**Chapter 1 –** **Imidacloprid Problem Formulation**

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# Introduction

This Biological Evaluation (BE) for imidacloprid makes effects determinations for all federally listed endangered and threatened species, as well as those that are proposed and candidates for listing and experimental populations (in sum referred to as “listed species”). In addition, this BE includes an analysis of designated critical habitats for listed species that may overlap with the registered use areas for imidacloprid. The methods employed in this BE follow the Revised Method for National Level Listed Species Biological Evaluations of conventional pesticides (referred to as the “Revised Method”) [[[1]](#footnote-2)].

This chapter describes the problem formulation (PF) which is the first step of ecological risk assessment. The PF establishes the goals, scope, and focus of the assessment. It is a systematic planning step that identifies major factors to be considered in a particular assessment.

Included in this chapter is a description of the federal action, the mode and mechanism of action of imidacloprid, summaries of its uses (based on registered product labels), usage, overview of environmental fate, identification of the residue of concern, and an analysis plan for how the BE will be conducted.

Description of the Federal Action

In 2006, the U.S. Environmental Protection Agency (EPA) initiated Registration Review to reevaluate all registered pesticide active ingredients on a regular cycle. EPA is required to review each pesticide active ingredient at least every 15 years to ensure that it has the ability to assess risks to human health and the environment as science evolves and policies and practices may change, all pesticide products in the marketplace continue to meet the standard of registration. Registration Review includes labels registered under Sections 3, 24(c), and 18 of FIFRA. The federal action relevant to this BE is the Registration Review for imidacloprid, which encompasses the review of all the registered uses and the approved product labels for all pesticide products containing imidacloprid.

Mode and Mechanism of Action

Imidacloprid (IUPAC name: N-[1-[(6-chloropyridin-3-yl)methyl]-4,5-dihydroimidazol-2-yl]nitramide) is a systemic, neonicotinoid insecticide which acts on the insect nicotinic acetylcholine receptors (nAChRs) of the nervous system via competitive modulation (IRAC 2016). Imidacloprid is in the N-nitroguanidine group of neonicotinoids (IRAC subclass 4A) along with clothianidin, thiamethoxam and dinotefuran[[2]](#footnote-3). Its mode of action on target insects (terrestrial and aquatic) involves out-competing the neurotransmitter acetylcholine for available binding sites on the nAChRs (Zhang et al. 2008)[[3]](#footnote-4). At low concentrations, neonicotinoids cause excessive nervous stimulation and at high concentrations, insect paralysis and death will occur (Tomizawa and Casida 2005)[[4]](#footnote-5). Imidacloprid is a xylem and phloem-mobile systemic compound that is readily taken up by the roots of the plant and translocated throughout the plant via the transpiration stream[[5]](#footnote-6).

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Use and Usage Characterization

Use data are based on registered product labels and include pesticide application information relevant to a treatment site (*e.g.*, an orchard). EPA determines the uses based on registered labels and defines crop or non-crop sites to which a pesticide may be applied. Use data also describe the labeled maximum single use rates, numbers of applications, minimum re-treatment intervals and method(s) of application (*e.g.,* aerial, ground and/or seed treatment).

Usage data describe how the pesticide has been applied to multiple use sites within a state, region or the entirety of the United States. EPA also reviews actual usage data that documents the actual applications of a pesticide, including information such as actual application rates and timing, and spatial distribution of applications across multiple sites (usually based on survey data). The key difference between use and usage is potential applications verses actual applications, respectively.

## Use Data (as Defined on Registered Product Labels)

The label on a pesticide package or container is legally enforceable. The label provides information about how to handle and safely use the pesticide product and avoid harm to human health and the environment. Using a pesticide in a manner that is inconsistent with the use directions on the label is a violation of FIFRA and can result in enforcement actions to correct the violations. This BE assesses the legal uses of imidacloprid as described on registered pesticide labels.

Imidacloprid is used on a wide variety of terrestrial food crops, as well as uses in turf management, ornamental production, and residential settings. There are currently twenty registrations for technical grade active ingredient and twelve formulation intermediates. Typical end use products (TEPs) include the following formulations: granules; ready-to- use solutions; emulsifiable concentrates; flowable concentrates; water soluble packaging; pelleted/tableted products; water dispersible granules; wettable powders; impregnated materials; dust; solid soluble concentrates; and pressurized liquids. End use products are applied as: liquid spray or drench; broadcast or in-band granules; broadcast or in station baits; and as seed coating.

