OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

WASHINGTON, D.C. 20460

October 26, 2023

PC Code: 044312

MEMORANDUM

SUBJECT: **Dinotefuran**: DRAFT Biological Evaluation and Effects Determinations for Federally Endangered and Threatened Species and Designated Critical Habitats

FROM: Katherine Stebbins, Biologist
Sheng Lin, Ph.D., Chemist
Environmental Risk Branch III
Environmental Fate and Effects Division (7507M)

KATHERINE STEBBINS — Digitally signed by KATHERINE STEBBINS Date: 2023.10.26 17:01:24 -04'00'

Jessica Joyce — Digitally signed by Jessica Joyce Date: 2023.10.26 16:49:31 -04'00'

THRU: Dana Spatz, Branch Chief
Environmental Risk Branch III
Environ mental Fate and Effects Division (7507M)

2023.10.26 17:12:18 -04'00'

REVIEWED BY: Jessica L. O. Joyce, Risk Assessment Process Leader
Sarah Hafner, Ph.D., Acting Senior Scientist
Michael Lowit, Ph.D., Acting Senior Science Advisor
Environmental Risk Branch III
Environ mental Fate and Effects Division (7507M)

Jessica Joyce — Digitally signed by Jessica Joyce Date: 2023.10.26 16:49:47 -04'00'

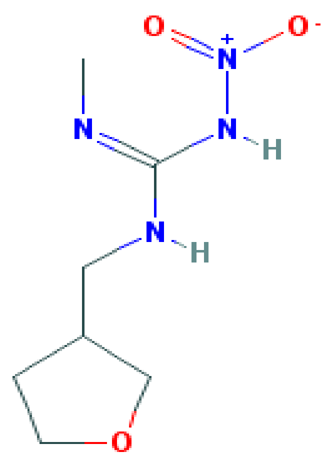
Digitally signed by SARAH HAFNER Date: 2023.10.26 17:09:17 -04'00'

TO: Dana Friedman, Branch Chief
Risk Management and Implementation Branch 1
Pesticide Re-evaluation Division (7508M)

The Environmental Fate and Effects Division (EFED) has completed DRAFT Biological Evaluation (BE) and associated effects determinations for Federally listed threatened and endangered ("listed") species for the currently registered uses of dinotefuran. For those species where EPA concluded that dinotefuran is likely to adversely affect one or more individuals of a species or a designated critical habitat, EPA included predictions of the likelihood for listed species to be jeopardized or for designated critical habitats to be adversely modified. These predictions help to inform the consultation process with U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) (collectively referred to as "the Services"). The Services will make the final determination as to any jeopardy to listed species and any adverse modification to designated critical habitats. EPA will finalize this draft assessment after receiving and considering public comments. EPA expects to consult with the Services after this BE is finalized. Dinotefuran is also in the same neonicotinoid class (subgroup 4a) as three other active ingredients (imidacloprid, clothianidin and thiamethoxam) that have BEs further in the process and discussions with the Services have begun.

Dinotefuran DRAFT Biological Evaluation: Effects Determinations for Federally Listed Endangered and Threatened Species and Designated Critical Habitats

October, 2023



Prepared by:
ENVIRONMENTAL FATE AND EFFECTS DIVISION
OFFICE OF PESTICIDE PROGRAMS

U.S. Environmental Protection Agency
1200 Pennsylvania Ave., NW
Washington, DC 20460

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1 EXECUTIVE SUMMARY

The purpose of this assessment is to complete draft effects determinations including predictions of whether there is a potential likelihood that dinotefuran registrations (PC Code 044312) could lead to a future jeopardy or adverse modification finding by U.S. Fish and Wildlife Service or the National Marine Fisheries Service (collectively referred to as the Services) for federally listed endangered and threatened ("listed") species and any designated critical habitats (CHs). For every listed species and CH, EPA determined whether dinotefuran will have No Effect (NE) or May Affect (MA) an individual of each listed species or CH.

