Spatially defining relationships between ESA-listed species and pesticide uses in agricultural crops

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OBJECTIVE

In the conduct of Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) risk assessments related to evaluating the potential risk of pesticides to ESA-listed species, the EPA Office of Pesticide Programs (OPP) relies upon various sources of data, including spatial and temporal, that can help define "proximity" of a known species location or habitat to potential product use. Additionally, the Services (USFWS and NOAA NMFS), who are responsible for management of listed species, are concerned about the spatial representation of crop locations when FIFRA endangered species matters are forwarded to them for consultation. This poster describes datasets obtained and aggregated by the FIFRA Endangered Species Task Force (FESTF) and illustrates how these datasets are used in the FIFRA risk assessment setting to spatially define relationships between ESA-listed species and proposed product use in agricultural crops. A process for defining these relationships in rotational crop systems, or in crop systems over time is also explored.

SPATIAL DATASETS

FESTF obtains, aggregates, and corrects (with documentation where needed) data from the various data sources described below. Benefits and shortcomings associated with these data sources are also discussed.

Federally Listed Species

Due to inaccessibility or restricted access to survey sites, data sensitivity, release policies and budget and time constraints, all areas for all listed species have not been thoroughly surveyed. As such, gaps may exist in any of the individual sources described below. In addition, not all data sources provide species location data at the same resolution. To address these issues, FESTF obtains, aggregates and maintains as current data from all of the sources below to develop the most complete and comprehensive dataset available, making it the "best available" nationally aggregated dataset on federally listed species. This helps to ensure that all potential species locations are addressed in a national-level endangered species assessment.

- FESTF MJD – Via a licensing agreement with NatureServe, the developer of the only fully aggregated national dataset on species distribution in the U.S, FESTF obtains access to specific location data on listed species, from NatureServe's Multi-Jurisdictional Database (MJD). FESTF's licensed database is accessible to members with proper access via the FESTF MJD, a website that includes detailed biological data, access to spatial data files for use in GIS, and a map viewing window. Species locations in the FESTF MJD, referred to as Element Occurrences (EOs), are represented as polygon features and are either plotted manually or mapped in GIS using Biotics Mapper (a mapper tool developed by NatureServe) (NatureServe, 2009). Figure 1 shows the distribution of species location data in the currently licensed FESTF MJD.

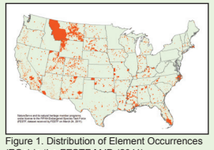

Figure 1. Distribution of Element Occurrences (EOs) in the FESTF MJD (2011)

- Data Providers – FESTF obtains the location of listed species from Natural Heritage Programs and other data providers (Figure 2), to fill in data gaps in the FESTF MJD.

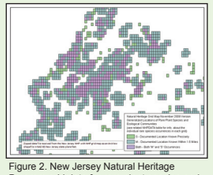

Figure 2. New Jersey Natural Heritage Program grid data for rare plant species and ecological communities

- USFWS – Because (1) data on specific locations are missing for some species, and (2) the Services are the regulatory authority for describing species locations, Species-by-County locations are obtained from "presence by county lists" from state FWS office websites.
- NMFS – Similar to recovering data from FWS to assure completeness, county and sub-county species locations for NMFS-regulated species are obtained from GIS shapefiles provided by NMFS personnel.
- Species Experts – Additional county and sub-county species locations (shapefiles and textual descriptions) are obtained from species experts, when possible.

Designated Critical Habitat

Compared to locations of federally listed species, locations of designated critical habitat boundaries are less sensitive in terms of data release and more precise in terms of spatial definition. Some Federal Register Notices designating critical habitat contain a spatial component and GIS data for critical habitat boundaries while others provide only textual descriptions. Interpreting such descriptions naturally leads to uncertainty in any further species assessment activities. The Services issued a proposed rule to make new designations or revisions to critical habitat boundaries in data files available to the public (see 76 FR 28405).