TEP use patterns may be categorized into two main categories: ***agricultural*** and ***non-agricultural***.

***Agricultural*** use patterns include the following:

* + 1. Foliar use patterns where TEPs are diluted and applied directly to the crop foliage as liquid spray mainly by ground, air or airblast for tree crops;
    2. Soil use patterns where TEPs are either diluted and applied directly to the soil as liquid spray/drench, or applied as is directly into the soil (*e.g.,* granules); and
    3. Seed treatment use patterns where TEPs are applied to the seeds in various procedures.

Additionally, for certain use patterns, imidacloprid can be applied to the same crop through various application methods within the same growing season. For example, imidacloprid can be applied to stone fruits via a soil application which is then followed by a foliar application so long as the maximum annual use rate does not exceed 0.5 lbs. a.i/A; in a few crops, this maximum annual use rate is <0.5 lbs. a.i/A.

**APPENDIX 1-1** contains a list of the crops belonging to designated crop groups and subgroups on various imidacloprid labels. Detailed information on agricultural use patterns was extracted from the labels and is presented in summary tables in **APPENDIX 1-1** for foliar application, soil application and seed treatment. **Table 1-1** contains a summary of registered agricultural use patterns of imidacloprid showing registered combinations for each use.

Table 1-1. Summary of Registered Agricultural Use Patterns for Imidacloprid

| **Crop or Crop Group** | **Foliar1** | **Soil1** | **Seed Treatment1** |
| --- | --- | --- | --- |
| Artichoke, Globe | **X** | **X** | Not Registered |
| Berries and Small Fruits | Caneberry, bushberry, grape and strawberry | Caneberry, bushberry, grape, cranberry, and strawberry | Not Registered |
| Brassica (Cole) Leafy Vegetables | **X** | **X** | Broccoli and mustard |
| Bulb Vegetables | Not Registered | **X** | Onion, leek, and scallion |
| Cereal Grains | Not Registered | Not Registered | **X** |
| Citrus Fruits | **X** | **X** | Not Registered |
| Coffee | **X** | **X** | Not Registered |
| Cucurbit Vegetables | Not Registered | **X** | Not Registered |
| Fruiting Vegetables | **X** | **X** | Not Registered |
| Herbs and Spices | **X** | **X** | Borage and mustard |
| Hops | **X** | **X** | Not Registered |
| Leafy Green Vegetables | Leafy green vegetables | **X** | Not Registered |
| Legume Vegetables | **X** | Legumes vegetables except soybean | **X** |
| Oilseeds | Cotton | Cotton | **X** |
| Peanuts | **X** | **X** | **X** |
| Pome Fruits | **X** | **X** | Not Registered |
| Root and Tuber Vegetables | Potato, tuberous, and corm | **X** | Sugar beet, root vegetables, and potato |
| Stone Fruits | **X** | **X** | Not Registered |
| Tobacco | **X** | **X** | Not Registered |
| Tree Nuts | **X** | **X** | Not Registered |
| Tropical and subtropical Fruit | **X** | **X** | Not Registered |
| 1 **X =** Use permitted and can be combined for the crop or the whole crop group unless crops are specified. For example, foliar and soil application is permitted/can be combined for Brassica, but seed treatment is permitted to broccoli and mustard only. In this case, foliar/soil/seed treatment are permitted to broccoli and mustard; No use: use is not permitted | | | |

***Non-agricultural*** use patterns include the following:

1. Turf & ornamentals in nurseries and residential/commercial areas;
2. Poplar/cottonwood and Christmas tree plantations;
3. Forestry;
4. Bait & pellets in farms/residential/commercial areas;
5. Pet collars; and
6. Controlling burrowing shrimp in commercial shellfish beds in Willapa Bay, WA.

A summary of labeled non-agricultural use patterns are also included in **APPENDIX 1-1**. Furthermore, a master use summary table and the summary table used in aquatic modeling are included in **APPENDIX 1-2** and **APPENDIX 1-3,** respectively.

