**Chapter 1 – Final Carbaryl Problem Formulation**

Contents

[1 Introduction 1](#_Toc66888747)

[2 Description of the Federal Action 2](#_Toc66888748)

[3 Mode and Mechanism of Action 2](#_Toc66888749)

[4 Use and Usage Characterization 2](#_Toc66888750)

[4.1 Use Data (as Defined on Registered Product Labels) 2](#_Toc66888751)

[4.2 Usage Data 4](#_Toc66888752)

[5 Overview of Environmental Fate 4](#_Toc66888753)

[6 Residue of Concern 5](#_Toc66888754)

[7 Analysis Plan 5](#_Toc66888755)

[8 Literature Cited 9](#_Toc66888756)

Introduction

This problem formulation provides the foundation for the carbaryl Biological Evaluation (BE) 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”). This BE also includes an analysis of designated critical habitats. 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). The assessment for carbaryl represents EPA’s Biological Evaluation (BE) for all federally listed species and designated critical habitats.

Included in this chapter is a description of the federal action; the mode and mechanism of action of carbaryl; summaries of its uses (based on registered product labels), usage, and fate; definition of the residue of concern; an analysis plan for how the risk assessment will be conducted and a brief summary of previous FIFRA risk conclusions as well as listed species assessments. As part of the FIFRA registration review process, a detailed Problem Formulation for the FIFRA ecological risk assessment of carbaryl was finalized in September 2010[[2]](#footnote-3) (USEPA, 2010, DP Barcode D374937). The problem formulation considered data needs for both a FIFRA ecological risk assessment and an assessment for potential impacts on listed species.

Description of the Federal Action

In 2006, U.S. Environmental Protection Agency (EPA) initiated Registration Review to reevaluate all pesticides on a regular cycle. EPA is required to review each pesticide active ingredient at least every 15 years to make sure 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 the Federal Insecticide Fungicide Rodenticide Act (FIFRA). The federal action of Registration Review for carbaryl encompasses the review of all the registered uses, and the approved product labels for all pesticide products containing carbaryl.

Mode and Mechanism of Action

Carbaryl is an N-methylcarbamate insecticide. N-methylcarbamate insecticides act by inhibiting acetylcholinesterase, thereby reducing the degradation of the cholinergic neurotransmitter acetylcholine. As a result, inter-synaptic concentrations of acetylcholine increase as the neurotransmitter accumulates, leading to increased firing of the postsynaptic neurons. This may ultimately lead to convulsions, paralysis, and death of an organism exposed to the chemical. Acetylcholinesterase inhibition is rapidly reversed in many taxa once exposure to an N-methylcarbamate insecticide has ended.

Carbaryl is also used as a plant growth regulator to thin blossoms in orchards. Carbaryl’s activity in the abscission of flower buds may be related to its structural similarity to plant auxins, such as α-naphthalene acetic acid.

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 define crop or non-crop sites to which a pesticide may be applied. Use data also describe the maximum application rates, method (*e.g.,* aerial or ground spray), re-treatment intervals and number of applications that may occur according to registered product labels.

Usage data describe how the pesticide has been applied to multiple use sites within a state, region or the US. 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 vs. actual applications.

## 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 carbaryl that are described on registered pesticide labels.

Carbaryl is used on a wide variety of terrestrial food and feed crops, as well as uses in turf management, ornamental production, rangeland, and residential settings. Additionally, carbaryl is used to thin fruit in orchards to enhance fruit size and enhance repeat bloom. Carbaryl is also used to control mud and ghost shrimp and in commercial shrimp ponds in Texas. There are currently five active technical registrants of carbaryl with 61 active product registrations (60 Section 3s and 1 Special Local Needs), which include formulated products (**APPENDIX 1-1**). Carbaryl can be applied in liquid (*i.e*., flowable concentrate, emulsifiable concentrate, wettable powder, water soluble powder), bait, granular, or dust forms. Aerial and ground application methods are allowed, as are pressure sprayers, dust applicators, spreaders and shank applicators, and baits.