In this draft BE, EPA first evaluated whether the registered uses (and pending new use of dinotefuran on soybean) will have No Effect (NE) or if the registered uses May Affect (MA) an individual of such species or habitat (separate determinations made for each species and critical habitat). For listed species and CHs where EPA makes a MA determination, EPA performs additional analyses to determine if dinotefuran registrations are likely to adversely affect (LAA) or not likely to adversely affect (NLAA) those listed species. EPA makes NLAA determinations when effects are either discountable (highly unlikely to occur), insignificant, or wholly beneficial. For those listed species and CHs where EPA determined that there is likelihood to adversely affect one or more individuals or the CH, EPA also included in its effects determinations its prediction as to whether the registered uses of dinotefuran have a potential likelihood of jeopardizing (J) a listed species or adversely modifying (AM) any CH (collectively abbreviated as J/AM), consistent with 50 C.F.R. §402.40(b)(1). While EPA is not required to include J/AM analyses in its effects determinations, EPA is including this analysis to improve the consultation process. EPA used the draft and final biological opinion (BiOp) for malathion (USFWS, 2021; USFWS, 2022) as a guide in this assessment to predict those species and CHs where the Services are likely to determine the use of dinotefuran results in jeopardy or adverse modification. This draft BE also considered elements from recent NMFS BiOps for malathion, diazinon, and chlorpyrifos (NMFS, 2022) as they pertain to listed species under the purview of NMFS.

Details on the method, models, and tools used for making NE, NLAA, LAA and predictions of the potential likelihood of J/AM are in **Section 5** of this BE. While EPA predicted potential likelihood of J/AM as part of its effects determinations, the Services are responsible for making the final J/AM findings and have the sole authority to do so.

Practically, the LAA threshold for an effects determination is very conservative as the likely "take" of even one individual of a species triggers LAA (even if that species is almost recovered). This often results in a high number of May Affect determinations in a BE. An LAA determination in the BE, however, should not be interpreted to mean that EPA has made a determination that dinotefuran is putting a species in jeopardy. Those determinations are made by the National Marine Fisheries Service and the Fish and Wildlife Service (referred to as The Services) during formal consultation. Here, the Services prepare a biological opinion (BiOp), which builds upon EPA's BE to determine whether the potential adverse effect will jeopardize the continued existence of a species or destroy or adversely modify critical habitat. The predictions of the potential likelihood of future J/AM analysis considers whether the anticipated adverse effects to individuals described in the BE have the potential to negatively affect populations and the species they comprise such that EPA predicts there is a potential likelihood to jeopardize the future continued existence of the species. As noted earlier, EPA is including analyses to help facilitate these determinations by the Services.

The draft effects determination is a comprehensive analysis of all currently registered uses (and pending new use on soybean) of dinotefuran and all currently submitted toxicity and environmental fate data, updated modeling of exposure, and incorporates current label language to assess dinotefuran. The assessment scope is specific to listed species, current as of February 16, 2022. Between the draft and final versions of this document, EPA will consider public comments and will further incorporate usage data (e.g., quantitative analysis using Percent Cropped Area (PCA) adjustments).

1.1 Use Overview

Dinotefuran was first registered for use in the United States in 2004. Dinotefuran (N-methyl-N'-nitro-N"-[(tetrahydro -3-furanyl)methyl)]guanidine) is a systemic, neonicotinoid insecticide which acts on the nicotinic acetylcholine receptors (nAChRs) of the central nervous system via competitive modulation. Dinotefuran affects insects via ingestion or direct contact routes of exposure. Dinotefuran is in the N-nitroguanidine group of neonicotinoids (IRAC subclass 4a) along with clothianidin, imidacloprid, and thiamethoxam. Since dinotefuran is taken up by plants (*i.e*., is systemic and distributed throughout the plant), target pests include chewing and sucking pests such as aphids, whiteflies, thrips, leafhoppers, scales, and leaf miners.