## Usage Data

Between 2013 and 2018, for all the registered uses of imidacloprid, cumulatively the annual average agricultural usage was approximately 891,400 pounds of imidacloprid whereas the total treated acreage was 5.6 million. During this time frame, the crops with the most usage in terms of average annual total pounds of active ingredient applied were cotton (200,000), grapes (for wine) (100,000), potatoes (80,000), oranges (80,000), tomatoes (60,000), peanuts (60,000) and soybeans (50,000). The crops with the most usage in terms of total treated acreage were the same with 1,500,000, 1,300,000, 400,000, 300,000, 300,000, 300,000 and 200,000 acres treated for cotton, soybeans, potatoes, tomatoes, oranges, grapes for wine, and peanuts, respectively. On average, the states with the most agricultural usage in terms of pounds applied on average, per year were California with ~320,000 pounds, Florida with 65,900 pounds, Georgia with 49,600 pounds, North Carolina with 45,000 pounds, Idaho with 40,000 pounds and Texas with 40,000 pounds. Other states with between <500 and 23,000 pounds applied annually included WA, AZ, LA, MI, IL MO, MS, KY, IA, ME, WI, TN, VA, PA, OK, NY, OR, CT, MA and MN **(APPENDIX 1-4**).

The most recent non-agricultural usage data from 2014, 2015 or 2016 depending on the use site (see **APPENDIX 1-4** for details) shows that the largest use in terms of average annual pounds applied is application to application to building sites for termite control (220,000 pounds), followed by indoor and outdoor premises of household/domestic or occupational/manufacturing/processing/industrial areas, ranging from (2,000 up to 80,000 pounds), and tree sites (5,000 pounds)**.** Other use sites were not surveyed including ornamentals in nurseries, turf (sod, golf course and other types of turf) in addition to bait applications to control insects, rodents, ground squirrels and others.

Seed treatment with imidacloprid is generally considered to be widespread in terms of the number of crops and the percentage of the crop planted with treated seed. However, quantitative seed treatment usage data are difficult to obtain due to the complexities of capturing this usage information from growers. While verifiable quantitative usage data that indicate the total pounds active ingredient used to treat seed or the location and the number of acres planted with treated seed are not currently available, applications of imidacloprid to seed and seed pieces may be generally characterized as commonly used on a wide variety of crop seeds and seed pieces for planting based on extension recommendations and other information.

# Overview of Environmental Fate

The major transport routes from imidacloprid treated areas are runoff and spray drift. Information on leaching and adsorption/desorption indicate that imidacloprid is considered moderately mobile according to the Food and Agricultural Organization (FAO) mobility classification system[[6]](#footnote-7). Based on physical chemical properties as well as empirical data, imidacloprid is highly soluble in water, volatilization from soil and water surfaces is not expected to be a major transport pathway and most likely not a concern for long-range transport. A low octanol-water partition coefficient (Kow of 3.7) suggests that imidacloprid will have a low tendency to accumulate in aquatic and terrestrial organisms.

Imidacloprid is stable to abiotic hydrolysis and highly persistent in aerobic soil/aquatic systems based on the Goring persistence scale[[7]](#footnote-8) (half-lives 254 and 236 days, respectively). In contrast, the chemical is non-persistent to photolysis in shallow clear waters (half-life= 0.2 days). Additional details on the fate of imidacloprid are provided in **Chapter 3** of the Biological Evaluation.

# Residue of Concern

As discussed in **Chapter 3**, imidacloprid is empirically shown to degrade into various products through multiple pathways. Metabolites identified from aerobic soil metabolism studies include IMI-olefin, nitrosamine, guanidine, and 5-keto urea isomers. The formation rates of the degradates from this pathway do not exceed 2% of the applied parent and residues are therefore considered to be minor. Conversely, in the aqueous photolysis pathway, imidacloprid degradates to the guanidine and urea metabolites at rates up to 17 and 10% of the applied residues, respectively. Formation rates for guanidine also reach 12 and 21% for the aerobic and anaerobic aquatic metabolism pathways, respectively. For aquatic organisms, available acute toxicity data for the guanidine and urea degradates indicate their toxicity is at least 3 orders of magnitude less than that of imidacloprid. Therefore, the stressor of concern for aquatic and terrestrial organisms (except terrestrial invertebrates) in this assessment is determined to be imidacloprid alone.

