:
Originators: Forest Health Technology Enterprise Team (FHTET) USDA Forest Service

Title:
Establishment Potential Surface for *Ips typographus*

Publication date: 6/20/2006
Edition: 2.0
Geospatial data presentation form: map

Online linkage: http://www.fs.fed.us/foresthealth/technology/products.shtml

Description:
Abstract:
The Establishment Potential Surface for *Ips typographus* was produced for the conterminous United States in 1 square kilometer (km^2) units by the U.S. Forest Service (USFS), Forest Health Technology Enterprise Team's (FHTET) Invasive Species Steering Committee; a multidisciplinary team with participation from USFS and the USDA Animal and Plant Health Inspection Service (APHIS). Supporting information for this product was taken from Exotic Forest Pest (ExFor) website (http://spfnic.fs.fed.us/exfor/).

Purpose:
The product's intended use in conjunction with the Introduction Potential Surface is to develop a Susceptibility Potential Surface for *Ips typographus*. Eight primary datasets with standardized values from 0 to 10 were used in the analysis. The output values also range from 0 to 10 with 10 having the highest establishment potential. Establishment potential is related to disturbance (Gilbert 2005). These data sets were broken down into two primary data themes: 1) Host, and 2) Disturbance. The Disturbance consists of: Tornadoes, Maximum High Winds, Hurricanes, Fire, Lighting, and Avalanche Potential. Host data consists of: Urban Forests and the Forest Service Inventory and Analysis (FIA) host species data. Data were combined into a weighted overlay.

Supplemental information:

Host

Host Species: Source: US Forest Service Inventory and Analysis (FIA) spruce, larch and fir species data (Appendix B).
Urban Forest: Source: Four primary data sets were used: A) Environment Systems Research Institutes (ESRI) polygon data set that depicts Cities in the United States, B) National Land Cover Data (NLCD) Evergreen Forest Type, C) NLCD Mixed Forest Type, and E) USDA Plant Hardiness Zones. All data were combined to create the Urban Forest.

Finally the Urban Forest was combined with the FIA Host Species data using a maximum overlay process. The Urban Forest was considered to contain highly susceptible host

species in Plant Hardiness Zones 2a – 7a, inclusive (http://www.usna.usda.gov/Hardzone/ushzmap.html).

Three primary data sets were used in the construction of the Establishment potential. These primary data sets are: Disturbance, Host species, and Urban Forests.

1) **Host Species**. Source: USDA Forest Service, Forest Inventory and Analysis (FIA) data (Appendix B). *Picea* species were classified as Very High Potential (GRID Value of 10). All other host species were given a Low Potential (GRID Value of 1). However, if any GRID cell was mixed with any *Picea* species (listed in Appendix B) then the Potential was Medium and the GRID value was 5.

2) **Urban Forest**. Source: Three primary data sets were used in the construction of the Urban forest: A) A polygon data set from Environmental Systems Research Institute (ESRI) that depicts Cities in the United States. These City polygons were included as standard spatial data with the shipment of ArcGIS ver 9.1 in the year 2005 and B) National Land Cover Data (NLCD) from the USDA Natural Resources Conservation Service (NRCS), and C) USDA Plant Hardiness Zones. First the City polygons were converted to 1000 meter cells (CITY GRID). Next a subset forest type of the NLCD data (at 30 meter resolution) was extracted. This NLCD forest type was labeled Evergreen Forest (GRID Value 42). The NLCD Evergreen Forest type was resampled to 1000 meter cell resolution; however, the percent of cells of 30 meter NLCD Evergreen Forest that made up the entire 1000 meter cell was maintained as an attribute (NLCD Evergreen Forest GRID). The Plant Hardiness zone (zones 2a – 7a, inclusive) were extracted and converted to 1000 meter cells. Finally, the City GRID was overlain with the NLCD Evergreen Forest GRID (where the NLCD Evergreen Forest GRID and Mixed has 30 percent or more Evergreen forest and or Mixed). These data were combined with the Host Species data using a maximum overlay process. The Urban Forest was considered to be associated with highly susceptible host species (Piel 2005).

3) **Disturbance**. Consisted of: Tornadoes, Maximum High Winds, Hurricanes, Fire, Lightning, and Avalanche Potential (see below). Disturbance was considered to be associated with highly susceptible host species (Forsse and Solbreck 1985)

Disturbance

Tornadoes: Source: National Climate Atlas. Tornado line density from the year 1950 – 2004. These tornado events were calculated into tornado events per square kilometer; then, reclassed into 10 classes using Jenk’s natural breaks.

The density function applied to these data is kernel in nature. A smooth curve is given over the entire search radius illustrating where the concentration of lines are located in the search radius. The kernel function is based on the quadratic kernel function described in Silverman 1986.
Therefore, the following parameters for calculating the density are applied: Using ESRI ArcView 9.1 Spatial Analysis extension, we applied the Density function with the following parameters:

Population Field:	Value
Density Type:	Kernel
Search Radius:	50,000 Meters
Area Units:	Square Kilometers
Cell Size:	1000 meters
Extent:	The Entire Lower 48 of the United States

The Fujita Scale (F-SCALE) corresponds to the following wind and damage descriptions: Fujita Scale 0 (F0): Winds of 40-72 mph, MINIMAL DAMAGE (Some damage to chimneys, TV antennas, roof shingles, trees, and windows).