Current carbaryl labels are reflective of the attached Master Use Summary (**APPENDIX 1-2**). In general, the single maximum carbaryl application rates do not exceed 9 lb a.i./A nationwide granular formulations and 8.33 lbs a.i./A for flowable formulations. The maximum single application rate is 12 lbs a.i./A for a flowable formulation applied to citrus in California. The maximum annual rate of carbaryl that may be applied to a crop site is 15 lb a.i./A for olives, tree nuts, and pome fruit. The maximum annual rate that may be applied to a non-crop site is 16 lbs a.i./A/year for golf courses, sod farms, and lawns.

Carbaryl is currently registered on a variety of agricultural and non-agricultural use sites (**APPENDIX 1-2**) and to treat some specific pests, as listed below.

**Agricultural:** alfalfa, apple, asparagus, beans, beans (dried type), beets (greens), beets (root), blackberry, blueberry, boysenberry, Brassica (Head and stem) vegetables, broccoli, brussels sprouts, bushberry subgroup 13-07B, cabbage, caneberry subgroup 13-07A, carrot, cauliflower, cherry, citrus crop group 10, clover, collards, cranberry, cucumber, cucurbit crop group 9, dandelion, dewberry, dried shelled pea and bean subgroup 6C, edible-podded legume vegetables subgroup 6A , eggplant, endive, fallow land, field corn, flax, forage crops, fruiting vegetables, grapes, grass forage, grasses grown for seed, hay, horseradish, kale, kohlrabi, leaf petioles subgroup 4B, leafy greens, legume vegetables crop group 7, lettuce, loganberry, melons, nectarine, okra, olive, parsley, peach, peanuts, pear, peas, pepper, pistachio, plum, popcorn, pome fruit crop group 11, potato, prickly pear cactus pads, prune, pumpkin, radish, raspberry, root and tuber vegetables, rutabaga, salsify, small fruits, sorghum, soybeans, spinach, squash, sweet corn, rice, stone fruit crop group 12, strawberry, sugar beet, sunflower, sweet potato, tree nut crop group 14, tobacco, trefoil, turnip greens, walnut

**Non-agricultural**: outdoor household domestic premises, outdoor buildings and structures, perimeter treatments, ornamentals, paths and patios, non-agricultural uncultivated areas, rights of way, fencerows, hedgerows, ornamental lawns and turf, residential lawns, recreational areas, cemeteries, camp sites, golf courses, noncropland, conservation reserve areas, forested areas and rangeland trees, pastures, rangeland, sod farms, and commercial fisheries[[3]](#footnote-4)

**Pests:** Grasshoppers, imported fire ants, nuisance pests, ticks, Mormon crickets

## Usage Data

Based on usage data compiled by EPA’s Office of Pesticide Program’s Biological and Economic Analysis Division (BEAD), approximately 700,000 pounds of carbaryl are used each year for agricultural purposes in the United States (based on a yearly average from 2013 to 2017) (see **APPENDIX 1-4** for details). Approximately 50% of the pounds of carbaryl applied agriculturally are made to two crops (apples and soybeans). Pounds of carbaryl applied to citrus is similar to the pounds applied to soybeans. Approximately, 50% of the acres treated with carbaryl are planted with three crops (apples, pecans and soybeans). Other crops with relatively high usage of carbaryl (at least 20,000 lb/year) include tomatoes, stone fruit, pecans, rice, and asparagus.

Non-agricultural usage information is more limited than the agricultural usage data; however available data show that non-agricultural usage makes up a large portion of the total carbaryl applied. Survey data from 2013 and 2016 indicate that approximately 2 million pounds of carbaryl is applied in non-agricultural use areas with 1.32 million of the 2 million pounds applied to residential areas (by homeowners and professional applicators). Usage on ornamental trees and shrubs and golf course turf all had more than 30,000 lbs of carbaryl applied per year.

