**Glyphosate Executive Summary for Draft Biological Evaluation**

This Biological Evaluation (BE) assesses potential risks that registered uses of glyphosate (PC Codes: 417300, 103601, 103604, 103607, 103608, 103613, 103605) may pose to an individual of a listed species or designated critical habitat. The federal action considered in this BE is the Registration Review for glyphosate, which encompasses the review of all the registered uses, and the approved product labels for all pesticide products containing glyphosate.

The term “listed species” includes those that are federally listed as endangered and threatened, as well as those that are proposed and candidates for listing and experimental populations. 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 Revised Method incorporates input from the public, US Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS) and US Department of Agriculture (USDA).

As described in the Revised Method, EPA’s development of this BE includes two steps. The BE includes an evaluation of whether an individual of a listed species is reasonably expected to be exposed to a pesticide at a level that results in a discernable effect, 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 glyphosate 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 2, EPA will determine if glyphosate 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 document.

# General Information

Glyphosate is one of the most widely used herbicides in North America. Glyphosate belongs to the phosphono amino acid class of herbicides and is a foliar, non-selective, systemic herbicide widely used to control weeds in agricultural crops and non-agricultural sites. Glyphosate inhibits an enzyme on the shikimate pathway that is essential for the biosynthesis of some aromatic amino acids in algae, higher plants, bacteria and fungi. Inhibition of this enzyme leads to cell death. Glyphosate is used on a wide variety of agricultural food and feed crops, non-food/feed crops, for plantation/silviculture uses, and for nursery/greenhouse use. Important non-agricultural uses include applications for noxious and invasive weed control in aquatic systems, pastures/rangelands, public lands, forestry, and rights-of-way applications. Glyphosate is also used for general weed control or for lawn replacement/renovation in commercial, industrial, and residential areas (by homeowners, landscaping operators, etc.).

This BE assesses all currently registered labels. The label data used in this assessment were derived from the label/use information compiled by the Joint Glyphosate Task Force (JGTF) and submitted to the Agency to provide further clarification on the label use patterns. **APPENDIX 1-2** provides the use information as further refined by EPA, summarizing details relevant for modeling the maximum use patterns. **APPENDICES 1-2** and **3-1** provide additional details on how these uses were modeled.

Glyphosate is formulated as water-dispersible granules (WG) (80% active ingredient), emulsifiable concentrate (EC) (13.4% - 36.5% active ingredient), water-dispersible liquids (L) (5% - 14.6% active ingredient), ready to use (RTU) (0.81% active ingredient), and soluble concentrate/solid (SC/S) (95.2% - 96.7% active ingredient). Application equipment includes aircraft and various ground equipment. Application is via band treatment, broadcast, crack and crevice treatment, directed spray, edging treatment, ground spray, high volume spray (dilute), low volume spray (concentrate), perimeter treatment, soil broadcast treatment, spot treatment, spray, strip treatment, stump treatment, and wipe-on/wiper treatment. Single application rates are up to 8 pounds active ingredient (as acid equivalents)/acre (lb a.e./A) but are generally 1.55 lb a.e./A for aerial applications and 3.75 lb a.e./A for ground application. Maximum combined annual application rates are up to generally 6 to 8 lbs a.e./A. For some non-agricultural uses, the single application rates were calculated at rates up to 40 lbs a.e./A. These higher rates of 40 lbs a.e./A are calculated by extrapolating up from a smaller area as is expressed on the label (*e.g.,* rate expressed per 150 sq. feet instead of per acre). These rates are interpreted to be relevant for a wide variety of non-crop areas where total vegetation control is desired. In the absence of a pound a.e/acre rate, these calculated rates were selected for modelling and it is noted that this is an area that may lead to refinement should the labels be revised in the future.

Between 2013 and 2018, the national annual total agricultural usage averaged approximately 280 million pounds of glyphosate whereas the average total treated acreage was 285 million. During this time frame, the crops with the most usage in terms of annual average total pounds of active ingredient applied were soybeans (114 million lbs), corn (90 million lbs), and cotton (20 million lbs). The crops with the most usage in terms of total treated acreage were the same with 114, 93 and 19 million acres treated for soybeans, corn and cotton, respectively. Over 21 million pounds of glyphosate are applied to non-agricultural sites annually (**APPENDIX 1-4**).

The major transport routes off the treated area for glyphosate include runoff and spray drift. Glyphosate has a high solubility, low octanol-water partitioning coefficient, low vapor pressure, and low Henry’s Law Constant. These data suggest that glyphosate has a low potential for volatilization and bioaccumulation. It is assumed that the glyphosate salts dissociate rapidly to form glyphosate acid and the counter ion. The main routes of dissipation are microbial degradation under aerobic conditions, and runoff. Glyphosate is expected to reach surface water primarily through spray drift; however, transport in runoff may also occur primarily via sorption of glyphosate-metal complexes to eroded soil. The highest concentrations of glyphosate in surface water are in urban environments and in the vicinity of local use areas. Additional details on the fate of glyphosate are provided in **Chapter 3** of the Biological Evaluation.