Fujita Scale 1 (F1): Winds of 73-112 mph, MODERATE DAMAGE (Automobiles overturned, carports destroyed, trees uprooted).
Fujita Scale 2 (F2): Winds of 113-157 mph, MAJOR DAMAGE (Roofs blown off homes, sheds and outbuildings demolished, mobile homes overturned).
Fujita Scale 3 (F3): Winds of 158-206 mph, SEVERE DAMAGE (Exterior walls and roofs blown off homes. Metal buildings collapsed or are severely damaged. Forests and farmland flattened).
Fujita Scale 4 (F4): Winds of 207-260 mph, DEVASTATING DAMAGE (Few walls, if any, standing in well-built homes. Large steel and concrete missiles thrown far distances).
Fujita Scale 5 (F5): Winds of 261-318 mph, INCREDIBLE DAMAGE (Homes leveled with all debris removed. Schools, motels, and other larger structures have considerable damage with exterior walls and roofs gone. Top stories demolished).

Fscale	Value
F0	1
F1	2
F2	3
F3	4
F4	5
F5	6

The Density Function with the above parameters works as follows:

Each GRID cell value is7 calculated by using the number of times a Tornado passes through a particular GRID cell, times the Value of the Tornado (from the Population Field) and times the distance the Tornado covers in a particular cell. See example below:

Data Resolution: Is unknown since the data were collected from 1950 to 2004. Therefore we used 1 kilometer.

Data Source: The tornado track data set was provided by the U.S. Air Force Combat Climatology Center, Air Weather Service. Data originated from the Storm Prediction Center, NOAA. The information is based on tornado reports published in NCDC's *Storm Data*. Data is from the Climate Atlas Compact Disk and the shapefile is called torn47.

Hurricanes: Source: National Climate Atlas. Hurricane line density from the year 1851 – 2003. These hurricane events were calculated into hurricane events per square kilometer; then, reclassed into 10 classes using natural breaks.

The Hurricane Line data sets were clipped to the Main land of the USA (Lower 48 States). Therefore all Hurricane data used in this analysis existed on land. This resulted in 1,990 hurricanes used in the analysis.

Hurricane data were edited. That is only Tropical Storms (TS), Category 1 (H1), Category 2 (H2), Category 3 (H3), Category 4 (H4), and Category 5 (H5) Hurricanes were used. All other data were deleted and not used in this analysis. This uses the same technique as was applied to the tornado data (see above).

A tropical storm (TS) is a tropical cyclone with maximum sustained surface (10 meter) winds of 34 knots/39 mph to 64 knots/73 mph, inclusive.

A Category 1 (H1) hurricane is a tropical cyclone with maximum sustained surface (10 meter) winds of 64 knots/74 mph to
82 knots/95 mph, inclusive.

A Category 2 (H2) hurricane is a tropical cyclone with maximum sustained surface (10 meter) winds of 83 knots/96 mph to 95 knots/110 mph, inclusive.

Category 3 (H3) hurricane is a tropical cyclone with maximum sustained surface (10 meter) winds of 96 knots/111 mph to 113 knots/130 mph, inclusive.

Category 4 (H4) hurricane is a tropical cyclone with maximum sustained surface (10 meter) winds of 114 knots/131 mph to 135 knots/155 mph, inclusive.

A Category 5 (H5) hurricane is a tropical cyclone with maximum sustained surface (10 meter) winds greater than 135 knots/155 mph.

Population Field:	Value
Density Type:	Kernel
Search Radius:	50,000 Meters
Area Units:	Square Kilometers
Cell Size:	1000 meters
Extent:	The Entire Lower 48 of the United States

Hurricane Data were classified and attributed as follows:

Category	Value
TS	1
H1	2
H2	3
H3	4
H4	5
H5	6

Data Source: The National Oceanic and Atmospheric Administration (NOAA), Tropical Prediction Center/National Hurricane Center. (http://nationalatlas.gov/atlasftp.html)

Fire: Source: Desert Research Institute (DRI) Program for Climate, Ecosystem and Fire Applications. Fire point events density on federal lands from 1970 – 2004. These fire events were calculated into fire events per square kilometer, then reclassed into 10 classes using Jenk's natural breaks.

Fire point events density on federal lands from 1970 – 2004. These fire events were calculated into fire events per square kilometer. These data were then reclassed into 10 classes using Jenk's natural breaks. The density function applied to these data is kernel in nature. Therefore the following parameters for calculating the density are applied: Using ESRI ArcView 9.1 Spatial Analysis we applied the Density function with the following parameters:

Population Field:	Value
Density Type:	Kernel
Search Radius:	50,000 Meters
Area Units:	Square Kilometers
Cell Size:	1000 meters
Extent:	The Entire Lower 48 of the United States

In essence all the fire points are counted up in the 50,000 meter search radius and then divided by the number of GRID cells in that search radius. A smooth curve is given over the entire search radius illustrating where the concentration of points are located in the search radius. The kernel function is based on the quadratic kernel function described in Silverman 1986.

Data Resolution: The metadata indicated that these data were collected using Township Range and Section (TRS) commonly referred to as the Public Land Survey (PLS).

Therefore, it is likely that these data have a positional accuracy no better than 160 acres (1/4 of a section).