# Overview of Environmental Fate

The major transport routes off the treated area for carbaryl include runoff and spray drift. Information on leaching and adsorption/desorption indicate that carbaryl is considered moderately mobile according to the Food and Agricultural Organization (FAO) mobility classification system[[4]](#footnote-5). Based on physical chemical properties as well as empirical data, 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. While detections in precipitation have occurred, the atmospheric half-life for carbaryl is hours and carbaryl should degrade quickly. A low octanol-water partition coefficient (Kow 229) suggests that carbaryl will have a low tendency to accumulate in aquatic and terrestrial organisms. Bioconcentration data confirm this conclusion, with a bioconcentration factor of 45 L/kg-wet weight measured in whole tissues of bluegill sunfish.

EPA determined that the major routes of degradation of carbaryl are hydrolysis and aerobic metabolism. The hydrolysis of carbaryl is pH dependent. At acidic pH (5) the compound is hydrolytically stable, while under neutral (pH 7) and alkaline (pH 9) conditions carbaryl hydrolyzes with half-lives of 12 days and 0.13 days, respectively. In aerobic soils carbaryl half-lives range from 4 to 253 days. These half-lives exhibit a monotonic decrease with increasing pH that is consistent with study results showing the chemical to be susceptible to hydrolysis under alkaline, but not acidic, conditions. Carbaryl photodegrades in water with an observed half-life (at pH 5) of 21 days; this is important in shallow clear acidic waters. Degradation rates for carbaryl are relatively slow (half-life: 68.9 days) under anaerobic aquatic conditions. Metabolism in the aerobic aquatic environment is more rapid, with an observed half-life of 4.9 days in one system. In soil and water under both aerobic and anaerobic conditions the major degradate is 1-naphthol, which is also the major hydrolytic degradate. Available field data indicate that carbaryl dissipation half-lives ranged from 62 to 116 days. Additional details on the fate of carbaryl are provided in **Chapter 3** of the Biological Evaluation.

# Residue of Concern

Three major degradates (*1-naphthol, 1, 4* napthoquinone, and carbon dioxide) were detected in various environmental fate studies. These degradates are not considered to be of toxicological concern because they do not contain a carbamate functional group. Additionally, 1-naphthol can also be generated by a variety of natural and anthropogenic processes, including the breakdown of the polycyclic aromatic hydrocarbon (PAH) naphthalene, its presence in the environment is not necessarily indicative of carbaryl use. Therefore, carbaryl alone is the residue of concern for the ecological risk assessment (see **Chapter 3**).

# Analysis Plan

For the draft BE, effects determinations were made for listed species and designated critical habitats that were listed as of January 30, 2019, but excluded 50 species and 16 critical habitats and 12 newly listed species (since January 30, 2019). For the final BEs, the list was updated to include these excluded species, and compared against the species list as of November 17, 2020 specifically for removal of any species that had been delisted. New species were not included from the 2020 list as there was insufficient time to include those species in the analysis. One species population for the fisher, entity ID 4648 had been delisted under this entity ID in the November 2020 list, but a new species population was still included in the new list under two new entity IDs, that still partially share the area of the range of the former entity ID. For this reason, the fisher, under the entity ID 4648, was retained in the analysis. Effects determinations were made for 1805 listed species and 791 designated critical habitats (see **APPENDIX 4-1** for complete species lists).

As described in the Revised Method, 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 carbaryl 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 carbaryl 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 carbaryl 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 carbaryl overlap analysis is conducted using ArcGIS version 10.8. The action area is derived using potential use sites and the off-site transport zone. The currently registered uses (summarized in **Section 4** and **APPENDIX 1-2**) include agricultural, non-agricultural, and forest areas. For some of carbaryl’s ornamental use patterns, reliable data are not available to map the locations of the potential use sites; specifically, ornamental and/or shade trees. The spatial extents of these non-mappable uses are limited and overlap with other carbaryl uses mapped with the Developed and Open Spaced Developed UDLs, therefore, the non-mappable uses are assumed to be represented by other uses. The total spatial footprint for carbaryl is not affected by this due to the overlap with other mapped uses. So, for carbaryl, agricultural and non-agricultural use sites are used to derive the action area (along with the associated off-site transport zone).