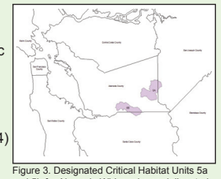

Figure 3. Designated Critical Habitat Units 5a and 5b for Alameda Whipsnake as delineated by UTM Zone 10, NAD83 coordinates obtained from 71 FR 190

FESTF obtains and aggregates data from:

- Federal Register Notices (Figure 3)
- USFWS Critical Habitat Portal (Figure 4)
- Lead FWS Region for the species in question
- NMFS Critical Habitat Maps and GIS data

Agricultural Crops

FESTF's agricultural crop spatial data sources are:

- National Land Cover Database (NLCD) (USGS LCI, 2001) - Provides sub-county spatial data categorized by land use classes; class 82 represents cultivated crops and class 81 represents pasture/hay. When assessing potential exposure to a specific crop, these classes may overestimate. Conversely, this dataset is useful when representing locations of multiple crops.

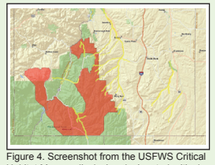

Figure 4. Screenshot from the USFWS Critical Habitat Mapper displaying designated critical habitat for the Mexican Spotted Owl and Preble's Meadow Jumping Mouse in Douglas County, CO

- USDA Agricultural Statistics and Census - Provides reported acreage of crops in each county but does not provide sub-county spatial data.
- Cropland Data Layer (CDL; USDA NASS, 2010) - Provides sub-county spatial data for specific crop locations but not all crops are represented.
- State-generated land use data.

Due to these shortcomings and in response to our understanding of EPA's current assessment approach, FESTF utilizes a combination of these data sources, as appropriate, to represent the location of agricultural crops.

APPROACHING AN ENDANGERED SPECIES ANALYSIS

In the conduct of national-level endangered species analyses, the spatial datasets described above, along with additional FESTF-aggregated data described below, are utilized based on FESTF's understanding of OPP and Services' needs and requirements for data supporting a national-level assessment.

Proximity Analyses

Where sub-county data are available, proximity analyses in GIS determine the distance between species or critical habitat locations and potential pesticide use sites. Analyses are conducted using EOs from the FESTF MJD and critical habitat spatial datasets described above along with agricultural crop spatial datasets (Figure 5).

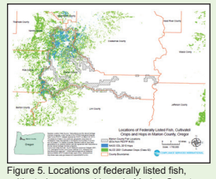

Figure 5. Locations of federally listed fish, cultivated crops, and hops in Marion County, Oregon

The minimum distance is used to assess whether or not exposure is likely based on spatial separation. This process was utilized by the EPA in the Registration Review Draft Ecological Risk Assessment and Effects Determination for Clomazone (2009). Species, designated critical habitat, or species locations outside the minimum distance of concern can be eliminated from the need for further analysis.

Additional FESTF-Aggregated Data to Enhance Spatial Data

Currently, FESTF's "best available" spatial data on species locations are not fully representative of all sub-county locations. In fact, sub-county location data are available for less than half of all species locations requiring assessment in a national evaluation. Therefore, additional data types must be assembled and utilized to assist in the conduct of a national endangered species evaluation related to pesticide use in agricultural crops. In addition to biological data (such as habitat) available in the FESTF MJD, FESTF has compiled data on:

1. Primary Constituent Elements (PCEs) – Physical and biological features identified by the Services as necessary for survival and reproduction of a species
2. Diet and dependencies such as reproduction and habitat requirements
3. Size information (Box 1)
4. Plant habitat descriptions and classifications