Data Source: Desert Research Institute (DRI), Program for Climate, Ecosystem and Fire Applications. *Coarse Assessment of Federal Wildland Fire Occurrences Data.* Report for the National Wildfire Coordinating Group. Authors: Timothy J. Brown, Beth L. Hall, Charlene R. Mohrle, and Hass J. Reinbold, December 2002. CEFA Report 02-04.

Maximum Winds: Source: National Climate Atlas The extreme 5% Wind Speed for a 30 year time period (1972 – 1992).

Mean Extreme 5% Wind Speed. The annual value was computed by taking the 30-year mean of the extreme 5% wind speed for each calendar year. Annual mean extreme wind speeds for the identified percentile were computed by determining the percentile from all hourly averaged wind speed observations for the month year. These data were reclassified as follows: 1 = < 15 MPH, 2 = 15 to 16 MPH, 4 = 17 to 18 MPH, 5 = 19 to 20 MPH, 7 = 21 to 22 MPH, 8 = 23 to 24 MPH, 9 = 25 to 26 MPH, 10 = > 26 MPH.

Data Source: This element was computed using data from the National Climatic Data Center's Surface Airways Hourly (TD-3280) database (NOAA, 2000a). The original data is given in knots. This element is given in miles per hour. Data is from the Climate Atlas Compact Disk and the shapefile is called WIND64B.

Lightning: Source: NASA Lightning Imaging Sensor / Optical Transient Detector (LIS/OTD) Science Team The product is a 0.5˚ x 0.5˚ gridded composite of total (IC+CG) lightning bulk production, expressed as a flash rate density (fl/km^2/yr). Climatologies from the 5-yr OTD (4/95-3/00) and 5-yr LIS (12/97-12/02) missions are included, as well as a combined OTD+LIS climatology and supporting base data (flash counts and viewing times).

Data were then resampled to 1000 meter by 1000 meter grid cells; then, reclassed into 10 classes using Jenk’s Natural Breaks. Unclassified data range from a minimum value of 0 to a maximum value of 58.53.

Avalanche: Source: FHTET. Avalanche potential areas were calculated by the following parameters: 1) Areas greater than 5,000 feet above mean sea level, 2) Areas that are greater than 30˚ and less than 60˚ in slope, and 3) Areas that have 60 inches or more annual average snow accumulation. Data was created by FHTET via parameters (listed above) illustrated by Maggioni 2001.

Data Source:

Snow

The snow elements were obtained from the snow climatology (NOAA, 1997). The criteria for handling missing data for computing the mean monthly and annual normal snowfall differed for the coop stations and the first order (WBAN) stations. For the coop stations, the total snowfall had no tolerance for missing data. If even one day was missing in a month, the total snowfall was not to be computed for that year's month. Consequently, the number of years with non-missing data varied with month. For first order stations, the criteria were not as stringent as for coop stations. The WMO guidelines for computing normals were used. They defined a missing month as having (1) five or more consecutive daily values missing, or (2) a total of eleven or more missing daily values in the month. Data is from the Climate Atlas Compact Disk and the shapefile is called SNOW29.

Elevation

Derived from USGS National Elevation Data (NED) Digital Elevation Models (DEMs) and resampled to 1000 meter by 1000 meter grid cells.

Slope

Derived from the USGS DEMs using ESRI ArcGIS ver 9.1 Spatial Analysis Slope generation algorithms.

Data from Tornadoes, Hurricanes and Fire were partitioned via the last three years of data then combined via a maximum overlay process and labeled as Current data. The remaining years of data from Tornadoes, Hurricanes, and Fire coupled with Maximum Winds, Lightning, and Avalanche were combined via a maximum overlay process and labeled as Historic data. The Current and Historic data were combined using an equal weighted overlay process to produce the Disturbance data.

Finally Host data and Disturbance data were combined in a weighted overlay (table 4) to produce the Establishment Potential.

Table 4
Establishment Variables and Arithmetic Weights.

Variable	Weight
Disturbance	40%
Host	60%

References:

Forsse, E. and CH. Solbreck. 1985. Migration in the bark beetle Ips typographys L.: duration, timing and height of flight. Z.Angew Entomol 100:47-57.

Gilbert, M., L.-M Nageleisen, A. Franklin, and J.-C Grégoire. 2005. *Post-storm surveys reveal large-scale spatial patterns and influences of site factors, forest structure and diversity in endemic bark-beetle populations*. Landscape Ecology Volume 20, Number 1, Page 35 – 49.

Maggioni. M., U. Gruber, and A. Stoffel, "*Definition and characterization of potential avalanche release areas*" Proceedings of the 2001 ESRI International User Conference July 9-13, 2001, San Diego. http://gis.esri.com/library/userconf/proc02/pap1161/p1161.htm

Piel. F., M. Gilbert, A. Franklin, and J.-C Grégoire. 2005. *Occurrence of Ips typographus* (Col., Scolytidae) *along an urbanization gradient in Brussels, Belgium*. Agricultural and Forest Entomology. Volume 7, Page 161.

Silverman, B.W. *Density Estimation for Statistics and Data Analysis*. New York: Chapman and Hall, 1986.