Dinotefuran may be applied to agricultural crops via a variety of methods including aerial and ground foliar sprays, soil treatment (*e.g*., drench), granular, chemigation (*e.g.,* soil incorporation or foliar), and as a tree trunk injection. Dinotefuran is used in a wide array of agricultural crops, including root and tuber vegetables, bulb vegetables, leafy vegetables, brassicas, cucurbits, and fruiting vegetables, stone fruit, berries, grapes, cereal grains, and oilseed crops (*e.g*. cotton). In addition to the agricultural uses, there are a wide variety of non-agricultural uses, including Christmas trees, forestry, shelterbelts, turf, and ornamental applications, as well as a variety of other indoor and outdoor uses. The maximum application rate for non-agricultural outdoor uses is 0.54 lb a.i./A. This BE includes all FIFRA section 3 registrations, FIFRA section 24c special local need registrations, and FIFRA section 18 emergency exemption uses, as well as the proposed use on soybean.

For agricultural uses, the maximum single application rate allowed for dinotefuran is 0.54 lb a.i./A (pounds of active ingredient per acre; soil application to tree nuts). Single application rates of 0.54 lb a.i./A are also associated with the non-agricultural uses (up to 0.60 lb a.i./A for residential crack and crevice uses). More details on use patterns are provided in **Section 2**.

1.2 Ecological Effects Overview

Dinotefuran is practically non-toxic to fish (and to aquatic-phase amphibians for which freshwater fish serve as surrogates) and is moderately toxic to aquatic invertebrates on an acute exposure basis, although, there is a broad range of sensitivity to dinotefuran across aquatic invertebrates.

For terrestrial organisms, on an acute exposure basis, dinotefuran is practically non-toxic to moderately toxic to birds (and to reptiles and terrestrial-phase amphibians for which birds serve as surrogates) and practically non-toxic to mammals. Chronic exposure of birds resulted a reduction in the number of hatchlings, eggs set, and 14-day old survivors at the lowest observable effect concentration (LOAEC) of 5,270 mg a.i./kg-diet, with a No Effect Concentration (NOAEC) of 2,150 mg a.i./kg-diet. For mammals, a 2-generation reproduction study resulted in growth effects as reductions in offspring body weight at the highest concentration (LOAEC=10,000 mg a.i./kg-diet/NOAEC=3000 mg a.i./kg-diet).

For terrestrial plants, there were no signs of toxicity observed at the maximum application rates tested. Relative to animals, the sensitivity of aquatic plants is also considerably lower (*e.g.,* aquatic plant endpoints are >100 times less sensitive than invertebrates).

Dinotefuran is highly toxic to adult honey bees (*Apis mellifera*) on an acute exposure basis, but is practically non-toxic to larval bees. On a chronic (repeat dose) exposure basis, for adult honey bees, there were impacts to food consumption at the LOAEL of 0.0035 µg a.i./bee (NOAEL=0.0015 µg a.i./bee) and the 22-day larval study had no impacts to pupal or adult survival. EPA has received several reports of alleged incidents involving terrestrial invertebrates (specifically insects). These reported alleged incidents all are related to ornamental use and report lethality to social Apis and non-Apis bees.

More details on the available toxicity data are provided in **Section 4** in this BE.

1.3 Environmental Fate Overview

Dinotefuran is classified as having low to moderate persistence in the environment and is considered mobile (FAO, 2000). The major routes of dissipation are aqueous photolysis, runoff, and leaching. This draft BE assessed the impact of various dinotefuran exposure pathways including runoff, spray drift, and direct consumption of granules. Aquatic organisms and terrestrial plants could be exposed through runoff and spray drift. Terrestrial wildlife could be exposed on-field through consumption of contaminated food (primarily seeds and terrestrial arthropods) in and on treated soil. Terrestrial wildlife off-field could be exposed through spray drift contaminating foliage and fruit, as well as seeds and arthropods. Based on a comparison of residue data from a tree trunk injection to estimated environmental concentrations (EECs) from a foliar application, for the purposes of this assessment, EECs for herbivorous animals from foliar spray applications are assumed to be approximately equivalent to EECs from tree trunk injection applications.