A number of spatial data sources were used to generate Use Data Layers (UDLs), which map the potential use sites for carbaryl. 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)[[5]](#footnote-6). 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 carbaryl’s registered agricultural crops and those UDLs. **APPENDIX 1-5** also defines how individual CDL layers are grouped into UDL categories[[6]](#footnote-7) and temporally combined to reach the accuracy criteria set by EPA of 85%. 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 (**ATTACHMENT 1-3**). 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[[7]](#footnote-8)). In Alaska and Puerto Rico, the US Geological Survey’s 2011 National Land Cover Dataset (NLCD)[[8]](#footnote-9) is used. In Hawaii, Guam, American Samoa, Virgin Islands and Northern Mariana Islands, the National Oceanic and Atmospheric Administration’s Costal Change Analysis Program (C-CAP)[[9]](#footnote-10) data from 2010-2012 are used. For non-agricultural use patterns in ConUS additional UDLs were created to represent carbaryl’s registered uses. The data sources used for these UDLs included but are not limited to the NLCD 2011, GAP Protected Areas Database, LandFire and NAVTEQ; for additional details see **APPENDIX 1-6** which summarizes all spatial data used to generate the agricultural and non-agricultural UDLs used for carbaryl’s potential use site footprints. Due to the limited availability of GIS data in some of the NL48 regions, the Nurseries UDL could not be created in Commonwealth of the Northern Mariana Island, Guam, and America Samoa and the Forest Trees UDL could not be created in America Samoa. A separate UDL specific to fallow area was not created in the NL48 regions because it would be identical to the agricultural UDL. **APPENDIX 1-6** summarizes all spatial data used to generate the agricultural and non-agricultural UDLs used for carbaryl’s potential use site footprints in the ConUS and NL48.

The Step 2 overlap analysis incorporates carbaryl usage data, which are provided in the SUUM (SIAB Use and Usage Matrix), combining it with information from the CoA (**APPENDIX 1-4, ATTACHMENT 1-4**). **APPENDICES 1-7 and 1-8** describe how the usage data for carbaryl, the CoA, 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 includes several method updates that are intended to improve the methods for assessing exposure and effects to plants. These updates include: a refined exposure model for plants inhabiting terrestrial, wetland and aquatic habitats; consideration of new methodology for surrogate endpoints for plants when No Observed Adverse Effects Concentrations (NOAEC) values are not available, updates to the MAGtool to improve accuracy, efficiency and transparency, revision of the spatial footprint for alfalfa and other agricultural grasses (non-grazing areas), pasture/rangeland (grazing areas) and revisions to the aquatic modeling for residential uses. These approaches are discussed below. Changes to the aquatic modeling for residential uses are discussed further in **Chapter 3**.

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 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.

For listed terrestrial and wetland plant species, NOAECs from seedling emergence and vegetative vigor studies are used to represent toxicity endpoints. There are often cases where NOAECs are not available (*e.g*., statistically significant effects occurred at all test concentrations) or are considered unreliable. Consistent with OPP’s longstanding practice, in cases where NOAECs are not available or reliable, an ICx value is used as a surrogate. Based on an analysis of the variability in the dry weight and height data of the controls of commonly tested species in vegetative vigor and seedling emergence studies, x values were assigned based on test type and endpoint (**Table 1-1**; supporting details in **ATTACHMENT 1-5**). This analysis does not consider the biological significance of the percent effect but rather identifies an ICx value at which we have confidence the measured effect is discernible. **Table 1-1**presents the ICx values that can be used as the Step 1 and 2 thresholds when a reliable NOAEC value is not available. However, this method was not necessary to use because a reliable NOAEC was available.