*__Language of dataset:__ en

Time period of content:
Time period information:
Single date/time:
Calendar date: 6-20-2006

Currentness reference:

publication date

Status:
Progress: Planned
Maintenance and update frequency: As needed

Spatial domain:
Bounding coordinates:
***West bounding coordinate:** -128.011472
***East bounding coordinate:** -51.920726
***North bounding coordinate:** 51.656290
***South bounding coordinate:** 17.299188

Local bounding coordinates:
***Left bounding coordinate:** -2364065.750000
***Right bounding coordinate:** 3376934.254584
***Top bounding coordinate:** 3178151.331894
***Bottom bounding coordinate:** -56848.670690

Keywords:
Theme:
Theme keywords: Forest Pathogen, Exotic, European spruce bark beetle, *Ips typographus*, Establishment

Place:
Place keywords: Conterminous United States
Place keyword thesaurus: Lower 48 States

Access constraints: None
Use constraints:
None

Point of contact:
Contact information:
Contact organization primary:
Contact person: Marla C. Downing
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Hours of service: 9:00 AM - 5:00 PM MT

Browse graphic:
Browse graphic file name: EstablishmentSummary.pdf
Browse graphic file description:
Portable Document Format (PDF)
Browse graphic file type: PDF

Data set credit:
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Security information:
Security classification: Unclassified

***Native dataset format:** Raster Dataset
***Native data set environment:**
Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 2; ESRI ArcCatalog 9.1.0.722

Cross reference:
Citation information:
Originators: Forest Health Technology Enterprise Team (FHTET) USDA Forest Service

Title:
Establishment Potential Surface for *Ips typographus*

Publication date: 6-20-2006
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Geospatial data presentation form: map
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***File or table name: establishment7.mdx**
Tool name: Ips_models

Model Name: Susceptibility2

Online linkage: http://www.fs.fed.us/foresthealth/technology/products.shtml

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Data Quality Information:

Attribute accuracy:

Attribute accuracy report:
One kilometer

Lineage:
Process step:
Process description:
Summary of Establishment Potential for *Ips typographus*: June 20, 2006
Website URL: http://www.fs.fed.us/foresthealth/technology/products.shtml

The Establishment Potential Surface for *Ips typographus* was produced for the Conterminous United States (CUS) in 1 square kilometer (km^2) units by the U.S. Forest Service, Forest Health Technology Enterprise Team's (FHTET) Invasive Species Steering Committee (Table 1). The product's intended use in conjunction with the Introduction Potential Surface is to develop a Susceptibility Potential Surface for *Ips typographus*. Supporting information for this product was taken from Exotic Forest Pest (ExFor) website (http://spfnic.fs.fed.us/exfor/). Eight datasets with standardized values from 0 to 10 were used as variables in the analysis. The output values also range from 0 to 10; with 10 having the highest establishment potential. These data sets were broken down into two primary data themes: 1) Disturbances, and 2) Host. The Disturbance consists of: Tornadoes, Maximum High Winds, Hurricanes, Fire, Lighting, and Avalanche Potential. Host data consists of: Urban Forests and FIA host species data. Data were combined in a weighted overlay (Table 4).

Disturbance

Tornadoes: Source: U.S. Air Force Combat Climatology Center, Air Weather Service. Data originated from the Storm Prediction Center, NOAA. The information is based on tornado reports published in NCDC's *Storm Data*.
Tornado line density from the year 1961 – 1990. These tornado events were calculated into tornado events per square kilometer; then, reclassed into 10 classes using Jenk's natural breaks.
Hurricanes: Source: The National Oceanic and Atmospheric Administration (NOAA), Tropical Prediction Center/National Hurricane Center. (http://nationalatlas.gov/atlasftp.html)
Hurricane line density from the year 1851 – 2003. These hurricane events were calculated into hurricane events per square kilometer; then, reclassed into 10 classes Jenk's using natural breaks.
Fire: Source: Desert Research Institute (DRI) Program for Climate, Ecosystem and Fire Applications. Fire point events density on federal lands from 1970 – 2004. These fire events were calculated into fire events per square kilometer, then reclassed into 10 classes using Jenk's natural breaks.
Maximum Winds: Source: National Climate Atlas The extreme 5% Wind Speed for a 30 year time period (1972 – 1992).
Lightning: Source: NASA Lightning Imaging Sensor / Optical Transient Detector (LIS/OTD) Science Team The product is a 0.5˚ x 0.5˚ gridded composite of total (IC+CG) lightning bulk production, expressed as a flash rate density ($fl/km^2/yr$). Climatologies from the 5-yr OTD (4/95-3/00) and 5-yr LIS (12/97-12/02) missions are included, as well as a combined OTD+LIS climatology and supporting base data (flash counts and viewing times).
Avalanche: Source: FHTET. Avalanche potential areas were calculated by the following parameters: 1) Areas greater than 5,000 feet above mean sea level, 2) Areas that are greater than 30˚ and less than 60˚ in slope, and 3) Areas that have 60 inches or more annual average show accumulation. Data was created by FHTET via parameters illustrated by Margherita Maggioni, Urs Gruber, and Andreas Stoffel, "*Definition and characterization of potential avalanche release areas*" Proceedings of the 2001 ESRI International User Conference July 9-13, 2001, San Diego. http://gis.esri.com/library/userconf/proc02/pap1161/p1161.htm

Data from Tornadoes, Hurricanes and Fire were partitioned via the last three years of data then combined via a maximum overlay process and labeled as Current data. The remaining years of data from Tornadoes, Hurricanes, and Fire coupled with Maximum Winds, Lightning, and Avalanche were combined via a maximum overlay process and labeled as Historic data. The Current and Historic data were combined using an equal weighted overlay process to produce the Disturbance data.

