

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:

- [Identification Information](#)
- [Data Quality Information](#)
- [Spatial Data Organization Information](#)
- [Spatial Reference Information](#)
- [Entity and Attribute Information](#)
- [Distribution Information](#)
- [Metadata Reference Information](#)

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 (km²) 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, reclassified 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 is 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, reclassified 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 reclassified 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 reclassified 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/km²/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, reclassified 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 typographus* 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

Contact organization: Forest Health Technology Enterprise Team (FHTET) Forest Health Protection

Contact position: FHTET Lead, Biological Scientist

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Address type: mailing and physical address

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City: Fort Collins

State or province: Colorado

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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

Browse graphic:

Browse graphic file name: [EstablishmentSummary.pdf](#)

Browse graphic file description:

Portable Document Format (PDF)

Browse graphic file type: PDF

Data set credit:

Michael F. Tuffly, ERIA Consultants, LLC

Steering Committee:

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Borys M. Tkacz, USFS FHP

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

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

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

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 (km²) 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, reclassified 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, reclassified 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 reclassified 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/km²/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
- C. Wayne Berisford, U of G
- Daniel M. Borchert, APHIS PPQ Donald A. Duerr, USFS R8
- Tom Eager, USFS R2
- Robert A. Haack, USFS NRCS
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- Frank J. Sapio, USFS FHTET
- Bill D. Smith, USFS SRS
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Table 2

Disturbance

| Variable | Weight |
|------------|--------|
| Current | 50% |
| Historical | 50% |

Table 3

Host Species

| Species | Value |
|--------------------------------|-------|
| Spruce (<i>Pices</i> species) | 10 |
| Mixed Spruce | 5 |
| Fir (<i>Abies</i> species) | 1 |
| Larch (<i>Larix</i> 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 | <i>Picea</i> | <i>engelmannii</i> | Very High |
| 98 | Sitka spruce | <i>Picea</i> | <i>sitchensis</i> | Very High |
| 95 | Black spruce | <i>Picea</i> | <i>mariana</i> | Very High |
| 94 | White spruce | <i>Picea</i> | <i>glauca</i> | Very High |
| 97 | Red spruce | <i>Picea</i> | <i>rubens</i> | Very High |
| ??? | Brewer spruce | <i>Picea</i> | <i>breweriana</i> | Very High |
| ??? | Norway spruce | <i>Picea</i> | <i>abies</i> | Very High |
| ??? | Blue spruce | <i>Picea</i> | <i>pungens</i> | Very High |
| 11 | Pacific silver fir | <i>Abies</i> | <i>amabilis</i> | Low |
| 12 | balsam fir | <i>Abies</i> | <i>balsamea</i> | Low |
| 15 | white fir | <i>Abies</i> | <i>concolor</i> | Low |
| 16 | Fraser fir | <i>Abies</i> | <i>fraseri</i> | Low |
| 17 | grand fir | <i>Abies</i> | <i>grandis</i> | Low |
| ??? | Rocky Mountain fir | <i>Abies</i> | <i>lasiocarpa</i> | Low |
| 20-21 | red fir | <i>Abies</i> | <i>magnifica</i> | Low |
| 22 | noble fir | <i>Abies</i> | <i>procera</i> | Low |
| 71 | European larch | <i>Larix</i> | <i>decidua</i> | Low |
| 71 | eastern larch | <i>Larix</i> | <i>laricina</i> | Low |
| 71 | subalpine larch | <i>Larix</i> | <i>layallii</i> | Low |
| 73 | western larch | <i>Larix</i> | <i>occidentalis</i> | Low |
| ??? | Scots pine | <i>Pinus</i> | <i>sylvestris</i> | Low |
| 119 | Western white pine | <i>Pinus</i> | <i>strobus</i> | Low |
| 202 | Douglas-fir | <i>Pseudotsuga</i> | <i>menziesii</i> | 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