Glyphosate is an acid which can be associated with different counter cations to form salts. These different salts, which have separate registrations, are included in this assessment. For comparison purposes, in this assessment, each salt is considered in terms of its “glyphosate equivalent,” (acid equivalent; ae) as determined by multiplying the glyphosate salt endpoint value by the acid equivalence ratio (the ratio of the molecular weight of N-(phosphonomethyl)glycine to the molecular weight of the salt). For the assessment, both application rates and the toxicity endpoint values are expressed as acid equivalents.

Technical glyphosate is practically non-toxic to terrestrial and aquatic animals on an acute exposure basis. Toxicity studies, particularly acute aquatic toxicity studies, show that while some formulated products are less toxic than glyphosate active ingredient alone, others can be up to 2 orders of magnitude more toxic. Formulated glyphosate is moderately to highly toxic to fish, highly to very highly toxic to aquatic invertebrates, moderately toxic to mammals, and slightly toxic to birds on an acute exposure basis. In both terrestrial and aquatic animals, technical and formulated glyphosate demonstrate a variety of growth and reproductive effects at a range of chronic exposure concentrations. Glyphosate has demonstrated adverse effects on growth to both vascular and non-vascular aquatic plants as well as terrestrial plants. There have been over 1,000 reported ecological incidents involving glyphosate use for birds, fish, terrestrial invertebrates, and terrestrial plants. More details on the available toxicity data and incident reports are provided in **Chapter 2**.

# Exposure Methods

Exposure estimates are based primarily on fate and transport model results. Aquatic exposures (surface water and benthic sediment pore water) are quantitatively estimated for representative glyphosate uses in specific geographic regions within generic habitats (referred to as bins) using the Pesticide Root Zone Model (PRZM5) and the Variable Volume Water Model (VVWM)[[2]](#footnote-3) in the Pesticides in Water Calculator (PWC). Aquatic exposure results for the bin(s) most appropriate for the species and/or critical habitat are discussed in **Chapter 3**. Also discussed in **Chapter 3** are available water monitoring data for glyphosate. For terrestrial exposures, existing models [*i.e.*, AgDRIFT, earthworm fugacity model, Terrestrial Herpetofaunal Exposure Residue Program Simulation (T-HERPS), Terrestrial Residue Exposure model (T-REX) and portions of the Terrestrial Investigation Model (TIM)] were combined and modified into a single tool that is referred to as the MAGTool (**Chapter 4**). This assessment replaces EPA’s TerrPlant model with the Plant Assessment Tool (PAT), the latter is a more refined exposure model for terrestrial, wetland and aquatic plants.

# Overlap Analyses

Step 1 of the BE involves an analysis of the potential overlap of the action area and individual species ranges and critical habitat. The action area was derived in ArcGIS 10.7 by combining the data layers representative of glyphosate potential uses plus off-site transport. Due to the broad extent of the potential uses the action area has a minimal off-site transport zone, almost all area is captured as potential use. For this reason, a separate ‘drift layer’ was derived by combining just the off-site transport zone across potential uses then buffering it out to the off-site transport distance estimated using the AgDRIFT model (**APPENDIX 1-6**). The overlaps of action area and individual species’ ranges or critical habitats were calculated. This analysis used spatial data of species’ ranges and habitats from the Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS). In the contiguous United States (ConUS), agricultural potential use sites are represented using the USDA Crop Data Layer (CDL) (**APPENDIX 1-6**). Other data sources are used to represent agricultural areas in states and US territories outside of the contiguous United States, for which the CDL is not available. All species or critical habitats with some overlap of the action area and their range or designated critical habitat, or with some overlap on species that the listed species depends on (**Chapter 4**) are assessed in the MAGTool to make LAA/NLAA determinations.

# Effects Determinations

This BE makes effects determinations (NE, NLAA or LAA) for 1795 listed species, and 792 designated critical habitats. For each species and designated critical habitat, the effects determination is based on the methodology detailed in Chapter 1 of this BE and the Revised Method document[[3]](#footnote-4). No NE determinations were made for any species or designated critical habitats; therefore, all species received a MA determination. All species and critical habitats with a MA determination progressed to the Step 2 analysis where an NLAA or LAA determination is made. NLAA determinations were made for 119 species and 33 species’ critical habitat and LAA determinations were made for 1676 species and 759 critical habitats. Most NLAA determinations were based on a qualitative analysis of species, based on factors such as being presumed extinct or having incomplete exposure pathways. Specific species determinations are provided in **APPENDIX 4-1.**

The MAGTool estimates the number of individuals of a listed species that are potentially affected, incorporating the degree of overlap of a species range with potential use sites and associated usage data for a chemical (and associated off-site transport areas) into the effects determinations. Using the toxicity endpoints for each taxon (**Chapter 2**), the MAGTool utilizes probabilistic methods to assess the likelihood that glyphosate will adversely affect an individual of a given species. To help determine the potential for risk, the MAGtool incorporates many of EPA’s standard pesticide exposure models to estimate exposures to listed species and their prey, pollination, habitat, and dispersal vectors (PPHD). Details on the individual effects determinations are found in **APPENDIX 4-1**. If the model estimates are not considered representative of the exposure of the species (due to an inconsistency in the exposure model and assessed species’ habitat), a qualitative analysis is conducted. In those cases, EPA makes either a LAA or a NLAA determination based on a qualitative weight of evidence. For each LAA determination, this assessment employs three categories (*i.e.,* strongest, moderate and weakest) to characterize the strength of the weight of evidence. Each species or critical habitat was assigned a weak, moderate or strong evidence in the LAA determination based on multiple factors, including: the impact of using less conservative assumptions in the analysis, the quality of the species range or usage data, impacts to both the species and PPHD as opposed to only one, the presence of reported incidents involving the species taxa or PPHD taxa, the presence of monitoring data that exceeds endpoints, exposure only due to spray drift and the likelihood of drift into a species habitat (e.g., if the species inhabits forests).