Host

Host Species: Source: US Forest Service Inventory and Analysis (FIA) spruce, larch and fir species data (Table 3).
Urban Forest: Source: Four primary data sets were used: A) Environment Systems Research Institutes (ESRI) polygon data set that depicts Cities in the United States, B) National Land Cover Data (NLCD) Evergreen Forest Type, C) NLCD Mixed Forest Type, and E) USDA Plant Hardiness Zones. All data were combined to create the Urban Forest.

Finally the Urban Forest was combined with the FIA Host Species data using a maximum overlay process. The Urban Forest was considered to contain highly susceptible host species in Plant Hardiness Zones 2a – 7a, inclusive. (Table 3)

Table 1

Steering Committee

Marla C. Downing, FHTET Lead
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Table 2

Disturbance

Variable	Weight
Current	50%
Historical	50%

Table 3

Host Species

Species	Value
Spruce (*Pices* species)	10
Mixed Spruce	5
Fir (*Abies* species)	1
Larch (*Larix* species)	1
Urban Forest	10

Table 4

Establishment Variables and Arithmetic Weights.

Variable	Weight
Disturbance	40%
Host	60%

Contractor Support

Michael F. Tuffly
ERIA Consultants, LLC

Appendix A FIA Measurement Year

State	Source	Measyear	FIA Cycle	Notes
Alabama	FIA Plots	1997	7	
Alabama	FIA Plots	1998	7	
Alabama	FIA Plots	1999	7	

Alabama	FIA Plots	2000	7			
Alabama	FIA Plots	2001	7			
Arizona	FIA Plots	1984	2			
Arizona	FIA Plots	1985	2			
Arizona	FIA Plots	1990	2			
Arizona	FIA Plots	1991	2			
Arizona	FIA Plots	1995	2			
Arizona	FIA Plots	1996	2			
Arizona	FIA Plots	1997	2			
Arizona	FIA Plots	1998	2			
Arizona	FIA Plots	1999	2			
Arizona	FIA Plots	2000	2			
Arizona	FIA Plots	2001	2			
Arkansas	FIA Plots	1900	1			
Arkansas	FIA Plots	1994	1			
Arkansas	FIA Plots	1995	1			
Arkansas	FIA Plots	1996	1			
California	FIA Plots	1991	3			
California	FIA Plots	1992	3			
California	FIA Plots	1993	3			
California	FIA Plots	1994	3			
California	FIA Plots	1997	3			
California	FIA Plots	1998	3			
California	Region 5, Pacific Southwest Region Plots				1980	N/A
California	Region 5, Pacific Southwest Region Plots				1984	N/A
California	Region 5, Pacific Southwest Region Plots				1993	N/A
California	Region 5, Pacific Southwest Region Plots				1994	N/A
California	Region 5, Pacific Southwest Region Plots				1995	N/A
California	Region 5, Pacific Southwest Region Plots				1996	N/A
California	Region 5, Pacific Southwest Region Plots				1997	N/A
California	Region 5, Pacific Southwest Region Plots				1998	N/A
California	Region 5, Pacific Southwest Region Plots				1999	N/A
California	Region 5, Pacific Southwest Region Plots				2000	N/A
California	Region 5, Pacific Southwest Region Plots				1993	N/A
California	Region 5, Pacific Southwest Region Plots				1995	N/A
California	Region 5, Pacific Southwest Region Plots				1996	N/A
California	Region 5, Pacific Southwest Region Plots				1997	N/A
Colorado	FIA Plots	1979	1			
Colorado	FIA Plots	1981	1			
Colorado	FIA Plots	1982	1			
Colorado	FIA Plots	1983	1			
Colorado	FIA Plots	1984	1			
Colorado	FIA Plots	1993	1			
Colorado	FIA Plots	1997	1			
Colorado	FIA Plots	2001	1	NF Lands Only		
Colorado	FIA Plots	2002	2	NF Lands Only		
Colorado	FIA Plots	2003	2	NF Lands Only		
Connecticut	FIA Plots	1997	4			
Connecticut	FIA Plots	1998	4			
Delaware	FIA Plots	1999	4			
Florida	FIA Plots	1900	2			
Georgia	FIA Plots	1900	7			
Idaho	FIA Plots	1981	1			
Idaho	FIA Plots	1990	1			
Idaho	FIA Plots	1991	1			
Idaho	FIA Plots	1992	1			
Idaho	FIA Plots	1993	1			
Idaho	FIA Plots	1994	1			
Idaho	FIA Plots	1995	1			
Idaho	FIA Plots	1996	1			
Idaho	FIA Plots	1997	1			
Idaho	FIA Plots	1998	1			
Idaho	FIA Plots	1999	1			