Common Name	Adult Weight (g)	Adult Length (cm)	T-REX or T-HERPS Class Bias (if applicable)	Source for Adult Values
Puerto Rican crested toad	Average Male Weight= 17.92 g; Average Female Weight 38.33 g.	4.3 to 11.4 (snout to vent)	>1.7g <37g	Length: Beacham's Volume 2, p. 691 Weight: HABITAT CHARACTERIZATION FOR THE PUERTO RICAN CRESTED TOAD (Peltophryne [Bufo] lemur) AT GUÁNICA STATE FOREST, PUERTO RICO. 2006. Master of Science Publication. 2006. Jaime J. Mateo-Torres. University of Puerto Rico. Mayaguez Campus. Found on-line on Dec 9, 2009 at http://grad.uprm.edu/tesis/matostorres.pdf
California red-legged frog	12.75-163 (adult male) 8.7-238 (adult female)	5.2-11.8 (adult male) 5.0-13.1 (adult female)	>1.7g <=238g	EPA. Undated. Effects Determination for the California Red-legged Frog and other California Listed Species. Attachment 1: Status and Life History of California Red-Legged Frog. Page 2. Found on-line on March 22, 2011 at http://www.epa.gov/oespp/litstatus/effects/redleg-frog/attach1.htm
Mountain yellow-legged frog	16.6	8	>1.7g <37g	Length: NatureServe, 2009. NatureServe Central Databases. Arlington, Virginia. U.S.A. Licensed to and received by the FIFRA Endangered Species Task Force from NatureServe, June, 2009. Weight: Fellers, Gary; Bradford, David; Pratt, David; and Wood, Leslie 2008, Experimental Repatriation of Mountain Yellow-legged Frogs (Rana mucosa) in the Sierra Nevada of California: U.S. Geological Survey Open-File Report 2008–1144, 56 p. Available at http://pubs.usgs.gov/of/2008/1144/. Average taken from Table 9.

Box 1. Examples of size information for federally listed species compiled by FESTF

NEW SPATIAL DATA PRODUCTS UNDER DEVELOPMENT

Due to the changing nature of species and crop location data, the source databases described above require regular updates and validation. Also, additional agronomic factors, such as crop rotations, crop trends and future use must be accounted for in the assessment process. FESTF is currently developing data to address:

Rotational Crop Systems

Many agricultural crops are part of a rotational crop system and FESTF is exploring the validity of an approach to define relationships between listed species and crops in such systems. One manner of depicting this can be accomplished by the following steps:

Step 1: For the crop of concern, consult USDA ARS publications for predominant rotational practices.

Step 2: Download the most recent year of CDL data for the area of interest and the next most current years of CDL data that will represent the rotation cycle (i.e., if the rotation cycle is three years, download the most recent, consecutive three years of CDL data) (Figure 6).

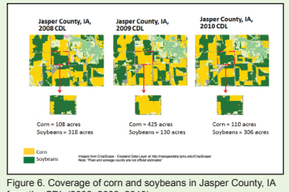

Figure 6. Coverage of corn and soybeans in Jasper County, IA from the CDL (2008, 2009, 2010)

Step 3: Determine the combined crop coverage for the years of interest.

Step 4: Use species location data from the FESTF MJD to determine the distance between a listed species and the crop of interest, using the combined data layer.

Determining Potential Future Use

To account for potential future use of a pesticide in a particular crop, FESTF is exploring a few approaches; Approach 1 is intended for crops with specific soil and climate requirements and Approach 2 applies to more adaptable crops. Within each approach are the steps used to generate the needed data.

Approach 1: Soil and climate requirements of crop determine potential future use

Step 1: For the crop of concern consult USDA ARS publications, or other reliable sources for growing conditions.

Step 2: Obtain information from soil surveys and/or climate data in area of interest. Include land capability classification from USDA NRI (Box 2; Figure 7).

Step 3: Determine land suitability for crop by comparing the soil and climate requirements of the crop in question, along with land capability classification, to soil survey and climate data in the area of interest.

Land Capability and Suitability. Some measures of land quality are used to monitor the capability or suitability of land for a particular purpose, such as growing crops or trees, grazing animals, or nonagricultural uses. Data on two commonly used measures--land capability classes (LCC) and the prime farmland designation--have been collected in the National Resources Inventory (NRI), conducted by USDA's Natural Resources Conservation Service (NRCS) every 5 years (USDA, 1994 and 1998b). (See appendix for a description of the NRI.)

Land capability classes range from I to VIII. Class I, about 7 percent of U.S. cropland, has no significant limitations for raising crops (Table 1.3.1). Classes II and III make up just over three-fourths of U.S. cropland and are suited for cultivated crops but have limitations such as poor drainage, limited root zones, climatic restrictions, or erosion potential. Class IV is suitable for crops but only under selected cropping practices. Classes V, VI, and VII is suited only for wildlife habitat, recreation, and other nonagricultural uses (USDA, 1989a).