Although there are a number of environmental transformation products of dinotefuran to which non-target organisms may be exposed, only the degradates MNG (1-methyl-2- nitroguanidine), DN (1-methyl-3- (tetrahydro-3- furylmethyl)guanidinium dihydrogen phosphate), UF (1-methyl-3- (tetrahydro-3-furymethyl)urea), MG-HCI (1-methylguanidinium chloride), DN-2-0H (Bis[1-(2- hydroxyetrahydro-2-furymethyl)-3-methylguanidinium]terephthalate), and DN-3-0H (Bis[1-(3- hydroxyetrahydro-3-furymethyl)-3-methylguanidinium]terephthalate) are structurally similar to parent dinotefuran and are therefore considered to exhibit similar toxicity. Therefore, aquatic exposure concentrations were derived using the total toxic residue (TTR) approach [parent plus degradates MNG, DN, UF, DN-2-OH + DN-3-OH]. For terrestrial taxa, the default 35-day foliar dissipation half-life was used which is protective of any transformation products. Additional details on the environmental fate of dinotefuran are provided in **Section 3** of this BE.

1.4 Exposure Methods Overview

Exposure estimates are based primarily on environmental fate and transport model[1] results, unless the available models poorly represent a species habitat, in which case exposure is assessed qualitatively. Aquatic exposures (*i.e*., surface water and benthic sediment pore water) are quantitatively estimated for representative dinotefuran uses in specific geographic regions within generic habitats (referred to as bins) using the Pesticide Root Zone Model (PRZM) and the Variable Volume Water Model (VVWM) in the Pesticides in Water Calculator (PWC). Estimated Environmental Concentrations (EECs) resulting from direct applications to water from the use of dinotefuran on rice and watercress were derived using the Pesticide in Flooded Application Model (PFAM; version 2).[2,3] Aquatic exposure results for aquatic habitats (*i.e.* bins) most appropriate for the species and/or designated critical habitats are discussed in **Section 3.**

Terrestrial animals may be exposed to dinotefuran through multiple routes of exposure, including diet, drinking water, dermal and inhalation exposure. Terrestrial dietary items may consist of plants, invertebrates or vertebrates (*i.e*., amphibians, reptiles, birds or mammals) that inhabit terrestrial areas or aquatic dietary items (*i.e*., fish, amphibians, aquatic invertebrates or aquatic plants). EPA determined the potential for dinotefuran to bioaccumulate in living tissues to be low based on its octanol-water partition coefficient (Kow) of 0.283 @25°C. Terrestrial exposures are estimated using the Terrestrial Residue Exposure (T-REX) model.

1.5 Scope of the Draft Effects Determination for Dinotefuran

The scope of the draft effects determination contained in this draft BE establishes the federal action area, the species and CH under consideration, and the species or CH that may be impacted either through direct effects or via indirect effects by impacting the species prey, pollination, habitat, or dispersal (PPHD).

This draft effects determination considers species federally listed as endangered and threatened and CHs that are designated final as of February 16, 2022. A taxa-based screening-level analysis was conducted under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) for registration review in 2017: Preliminary Ecological Risk Assessment (excluding terrestrial invertebrates) for the Registration Review of Dinotefuran (USEPA, 2017); and in 2020: Final Bee Risk Assessment to Support the Registration Review of Dinotefuran (USEPA, 2020). The federal action is the registration review of dinotefuran. Based on those FIFRA analyses for registration review, the primary risks identified were for aquatic and terrestrial invertebrates. There were no screening-level exceedances for terrestrial or aquatic plants, mammals, or fish, and narrow exceedances for birds. Moving into the more refined effects determination analysis, the risk profile for dinotefuran is for direct effects to aquatic and

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[1] The exposure models can be found at: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment and https://www.epa.gov/endangered-species/provisional-models-and-tools-used-epas-pesticide-endangered-species-biological