For terrestrial invertebrates, there is data that indicates two plant-derived metabolites (IMI-olefin and IMI-5-OH) are of similar toxicity as imidacloprid to the honey bee, while other metabolites are much less toxic (*e.g.* 6-CNA and urea). These metabolites are produced within treated plants. Therefore, based on similar toxicity of imidacloprid and its plant metabolites to bees (IMI-olefin, and IMI-5-OH), and their occurrence in pollen and nectar, the primary stressors of toxicological concern for terrestrial invertebrates in this assessment are imidacloprid, IMI-olefin, and IMI-5-OH.

# Analysis Plan

Listed species and designated critical habitats that were listed as of Nov 1, 2020 are considered in this BE (see **APPENDIX 4-1** for complete species lists). Effects determinations were made for 1821 listed species and 791 designated critical habitats.

As described in the Revised Method[[8]](#footnote-9), listed species risk assessments for pesticides include three steps. Steps 1 and 2 are represented by the BE, which evaluates whether an individual of a listed species is reasonably expected to be exposed to a pesticide, and, if so, distinguishes effects that are likely to adversely affect an individual of a species from those that are not likely to adversely affect an individual. This process is also applied to the designated critical habitat of listed species (when available). In Step 1, for every listed species and designated critical habitat, EPA determines whether imidacloprid will have No Effect (NE) or May Affect (MA) (separate determinations made for each species and critical habitat). For those species and critical habitats with MA determinations in Step 1, EPA will determine if imidacloprid is Not Likely to Adversely Affect (NLAA) or Likely to Adversely Affect (LAA) each individual species or critical habitat.

Details on the method, models and tools used for making NE, NLAA and LAA determinations are provided in the Revised Method. This analysis plan identifies imidacloprid-specific information that is used in the Revised Method to complete this BE.

Step 1 begins with an analysis of the potential overlap of the action area and individual species ranges or critical habitat. For species or critical habitats with no overlap (*i.e.,* species found outside of the action area), NE determinations are made. The currently registered uses (summarized in **Section 4, APPENDIX 1-2** and **APPENDIX 1-3**) include agricultural and non-agricultural uses. The imidacloprid overlap analysis is conducted using ArcGIS version 10.8. All labeled uses for imidacloprid are represented by one or more of the agricultural or non-agricultural Use Data Layers (UDL) created from a variety of landcover, land use and supplemental data sources (see **APPENDIX 1-6** for details). Agricultural and non-agricultural use sites are combined to derive the action area (along with the associated off-site transport zone).

A number of spatial data sources are used to generate Use Data Layers (UDLs), which map the potential use sites for imidacloprid. In the contiguous United States (ConUS), agricultural use pattern UDLs are represented by using the US Department of Agriculture’s (USDA) Crop Data Layer (CDL)[[9]](#footnote-10). This analysis utilizes data from 2013-2017. **APPENDIX 1-5** includes a crosswalk between crops found in the CDL and the resulting UDL while **APPENDIX 1-6** includes a crosswalk between imidacloprid’s registered agricultural crops and those UDLs. **APPENDIX 1-5** also defines how individual CDL layers are grouped into UDL categories[[10]](#footnote-11) and temporally combined to account for the accuracy of the data. USDA’s 2012 Census of Agriculture (CoA) is also used to improve accuracy of the individual UDLs by expanding the agricultural UDLs to meet or exceed the reported acres in the CoA as needed (see **APPENDIX 1-5** for additional information on the UDLs and **ATTACHMENT 1-3** for additional information on extracting the acres from the CoA). The CDL is only available for ConUS, so other data sources are used to represent agricultural areas in states and US territories outside of ConUS (referred to as NL48[[11]](#footnote-12)). In Alaska and Puerto Rico, the US Geological Survey’s 2016 and 2001 National Land Cover Dataset (NLCD)[[12]](#footnote-13) are used, respectively. In Hawaii, Guam, American Samoa, Virgin Islands and Northern Mariana Islands, the National Oceanic and Atmospheric Administration’s Coastal Change Analysis Program (C-CAP)[[13]](#footnote-14) data from 2004-2012 are used. For non-agricultural use patterns in ConUS and NL48 additional UDLs are created to represent imidacloprid’s registered uses. The data sources used for these UDLs included but were not limited to the NLCD 2016, GAP Protected Areas Database, LandFire and NAVTEQ. A new non-agricultural layer representing possible poultry litter applications was developed for use in this BE. Due to the limited availability of GIS data in some of the NL48 regions, the Field Nurseries UDL could not be created in Commonwealth of the Northern Mariana Island, Guam, and America Samoa. **APPENDIX 1-6** summarizes all spatial data used to generate the agricultural and non-agricultural UDLs used for imidacloprid’s potential use site footprints in the ConUS and NL48.