Idaho	FIA Plots	2000	1
Idaho	FIA Plots	2001	1
Idaho	FIA Plots	2002	1
Idaho	FIA Plots	2004	1
Illinois	FIA Plots	No Year Listed	4
Illinois	FIA Plots	1987	4
Illinois	FIA Plots	1996	4
Illinois	FIA Plots	1997	4
Illinois	FIA Plots	1998	4
Indiana	FIA Plots	1998	5
Indiana	FIA Plots	1999	5
Indiana	FIA Plots	2000	5
Indiana	FIA Plots	2001	5
Indiana	FIA Plots	2002	5
Indiana	FIA Plots	2003	5
Iowa	FIA Plots	1999	4
Iowa	FIA Plots	2000	4
Iowa	FIA Plots	2001	4
Iowa	FIA Plots	2002	4
Iowa	FIA Plots	2003	4
Kansas	FIA Plots	1992	4
Kansas	FIA Plots	1993	4
Kansas	FIA Plots	1994	4
Kentucky	FIA Plots	1999	4
Kentucky	FIA Plots	2000	4
Kentucky	FIA Plots	2001	4
Kentucky	FIA Plots	2002	4
Kentucky	FIA Plots	2003	4
Louisiana	FIA Plots	2000	3
Louisiana	FIA Plots	2001	3
Louisiana	FIA Plots	2002	3
Louisiana	FIA Plots	2003	3
Louisiana	FIA Plots	2004	3
Maine	FIA Plots	1999	5
Maine	FIA Plots	2000	5
Maine	FIA Plots	2001	5
Maine	FIA Plots	2002	5
Maine	FIA Plots	2003	5
Maryland	FIA Plots	1999	5
Maryland	FIA Plots	2000	5
Massachusetts	FIA Plots	1997	4
Massachusetts	FIA Plots	1998	4
Michigan	FIA Plots	2000	6
Michigan	FIA Plots	2001	6
Michigan	FIA Plots	2002	6
Michigan	FIA Plots	2003	6
Minnesota	FIA Plots	1982	5
Minnesota	FIA Plots	1984	5
Minnesota	FIA Plots	1986	5
Minnesota	FIA Plots	1987	5
Minnesota	FIA Plots	1988	5
Minnesota	FIA Plots	1989	5
Minnesota	FIA Plots	1990	5
Minnesota	FIA Plots	1991	5
Mississippi	FIA Plots	1900	1
Mississippi	FIA Plots	1992	1
Mississippi	FIA Plots	1993	1
Mississippi	FIA Plots	1994	1
Missouri	FIA Plots	1998	5
Missouri	FIA Plots	1999	5
Missouri	FIA Plots	2000	5
Missouri	FIA Plots	2001	5
Missouri	FIA Plots	2002	5

Missouri	FIA Plots	2003	5
Montana	FIA Plots	1988	1
Montana	FIA Plots	1989	1
Montana	FIA Plots	1990	1
Montana	FIA Plots	1993	1
Montana	FIA Plots	1994	1
Montana	FIA Plots	1995	1
Montana	FIA Plots	1996	1
Montana	FIA Plots	1997	1
Montana	FIA Plots	1998	1
Montana	FIA Plots	1999	1
Montana	FIA Plots	2000	1
Montana	FIA Plots	2001	1
Nebraska	FIA Plots	2001	4
Nebraska	FIA Plots	2002	4
Nebraska	FIA Plots	2003	4
Nebraska	FIA Plots	2004	4
Nevada	FIA Plots	1978	1
Nevada	FIA Plots	1979	1
Nevada	FIA Plots	1980	1
Nevada	FIA Plots	1981	1
Nevada	FIA Plots	1982	1
Nevada	FIA Plots	1994	1
Nevada	FIA Plots	1995	1
Nevada	FIA Plots	1996	1
Nevada	FIA Plots	1997	1
New Hampshire	FIA Plots	1996	5
New Hampshire	FIA Plots	1997	5
New Jersey	FIA Plots	1998	4
New Jersey	FIA Plots	1999	4
New Mexico	FIA Plots	1986	2
New Mexico	FIA Plots	1987	2
New Mexico	FIA Plots	1993	2
New Mexico	FIA Plots	1994	2
New Mexico	FIA Plots	1996	2
New Mexico	FIA Plots	1997	2
New Mexico	FIA Plots	1998	2
New Mexico	FIA Plots	1999	2
New Mexico	FIA Plots	2000	2
New Mexico	FIA Plots	2001	2
New York	FIA Plots	1991	4
New York	FIA Plots	1992	4
New York	FIA Plots	1993	4
New York	FIA Plots	1994	4
North Carolina	FIA Plots	1998	3
North Carolina	FIA Plots	1999	3
North Carolina	FIA Plots	2000	3
North Carolina	FIA Plots	2001	3
North Carolina	FIA Plots	2002	3
North Dakota	FIA Plots	1992	3
North Dakota	FIA Plots	1994	3
Ohio	FIA Plots	1990	4
Ohio	FIA Plots	1991	4
Ohio	FIA Plots	1992	4
Oklahoma	FIA Plots	1900	1
Oklahoma	FIA Plots	1988	1
Oklahoma	FIA Plots	1989	1
Oklahoma	FIA Plots	1990	1
Oklahoma	FIA Plots	1992	1
Oregon	FIA Plots	No Year Listed	4
Oregon	FIA Plots	1995	4
Oregon	FIA Plots	1996	4
Oregon	FIA Plots	1997	4