[2] Release of an Updated Pesticides in Flooded Applications Model (PFAM) and Guidance on Assessing Aquatic Exposure and Risk from Pesticide Use on Rice, Sept. 30, 2016

[3] White, K., Biscoe, M, Fry, M., Hetrick, J., Orrick, G., Peck, C., Development of a Conceptual Model to Estimate Pesticide Concentrations for Human Health Drinking Water and Guidance on Conducting Ecological Risk Assessments for the Use of Pesticides on Rice September 28, 2016

terrestrial invertebrates and indirect effects to the species that have a high reliance on invertebrates during their life stages for prey, pollination, habitat, or dispersal (PPHD).

The action area for dinotefuran encompasses the geographic space within the conterminous United States (CONUS) and its territories outside the conterminous states (referred to as non-lower 48; NL48) where potential effects to listed species may occur as a result of current uses of the insecticide. The action area is developed from 8 agricultural use data layers [(UDLs): Cotton, Soybean, Rice, Grapes, Other Crops, Other Orchards, Vegetable and Ground Fruit, and NL48Ag)] and 10 non-agricultural UDLs [(UDLs): CONUS and NL48 Developed, Open Spaced Developed, and Field Nurseries, Christmas trees and NL48 Managed Forests, Forest trees and NL 48 Forest trees], which capture all registered uses for dinotefuran. For the action area, these UDLs were buffered out by 792 meters to account for the maximum off-site transport. The action area is the starting point for the analysis, and refinements to the exposure areas and potential for exposure were incorporated as EPA moved through the species/CH determinations and to the predictions of the potential likelihood for future J/AM.

1.6 Summary of Effects Determinations Including Predictions of the Potential Likelihood of Future Jeopardy and Adverse Modification

Out of a total of 1,715 listed species, EPA determined NE for 240 species; out of a total of 826 CHs, EPA determined NE for 111 CH. EPA based these determinations primarily on either low overlap, or no direct toxicity/no dependency on PPHD. For these species, effects are not reasonably certain to occur, thus, they are classified as NE. For those listed species and CHs with MA determinations, EPA distinguished whether dinotefuran is likely to affect an individual when considering the species-specific habitat, life history, and other considerations of exposure and toxicity. Out of the listed species identified as MA, EPA made NLAA determinations for 216 listed species; out of the CH identified as MA, EPA made NLAA determinations for 91 CHs. A majority of the NLAA determinations (were based upon unlikely exposure due to the diet or habitat type or when specific physical and biological factors (PBFs) for the CHs are not likely to be impacted by dinotefuran. EPA made LAA determinations for 1,259 listed species and 624 CHs. For dinotefuran, EPA made LAA determinations for listed invertebrate (aquatic and terrestrial) species that may be directly affected, listed animals that rely upon aquatic and terrestrial insects (non-mollusks) for prey; or listed plants that rely upon insects for pollination or dispersal. For all CHs with LAA determinations, EPA considered as primary factors PBFs related to habitat quality for listed invertebrates and invertebrates that serve as prey, pollinators or dispersers leading to the determination. The draft effects determinations for listed species and designated critical habitats are summarized in **Table 1-1** and **1-2.**

EPA further evaluated the LAA species and designated CH and made predictions about the potential likelihood of future jeopardy (J) to any listed species or adverse modification of any designated CH from the use of dinotefuran. Of the species with LAA determinations, EPA predicted a potential likelihood of future jeopardy for 151 listed species. EPA also predicted a potential likelihood of future adverse modification of 59 designated CHs. EPA identified these predictions primarily for aquatic and terrestrial invertebrates, as well as other species reliant on invertebrates for PPHD and CHs that are either directly impacted or highly dependent on terrestrial or aquatic insects and have a high to medium overlap with the use data layer (UDL), expanded to 30 meters for population-level impacts.[4]

Table 1-1. Number of Listed Species Effects Determinations Including Predictions of Potential Likelihood of Future Jeopardy for Current Uses of Dinotefuran.