**Table 1-1. Alternate Step 1 and 2 thresholds.**

|  |  |  |
| --- | --- | --- |
| **Test Type**  | **Dry Weight**  | **Shoot Height**  |
| Vegetative Vigor  | IC15  | IC10  |
| Seedling Emergence  | IC20  | IC10  |

 1ICx values can be used as the Step 1 and 2 thresholds when a reliable NOAEC value is not available. However, this method was not necessary to use for carbaryl, because a reliable NOAEC was available.

Based on public comments and continued work to improve the tools, modifications were made to the MAGtool and an updated version was used in the final analysis. 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 website11 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.

In an update to the spatial analysis used for the BE, the final BEs include updates to the pasture and rangeland UDLs and include a new Alfalfa UDL. Cultivated grasses and grass crops, as identified in USDA Cultivated Layers are included in the new Alfalfa UDL. These crops included alfalfa switchgrass, and vetch. This new layer represents alfalfa and other agricultural grasses/non-grazing areas. Non-cultivated pasture/grass areas typically used for grazing are included in the new Pasture/Rangeland UDL. This Pasture/Rangeland UDL (referred to in previous assessments as Rangeland) includes CDL land cover categories, Other Hay/Non- Alfalfa, Pasture/Grass, Pasture/Hay, Pasture from the NLCD in addition to other grazing/rangeland sources outlined in **Appendix 1-6**. Additional information on these updates are available in **Appendices 1-5** and **1-6**.

**Chapter 2** of this BE includes carbaryl’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 carbaryl (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 carbaryl. For exposure in terrestrial habitats, the MAGtool[[10]](#footnote-11) (version 2.3) 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[[11]](#footnote-12)) and, where appropriate, the Pesticide in Flooded Applications Model (PFAM, version 2[[12]](#footnote-13)). 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.

Literature Cited

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1. USEPA. 2020. *Revised Method for National Level Listed Species Biological Evaluations of Conventional Pesticides*. March 12, 2020. Environmental Fate and Effects Division. Office of Pesticide Programs. U.S. Environmental Protection Agency. Available at <https://www.epa.gov/endangered-species/revised-method-national-level-listed-species-biological-evaluations-conventional>. [↑](#footnote-ref-2)
2. Carbaryl Registration Review Docket Folder. <https://www.regulations.gov/docket?D=EPA-HQ-OPP-2010-0230> [↑](#footnote-ref-3)
3. EPA registration number TX020007 allows for use of carbaryl to control mud and ghost shrimp in commercial shrimp ponds. The label requires that water in the treated ponds must be held for two weeks post-application to allow carbaryl degradation, and the pond must then be drained and dried before restocking. EPA, therefore, assumed minimal exposure for this use pattern as the representative model input aerobic aquatic metabolism half-life values range from 2.0 to 18.2 days and carbaryl is expected to degrade before the water is drained; however, some uncertainty with this assumption as degradation may be pH dependent. [↑](#footnote-ref-4)
4. The FAO mobility classification system is recommended for use in exposure assessments in the Office of Pesticide Programs in “*Guidance for Reporting on the Environmental Fate and Transport of the Stressors of Concern in the Problem Formulation for Registration Review, Registration Review Risk Assessments, Listed Species Litigation Assessments, New Chemical Risk Assessments, and Other Relevant Risk Assessments*” (USEPA, 2010). [↑](#footnote-ref-5)
5. 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 02/2021). USDA-NASS, Washington, DC. [↑](#footnote-ref-6)
6. 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-7)
7. where NL is “non-lower” and 48 refers to the number of states in ConUS [↑](#footnote-ref-8)
8. 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-9)
9. 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 02/2021). [↑](#footnote-ref-10)
10. 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 02/2021). [↑](#footnote-ref-11)
11. Available online at: [https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment#aquatic](https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment%23aquatic) (Accessed 02/2021). [↑](#footnote-ref-12)
12. Ibid. [↑](#footnote-ref-13)