Oregon	FIA Plots	1998	4	
Oregon	FIA Plots	1999	4	
Oregon	Bureau of Land Management Western Oregon Plots	1997	N/A	
Oregon	Region 6, Pacific Northwest Region Plots	1993	N/A	
Oregon	Region 6, Pacific Northwest Region Plots	1994	N/A	
Oregon	Region 6, Pacific Northwest Region Plots	1995	N/A	
Oregon	Region 6, Pacific Northwest Region Plots	1996	N/A	
Oregon	Region 6, Pacific Northwest Region Plots	1997	N/A	
Pennsylvania	FIA Plots	2000	5	
Pennsylvania	FIA Plots	2001	5	
Pennsylvania	FIA Plots	2002	5	
Pennsylvania	FIA Plots	2003	5	
Rhode Island	FIA Plots	1998	4	
South Carolina	FIA Plots	1998	3	
South Carolina	FIA Plots	1999	3	
South Carolina	FIA Plots	2000	3	
South Carolina	FIA Plots	2001	3	
South Carolina	FIA Plots	2002	3	
South Dakota	FIA Plots	No Year Listed	4	
South Dakota	FIA Plots	1900	4	
South Dakota	FIA Plots	1994	4	
South Dakota	FIA Plots	1995	4	
South Dakota	FIA Plots	1996	4	
South Dakota	FIA Plots	1999	4	
Tennessee	FIA Plots	1900	6	
Tennessee	FIA Plots	1996	6	
Tennessee	FIA Plots	1997	6	
Tennessee	FIA Plots	1998	6	
Tennessee	FIA Plots	1999	6	
Texas	FIA Plots	2001	3	
Texas	FIA Plots	2002	3	
Texas	FIA Plots	2003	3	
Utah	FIA Plots	1988	1	
Utah	FIA Plots	1991	1	
Utah	FIA Plots	1992	1	
Utah	FIA Plots	1993	1	
Utah	FIA Plots	1994	1	
Utah	FIA Plots	1995	1	
Utah	FIA Plots	1996	1	
Vermont	FIA Plots	1996	5	
Vermont	FIA Plots	1997	5	
Vermont	FIA Plots	1998	5	
Virginia	FIA Plots	1997	3	
Virginia	FIA Plots	1998	3	
Virginia	FIA Plots	1999	3	
Virginia	FIA Plots	2000	3	
Virginia	FIA Plots	2001	3	
Virginia	FIA Plots	2002	3	
Washington	FIA Plots	1988	3	
Washington	FIA Plots	1989	3	
Washington	FIA Plots	1990	3	
Washington	FIA Plots	1991	3	
Washington	FIA Plots	1998	3	
Washington	Region 6, Pacific Northwest Region Plots	1993	N/A	
Washington	Region 6, Pacific Northwest Region Plots	1994	N/A	
Washington	Region 6, Pacific Northwest Region Plots	1995	N/A	
Washington	Region 6, Pacific Northwest Region Plots	1996	N/A	
Washington	Region 6, Pacific Northwest Region Plots	1997	N/A	
West Virginia	FIA Plots	1999	5	
West Virginia	FIA Plots	2000	5	
West Virginia	FIA Plots	2001	5	
West Virginia	FIA Plots	2002	5	
Wisconsin	FIA Plots	1999	6	

Wisconsin	FIA Plots	2000	6
Wisconsin	FIA Plots	2001	6
Wisconsin	FIA Plots	2002	6
Wisconsin	FIA Plots	2003	6
Wyoming	FIA Plots	1998	2
Wyoming	FIA Plots	1999	2
Wyoming	FIA Plots	2000	2
Wyoming	FIA Plots	2001	2
Wyoming	FIA Plots	2002	2
Wyoming	FIA Plots	2004	2

Appendix B: Host Species

FIA Code	Common Name	Genus	Species	Potential
93	Englemann spruce	*Picea*	*engelmannii*	Very High
98	Sitka spruce	*Picea*	*sitchensis*	Very High
95	Black spruce	*Picea*	*mariana*	Very High
94	White spruce	*Picea*	*glauca*	Very High
97	Red spruce	*Picea*	*rubens*	Very High
???	Brewer spruce	*Picea*	*breweriana*	Very High
???	Norway spruce	*Picea*	*abies*	Very High
???	Blue spruce	*Picea*	*pungens*	Very High
11	Pacific silver fir	*Abies*	*amabilis*	Low
12	balsam fir	*Abies*	*balsamea*	Low
15	white fir	*Abies*	*concolor*	Low
16	Fraser fir	*Abies*	*fraseri*	Low
17	grand fir	*Abies*	*grandis*	Low
???	Rocky Mountain fir	*Abies*	*lasiocarpa*	Low
20-21	red fir	*Abies*	*magnifica*	Low
22	noble fir	*Abies*	*procera*	Low
71	European larch	*Larix*	*decidua*	Low
71	eastern larch	*Larix*	*laricina*	Low
71	subalpine larch	*Larix*	*layallii*	Low
73	western larch	*Larix*	*occidentalis*	Low
???	Scots pine	*Pinus*	*sylvestris*	Low
119	Western white pine	*Pinus*	*strobus*	Low
202	Douglas-fir	*Pseudotsuga menziesii*		Low

Potential	GRID VALUE
Very High	10
Low	1

Note: GRID Cells that were mixed with any *Pices* species (listed above) were given a **GRID VALUE** of 5.