The Step 2 overlap analysis incorporates imidacloprid usage data, which are provided in the SUUM (SIAB Use and Usage Matrix), combining it with information from the CoA 2017 (**APPENDIX 1-4, ATTACHMENT 1-4**). **APPENDIX 1-7 and 1-8** describe how the usage data for imidacloprid, the CoA 2017, and the potential use sites are combined to estimate the number of treated acres relevant to a given species located in ConUS or NL48 (respectively). These appendices also explain how the off-site transport zone (specifically spray drift) is adjusted based on available usage data.

The Revised Method document stated “Over time, EPA expects to update the MAGtool and other models and tools described in this document. When a pesticide BE is conducted, it will incorporate the most current versions of models and tools intended for use in the BEs.” This BE is consistent with the Revised Method and updates include a refined exposure model for plants inhabiting terrestrial, wetland and aquatic habitats and updates to the MAGtool to improve accuracy, efficiency and transparency, as discussed below.

To estimate exposures to plants in aquatic, wetland, and terrestrial habitats, this BE uses the Plant Assessment Tool (PAT), a new tool designed to refine screening-level exposure estimates to plants typically generated using TerrPlant. PAT employs mechanistic representations of fate (*e.g*., degradation) and transport (*e.g.*, runoff), using data that are typically available for pesticides, to model runoff and spray drift exposure to terrestrial and wetland environments. For terrestrial plants, runoff and erosion are modeled using the Pesticide Root Zone Model (PRZM; which is part of the Pesticide in Water Calculator (PWC)) and spray drift is modeled using AgDRIFT deposition values (also incorporated into the MAGtool). The model uses a mixing cell approach to represent water within the active root zone area of soil, and accounts for flow through the terrestrial plant exposure zone (T-PEZ) caused by both treated field runoff and direct precipitation onto the T-PEZ. Pesticide losses from the T-PEZ occur from transport (*i.e.*, washout and infiltration below the active root zone) and degradation. Wetlands are modeled using PRZM and the Variable Volume Water Model (VVWM) and are then processed in PAT to estimate aquatic (mass per volume of water) and terrestrial (mass per area) concentrations. Aquatic plant exposure is modeled using the PRZM/VVWM models and the standard pond. The results from PAT are summarized for use in the MAGtool in the same way as the results from PWC.

Since the publication of the Revised Methods, modifications were made to the MAGtool and an updated version was used in this analysis (MAGtool version 2.3.1). Updates to the tool incorporated continued efforts to improve the efficiency, accuracy, and refinement of the tool. These updates are outlined more fully in the MAGtool documentation included on the models[[14]](#footnote-15) website and included incorporation of a new batch function analysis, improvements to spray drift analysis methods and input options, as well as the ability to make effects determinations either deterministically or probabilistically. The model allows the user to make deterministic calculations using the upper and lower bounds of the exposure assumptions, or using a probabilistic analysis, to determine impacts to a species based on mortality effects, sublethal effect or effects to prey, pollination, habitat, and dispersal vectors (PPHD). This was done to provide more transparency to the results calculations and to streamline the calculations for shorter run times. For a subset of species, selected based on the potential to refine the effects analysis, probabilistic analysis was used in making effects determinations. For the majority of species, as impacts are predicted even at the minimum or lower bound of exposure assumptions, the probabilistic analysis does not change the effects determination and was not conducted.