Taxon	No Effect	Not Likely to Adversely Affect	Likely to Adversely Affect	Preliminary Jeopardy	Totals
Mammals	29	35	31	3	95
Birds	5	25	68	3	98
Amphibians	0	1	37	8	38
Reptiles	12	12	20	1	44
Fish	1	13	156	20	170
Plants	97	5	837	93	939
Aquatic Invertebrates	39	104	30	10	174
Terrestrial Invertebrates	57	21	79	13	157
Total	**240**	**216**	**1259**	**151**	**1715**
Percent of total	14%	13%	73%	**9%**	

Table 1-2. Number of Listed Species Effects Determinations and Predictions of Adverse Modification of Designated Critical Habitat for Current Uses of Dinotefuran.

Taxon	No Effect	Not Likely to Adversely Affect	Likely to Adversely Affect	Preliminary Adverse Modification	Totals
Mammals	11	16	12	1	39
Birds	2	3	26	1	31
Amphibians	0	0	26	6	26
Reptiles	6	6	7	0	19
Fish	1	12	97	19	110
Plants	56	2	403	18	461
Aquatic Invertebrates	22	52	16	4	90
Terrestrial Invertebrates	13	0	37	10	50
Total	**111**	**91**	**624**	**59**	**826**
Percent of total	13%	11%	76%	**7%**	

[4] EPA uses Use Data Layers (UDLs) to set the action area (i.e., the geographic bounds of the Federal action). To do so, the exposure areas are extended out to the farthest distance at which effects on listed species or designated CH are reasonably expected to occur. Section 5.3 provides further details.

2 Description of Products Undergoing Registration Review, Label Restrictions

2.1 Nature of Regulatory Action

This assessment serves as the DRAFT Biological Evaluation (BE) for the neonicotinoid insecticide, dinotefuran. This BE is following the first set of neonicotinoid insecticide BEs (*i.e.*, imidacloprid, clothianidin, and thiamethoxam) which were finalized on July, 2022. Assessments of dinotefuran uses under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) for registration review were completed in 2017 and 2020 referenced below. The federal action is the registration review of dinotefuran.

- Preliminary Ecological Risk Assessment (excluding terrestrial invertebrates) for the Registration Review of Dinotefuran (USEPA, 2017)
- Final Bee Risk Assessment to Support the Registration Review of Dinotefuran (USEPA, 2020)

In addition to assessing all current registrations for dinotefuran, this assessment includes a proposed new use for soybean on the BASF Entigris™ DG label. This new use was assessed in 2020.

- Dinotefuran: Ecological Risk Assessment for the Proposed Section 3 New Use on Soybean (USEPA, 2020a).

2.2 Mode of Action

Dinotefuran (IUPAC name: 2-methyl-1-nitro-3-[(tetrahydro-3-furanyl) methyl] guanidine) is a systemic, neonicotinoid insecticide which acts on the insect nicotinic acetylcholine receptors (nAChRs) of the central nervous system via competitive modulation.[5] Dinotefuran is in the N-nitroguanidine substituted group of neonicotinoids (IRAC[6] subclass 4A) along with clothianidin, thiamethoxam and imidacloprid.

The mode of action on target insects involves out-competing the neurotransmitter acetylcholine for available binding sites on the nAChRs (Zhang *et al*. 2008). At low concentrations, neonicotinoids cause excessive nervous stimulation and at high concentrations, insect paralysis and death will occur (Tomizawa and Casida, 2005).

As a systemic chemical in plants, dinotefuran is absorbed via the roots, stems and foliage and is considered xylem and phloem mobile, with dominant uptake routes following the transpiration stream (Bonmatin et al, 2014). Additionally, numerous submitted field residue studies have demonstrated that dinotefuran applied via foliar or soil methods can result in residues in pollen and nectar of blooming plants. Additionally, since dinotefuran is phloem mobile, the plant can also move residues from the treated plant into the soil.