Note: Introduction Potential Surface and the Establishment Potential Surface = Susceptibility Potential Surface

Publication date: 6-20-2006
Edition: 2.0
Geospatial data presentation form: map
***File or table name:** estab8a (GRID)
***File or table name: establishment7.mdx**
Tool name: Ips_models

Model Name: Susceptibility2

Process contact:

Contact information:
Contact organization primary:
Contact person: Marla C. Downing
Contact organization: Forest Health Technology Enterprise Team (FHTET) USDA Forest Service
Contact position: FHTET Lead, Biological Scientist

Contact address:
Address type: mailing and physical address
Address:
2150 Centre Avenue, Bldg A, Suite 331
City: Fort Collins
State or province: Colorado
Postal code: 80526-1891
Country: USA

Contact voice telephone: 970-295-5843

Contact electronic mail address: mdowning@fs.fed.us

Hours of service: 9:00 AM - 5:00 PM MT

Spatial Data Organization Information:

*__Direct spatial reference method:__ Raster

Raster object information:
*__Image format:__ ESRI GRID
*__Number of bands:__ 1

*__Row count:__ 4,614
*__Column count:__ 2,904
*__Vertical count:__ 1

Cell size X direction: 1000
Cell size Y direction: 1000

*__Bits per pixel:__ 8
*__Pyramid layers:__ FALSE
*__Image colormap:__ FALSE
*__Compression type:__ Default

*__Raster object type:__ Grid Cell
*__Raster display type:__ matrix values
*__Raster origin:__ Upper Left

Spatial Reference Information:

Horizontal coordinate system definition:
Coordinate system name:
*__Projected coordinate system name:__ NAD_1983_Albers
*__Geographic coordinate system name:__ GCS_North_American_1983

Planar:
Map projection:
*__Map projection name:__ Albers Conical Equal Area
Albers conical equal area:
*__Standard parallel:__ 29.500000
*__Standard parallel:__ 45.500000
*__Longitude of central meridian:__ -96.000000
*__Latitude of projection origin:__ 23.000000
*__False easting:__ 0.000000
*__False northing:__ 0.000000

Planar coordinate information:
*__Planar coordinate encoding method:__ row and column
Coordinate representation:
*__Abscissa resolution:__ 1000
*__Ordinate resolution:__ 1000
*__Planar distance units:__ meters

Geodetic model:
*__Horizontal datum name:__ North American Datum of 1983
*__Ellipsoid name:__ Geodetic Reference System 80
*__Semi-major axis:__ 6378137.000000
*__Denominator of flattening ratio:__ 298.257222

Entity and Attribute Information:

Detailed description:
*__Name:__ establishment

Entity type:
*__Entity type label:__ establishment
*__Entity type type:__ Table
*__Entity type count:__ 10
Entity type definition:
Establishment Potential Surface for *Ips typographus*

Attribute:
*__Attribute label:__ ObjectID
*__Attribute alias:__ ObjectID
*__Attribute definition:__
Internal feature number.
*__Attribute definition source:__
ESRI

*__Attribute type:__ OID

*Attribute width: 4
*Attribute precision: 0
*Attribute scale: 0

Attribute domain values:
*Unrepresentable domain:
Sequential unique whole numbers that are automatically generated.

Attribute measurement frequency:
Unknown

Attribute:
*Attribute label: Value
*Attribute alias: Value
Attribute definition:
Integer Value from 0 - 10 where 0 equals little or no potential for establishment and 10 equals extremely high potential for establishment.

*Attribute type: Integer
*Attribute width: 0
*Attribute precision: 0
*Attribute scale: 0

Attribute value accuracy information:
Attribute value accuracy: As Reported

Attribute measurement frequency:
As needed

Attribute:
*Attribute label: Count
*Attribute alias: Count
Attribute definition:
The frequency of 1000 by 1000 meter GRID cells
Attribute definition source:
ESRI

*Attribute type: Double
*Attribute width: 0
*Attribute precision: 0
*Attribute scale: 0

Attribute measurement frequency:
As needed

Distribution Information:

Resource description: Downloadable Data

Standard order process:
Digital form:
Digital transfer information:
*__Transfer size:__ 12.78 Megabytes (uncompressed)
*__Dataset size:__ 12.78 Megabytes (uncompressed)

Metadata Reference Information:

*__Metadata date:__ 20060620
Metadata review date: 20060620

*__Language of metadata:__ en

Metadata contact:
Contact information:
Contact organization primary:
Contact person: Marla C. Downing
Contact organization: Forest Health Technology Enterprise Team (FHTET) USDA Forest Service
Contact position: FHTET, Lead and Biological Scientist

Contact address:
Address type: mailing and physical address
Address:
2150 Centre Avenue, Bldg A, Suite 331
City: Fort Collins
State or province: Colorado
Postal code: 80526-1891
Country: USA

Contact voice telephone: 970-295-5843

Contact electronic mail address: mdowning@fs.fed.us

Hours of service: 9:00 AM - 5:00 PM MT

*__Metadata standard name:__ FGDC Content Standards for Digital Geospatial Metadata
*__Metadata standard version:__ FGDC-STD-001-1998
*__Metadata time convention:__ local time

Metadata security information:
Metadata security classification: Unclassified

Metadata extensions:
*__Online linkage:__ http://www.esri.com/metadata/esriprof80.html
*__Profile name:__ ESRI Metadata Profile