Box 2. Land Capability and Suitability from USDA ERS (2001)

For example, highbush blueberries require sandy soils with high organic matter and a pH between 4.2 and 4.8 and typically cannot survive temperatures below -20°F (Pritts, undated). Climate and soil data (including land capability classification) can be used to determine locations that cannot support the growth of highbush blueberries.

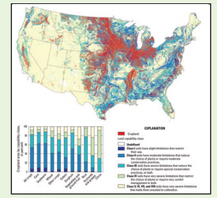

Figure 7. Location of cropland on each land capacity class and the percentage of cropland area for each capability class for selected crops in the conterminous United States (taken from Figure 16 in Baker and Capel, 2011).

Approach 2: Crop trends determine potential future use

Step 1: Compile reported harvested acreage data from multiple Census of Agriculture (ex. 1997, 2002 and 2007) to represent where the crop is or has been grown.

Step 2: Use information in Step 1 to determine trends in land used for a particular crop. This can be further confirmed using environmental factors that may limit crop extent, and examining other trends in land use, such as urban development.

For example, rice has not been reported in Monterey County, California, in the past 10 years (from Census of Agriculture (1997, 2002, or 2007) so it can be surmised that exposure to species locations within this county to a pesticide used on rice is not likely. This is confirmed with data describing the extent of cropland supporting rice based on environmental factors such as climate (Figure 8).

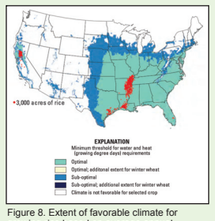

Figure 8. Extent of favorable climate for growing rice based on average annual growing degree-days and precipitation (1970-2001) and location of rice for the conterminous United States (taken from Figure 11 in Baker and Capel, 2011).

Additionally, due to the fact that "once converted to an urban area, land seldom shifts back to an agricultural use" (pg 17, UDSA, 2001), urban areas can be defined (Box 3) and used to determine where cropland is not likely to occur in the future.

Urban Area

Nationally, there are two sources of data on urban area. First, the Bureau of the Census, U.S. Department of Commerce, compiles urban area every 10 years, coincident with the Census of Population. Second, The Natural Resources Conservation Service, U.S. Department of Agriculture, publishes developed land, including urban components, at five-year intervals as part of the national Resources Inventory (NRI).

Urban area (Census) is technically defined by the bureau of the Census and consists of cities, towns and Census designated places of 2,500 or more persons, including urbanized areas with populations of 50,000 or more--central cities and their "urban fringe" (BOC; 1992). Included in this definition are residential areas and concentrations of nonresidential urban parks and recreational areas; and other land within urban defined areas. The definition allows for exceptions and special cases, and has changed slightly from decade to decade. Portions of extended cities that are essentially rural in character are excluded.

Developed land (NRI) in the National Resources Inventory consists of urban and built-up areas, as well as land devoted to rural transportation.

Urban and built-up areas consist of residential, industrial, commercial, and institutional land; construction and control structures, small parks, and transportation facilities within urban areas.

Large urban and built-up areas include developed tracts of 10 acres and more.

Small built-up areas include developed tracts of 0.25 to 10 acres, which do not meet the definition of urban area, but are completely surrounded by urban and built-up land.

Rural transportation land includes highways, roads, railroads and rights-of-way outside of urban and built-up areas.

Box 3. Definition of Urban Area from USDA ERS (2001)

CONCLUSIONS

FESTF has identified how defining relationships between federally listed species and pesticide use in agricultural crops is accomplished using species, critical habitat, and crop location data. Definition and refinement of these relationships should be based on various sub-county and county level data as well as spatial and non-spatial datasets. FESTF is also exploring and validating approaches to define such relationships in rotational crop systems and when potential future use needs to be accounted for. These relationships are important to FIFRA risk assessments related to evaluating the potential risk to federally listed species.

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COMPLIANCE SERVICES INTERNATIONAL

FESTF FIFRA Endangered Species Task Force