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[5] https://www.irac-online.org/

[6] The Insect Resistance Action Committee (IRAC) is a specialist technical group of the agricultural industry association Crop Life America to provide information to prevent or delay the development of insect resistance.

2.3 Characterization of Dinotefuran Uses

Dinotefuran was first registered for use in the United States in 2004. This Draft BE assesses all registered uses of dinotefuran as well as the proposed new use on soybean. As of August 2018, there are 58 Section-3 uses registered in the United States, along with 20 Special Local Needs (FIFRA Section 24c) registrations in the states of New York, West Virginia, Pennsylvania, New Jersey, New Hampshire, Maryland, North Carolina, Kentucky, IN, Delaware, and Connecticut, and 16 time-limited Emergency Exemptions (FIFRA Section 18) in Delaware, Maryland, Michigan, North Carolina, New Jersey, Pennsylvania, Virginia, and West Virginia.

Dinotefuran use on agricultural crops includes: root and tuber vegetables, bulb vegetables, leafy vegetables, brassicas, cucurbits, and fruiting vegetables, pome fruit, stone fruit, berries, grapes, rice, herbs, and cotton. In addition, there are a wide variety of nonagricultural uses, including Christmas trees, forestry, shelterbelts[7], turf, and ornamental applications, as well as a variety of other indoor and outdoor uses. Dinotefuran is registered for the control of insect pests such as: aphids, whiteflies, thrips, leafhoppers, leafminer, sawflies, mole crickets, white grubs, lacebugs, billbugs, beetles, mealybugs, stink bugs, weevils, cockroaches, and the spotted lanternfly.

Maximum single and seasonal application rates vary by crop and method, but do not exceed 0.54 lb. a.i./A. Dinotefuran is formulated as granules, emulsifiable concentrate, ready-to-use solution, and as a pressurized liquid. It may be applied to crops by a variety of methods including aerial and ground foliar sprays, soil spray applications (as drench, chemigation, soil injection, and in-furrow sprays), and tree trunk injection. Many of the labels allow for repeated or multiple applications within the same growing season provided the maximum annual rate is not exceeded. The granular and ready-to-use products are for use in and around residential, commercial, industrial buildings including ornamental plants in these settings.

The majority of dinotefuran products contain dinotefuran as the sole active ingredient (a.i.). However, there are registered co-formulations with other active ingredients including: the insect growth regulators s-methoprene and pyriproxyfen, the synthetic pyrethroid insecticides *alpha*-cypermethrin and prallethrin, the pyrethroid insecticide permethrin, the phenylpyrazole insecticide fipronil, the insect pheromone *cis*-9-tricosene, and the inorganic insecticide silicon dioxide.

While applications of these products may result in the simultaneous environmental exposure to multiple active ingredients during application, the environmental fate and transport of multiple active ingredients after application (*e.g*., runoff transport) are driven by the individual chemical's physiochemical properties. Consequently, each of these components within a co-formulation will result in differential exposure and effects following application of the product. The other active ingredients in each co-formulation were evaluated in separate ecological risk assessments. Therefore, these active ingredients are not considered further in this BE.

Table 2-1 shows the maximum application rates and maximum number of applications for the different dinotefuran uses with foliar and soil spray applications, as well as other labeled use

[7] Shelterbelts (*e.g*., windbreaks) are linear plantings of multiple rows of trees or shrubs established for environmental purposes such as protecting farmsteads and livestock areas (see https://www.fsa.usda.gov/Internet/FSA_File/ccrpcp16a.pdf).

information. It is noted that several crops have restrictions on applications made during the pre-bloom and bloom period. These include use patterns that may prohibit applications made pre-bloom, during bloom or when bees are foraging.

Forestry and ornamental uses also allow for tree trunk injection and brush-on applications, with a maximum single and seasonal application rate of 2 g a.i./in diameter at breast height (dbh). Forestry applications are not permitted for *Tilia spp.*, such as linden or basswood trees. These trees can also toxic to some bees (e.g., bumble bees) independent of pesticide applications. For the purposes of this assessment, the distinction between ornamental and forestry uses pertains to the environmental setting of use rather than the type of plant being treated. Forestry uses are considered those that involve application to trees in plantation or natural forest settings. Ornamental uses may involve the same tree species as a forestry use, but the settings include residential or nursery use sites.