**Chapter 2** of this BE includes imidacloprid’s toxicity endpoints and **Chapter 3** includes the exposure analysis. These toxicity endpoints and exposure estimates are used in Steps 1 and 2. **Chapter 2** also summarizes incident reports that are associated with applications of imidacloprid (incident reports associated with illegal uses or misuses are not included in the assessment). **Chapter 3** summarizes available monitoring data. **Chapter 4** includes the species and critical habitat-specific determinations for imidacloprid. For exposure in terrestrial habitats, the MAGtool[[15]](#footnote-16) (version 2.3.1) is used (additional details in **ATTACHMENT 1-1** and tool documentation). For aquatic habitats, exposure is estimated using the Pesticide in Water Calculator (PWC; version 1.52[[16]](#footnote-17)) and, where appropriate, the Pesticide in Flooded Applications Model (PFAM, version 2[[17]](#footnote-18)). Aquatic scenarios (referred to as “bins”) used to estimate exposures for each listed species with aquatic habitats are provided in **ATTACHMENT 1-2**. For plants, exposure is estimated using PAT. The MAGtool is used to integrate exposure, effects, and listed species life history information in order to make NE, NLAA and LAA determinations.

1. [] Available at: <https://www.epa.gov/endangered-species/revised-method-national-level-listed-species-biological-evaluations-conventional> [↑](#footnote-ref-2)
2. <http://www.irac-online.org/> [↑](#footnote-ref-3)
3. Zhang Y, Liu S, Gu J, Song f, Yao X, Liu Z. (2008). Imidacloprid acts as an antagonist on insect nicotinic-acetylcholine receptor containing the Y151M mutation. Neurosci. Let. 446: 97-100. [↑](#footnote-ref-4)
4. Tomizawa M, Casida J. (2005). Neonicotinoid insecticide toxicology: mechanisms of Selective Action. Annual Review of Pharmacology and Toxicology, 45, 247–268. [↑](#footnote-ref-5)
5. Sur, R. and Stork, A. (2003). Uptake, translocation, and metabolism of imidacloprid in plants. Bulletin of Insectology. 56 (1), 35 – 40. [↑](#footnote-ref-6)
6. FAO. 2000. Appendix 2. Parameters of pesticides that influence processes in the soil. In FAO Information Division Editorial Group (Ed.), *Pesticide Disposal Series 8. Assessing Soil Contamination. A Reference Manual*. Rome: Food & Agriculture Organization of the United Nations (FAO). Available at <http://www.fao.org/DOCREP/003/X2570E/X2570E06.htm> [↑](#footnote-ref-7)
7. Goring et al. (1975) provides the following persistence scale for aerobic soil metabolism half-lives:

   * Non-persistent less than 15 days
   * Slightly persistent for 15-45 days
   * Moderately persistent for 45-180 days, and
   * Persistent for greater than 180 days.

   [↑](#footnote-ref-8)
8. Revised Method for National Level Listed Species Biological Evaluations of Conventional Pesticides. 2020. US EPA. Available at https://www3.epa.gov/pesticides/nas/revised/revised-method-march2020.pdf [↑](#footnote-ref-9)
9. [] USDA National Agricultural Statistics Service Cropland Data Layer. 2013-2017. Published crop-specific data layer [Online]. Available at <https://www.nass.usda.gov/Research_and_Science/Cropland/SARS1a.php> (accessed 3/2018; verified 2/2020). USDA-NASS, Washington, DC. [↑](#footnote-ref-10)
10. [] Categories include: corn, cotton, rice, soybeans, wheat, vegetables and ground fruit, other grains, other row crops, other crops, pasture/hay, citrus, vineyards and other orchards. [↑](#footnote-ref-11)
11. [] where NL is “non-lower” and 48 refers to the number of states in ConUS [↑](#footnote-ref-12)
12. [] Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing, v. 81, no. 5, p. 345-354 [↑](#footnote-ref-13)
13. [] National Oceanic and Atmospheric Administration, Coastal Services Center. 1995-present. The Coastal Change Analysis Program (C-CAP) Regional Land Cover. Charleston, SC: NOAA Coastal Services Center. Accessed at <https://coast.noaa.gov/digitalcoast/data/ccapregional.html> (accessed 3/2020). [↑](#footnote-ref-14)
14. [] Information on the models and tools used to support this biological evaluation are available at: <https://www.epa.gov/endangered-species/models-and-tools-endangered-species-pesticide-assessments> (Accessed September 2020). [↑](#footnote-ref-15)
15. [] Information on the models and tools used to support this biological evaluation are available at: <https://www.epa.gov/endangered-species/models-and-tools-endangered-species-pesticide-assessments> (Accessed September 2020). [↑](#footnote-ref-16)
16. [↑](#footnote-ref-17)
17. [↑](#footnote-ref-18)