Of the LAA determinations, the majority (96% of species and 97% of critical habitats) were considered to have moderate evidence. The majority of the moderate evidence designations were based on non-agricultural uses being the main risk drivers and the lack of availability and uncertainty in usage data associated with these use sites. Strongest evidence was found for <1% of species and <1% of critical habitat LAA determinations. Weakest evidence was found for 4% of species and 3% of critical habitat LAA determinations.

Non-agricultural UDLs, including Non-cultivated, Open Space Developed, Right of Way, Forest Trees and Developed were the use sites most frequently associated with predicted impacts to species or critical habitats with LAA determinations, although numerous other non-agricultural and agricultural UDLS may also impact species. The Aquatic Herbicide UDL, which has overlap with all aquatic species ranges and critical habitats, is also anticipated to have potential impacts on aquatic species for which a LAA determination was made. LAA determinations were made for species across all taxa. For certain species, there were uncertainties in the glyphosate effects determinations based on the resolution of spatial data. For species and critical habitats there were uncertainties in the resolution of usage data and the threshold for assessing impacts on PPHD (detailed in **Chapter 4**).Tables 1 and 2 summarize the NE, NLAA and LAA determinations for species and critical habitats. Table 3 summarizes the strength of evidence classifications for the LAA determinations.

**Table 1. Summary of Species Effects Determinations for Glyphosate (Counts by Taxon).**

|  |  |  |  |
| --- | --- | --- | --- |
| **Taxon** | **Step 1 Effects Determinations** | **Step 2 Effects Determinations** | **Totals** |
| **No Effect** | **May Affect** | **Not Likely to Adversely Affect** | **Likely to Adversely Affect** |
| Mammals | 0 | 99 | 24 | 75 | 99 |
| Birds | 0 | 108 | 20 | 88 | 108 |
| Amphibians | 0 | 36 | 0 | 36 | 36 |
| Reptiles | 0 | 47 | 14 | 33 | 47 |
| Fish | 0 | 190 | 11 | 179 | 190 |
| Plants | 0 | 948 | 8 | 940 | 948 |
| Aquatic Invertebrates | 0 | 207 | 22 | 185 | 207 |
| Terrestrial Invertebrates | 0 | 160 | 20 | 140 | 160 |
| Total | 0 | 1795 | 119 | 1676 | 1795 |
| Percent of total | 0% | 100% | 7% | 93% |   |

**Table 2. Summary of Critical Habitat Effects Determinations for Glyphosate (Counts by Taxon).**

|  |  |  |  |
| --- | --- | --- | --- |
| **Taxon** | **Step 1 Effects Determinations** | **Step 2 Effects Determinations** | **Totals** |
| **No Effect** | **May Affect** | **Not Likely to Adversely Affect** | **Likely to Adversely Affect** |
| Mammals | 0 | 33 | 6 | 27 | 33 |
| Birds | 0 | 31 | 1 | 30 | 31 |
| Amphibians | 0 | 25 | 0 | 25 | 25 |
| Reptiles | 0 | 16 | 6 | 10 | 16 |
| Fish | 0 | 107 | 2 | 105 | 107 |
| Plants | 0 | 460 | 4 | 456 | 460 |
| Aquatic Invertebrates | 0 | 71 | 3 | 68 | 71 |
| Terrestrial Invertebrates | 0 | 49 | 11 | 38 | 49 |
| Total | 0 | 792 | 33 | 759 | 792 |
| Percent of total | 0% | 100% | 4% | 96% |   |

**Table 3. Classification of LAA Determinations by Strength of Evidence.**

|  |  |  |
| --- | --- | --- |
| **Strength of LAA call** | **Species range** | **Critical Habitat** |
| **Number** | **% of LAA determinations** | **Number** | **% of LAA determinations** |
| Strongest evidence of LAA | 1 | <1% | 6 | <1% |
| Moderate evidence of LAA | 1605 | 96% | 733 | 97% |
| Weakest evidence of LAA | 70 | 4% | 20 | 3% |

1. Available at: <https://www.epa.gov/endangered-species/revised-method-national-level-listed-species-biological-evaluations-conventional> [↑](#footnote-ref-2)
2. The exposure models can be found at: <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment> [↑](#footnote-ref-3)
3. Available at: <https://www.epa.gov/endangered-species/revised-method-national-level-listed-species-biological-evaluations-conventional> [↑](#footnote-ref-4)