Table 2-1. Maximum Label Rates and Application Information for Registered Foliar Spray and Soil Applications of Dinotefuran

Use Data Layer (UDL)	Crop	Application Method	Maximum Single Application Rate (lb a.i./A)	Maximum Number of Applications per Year	Minimum Application Interval (days)	Maximum Annual Application Rate (lb a.i./A)	Comments
Vegetables and Ground Fruit and Grapes	Crop Subgroup 13-07-Small fruit, vine climbing subgroup: Grape Crop Subgroup 13-07D	Foliar (aerial, ground, airblast)	0.132	2	14	0.26	Do not apply during bloom. Maximum combined foliar and soil application of 0.528 lb a.i./A.
		Soil (broadcast, drip)	0.33	1	14	0.33	
Vegetables and Ground Fruit	Small fruit-Subgroup 13-07F (Except fuzzy kiwifruit)	Foliar (aerial, ground)	0.135	2	14	0.26	Do not apply during bloom. Maximum combined foliar and soil application of 0.528 lb a.i./A.
		Soil (broadcast, drip)	0.338	1	14	0.33	
	13-07H. Low growing berry subgroup (Except strawberry)	Foliar (aerial, ground)	0.18	2	14	0.36	Do not apply during bloom.
Vegetables and Ground Fruit	Bulb Vegetables (Crop group 3)	Foliar (aerial, ground)	0.18	NS	7	0.36	Do not combine foliar application with soil application.
		Soil (band, in-furrow, sidedress, drench, drip)	0.270	2	--	0.54	
Vegetables and Ground Fruit	Cucurbit and fruiting vegetables (Crop groups 8 and 9)	Foliar (aerial, ground)	0.179	Up to 3	7	0.36	Do not apply during bloom. Do not combine foliar application with soil application.
		Soil (band, in-furrow, sidedress, drench, drip)	0.33	Up to 3	7	0.54	
Vegetables and Ground Fruit	Brassica head and stem vegetable subgroup (Crop Subgroup 5A)	Foliar (aerial, ground)	0.179	Up to 3	7	0.36	Do not combine foliar application with soil application.
		Soil (band, in-furrow, sidedress, drench, drip)	0.34	Up to 3	7	0.54	
Vegetables and Ground Fruit	Leafy Vegetables (Crop Group 4) and Brassica Leafy (Crop Group 5B)	Foliar (aerial, ground)	0.134	Up to 3	7	0.36	Do not combine foliar application with soil application.
Cotton	Oil seed (cotton, Crop Group 20C)	Foliar (aerial, ground)	0.134	NS	7	0.268	Do not apply during bloom
Other Orchards	Stone fruit (Peaches and Nectarines,	Foliar (aerial, ground, Airblast)	0.18	NS	7	0.36	Do not apply during bloom. Maximum combined with soil app is 0.36 lbs a.i./A
		Soil (drench, micro sprinklers)	0.54	1	NA	0.54	---
		Foliar	0.068	NS	14	0.198	Do not combine foliar application with soil

Use Data Layer (UDL)	Crop	Application Method	Maximum Single Application Rate (lb a.i./A)	Maximum Number of Applications per Year	Minimum Application Interval (days)	Maximum Annual Application Rate (lb a.i./A)	Comments
Vegetables and Ground Fruit	Potato, corm and tuberous vegetables (Crop Groups 1C; 1D)	(aerial, ground)					application.
		Soil (band, in-furrow, sidedress)	0.338	1	NA	0.338	---
Soybean Pending New Use	Soybean	Foliar	0.1	2	7	0.2	Mandatory 150 ft aerial and 25 ft ground buffers
Rice	Rice	Foliar (aerial, ground)	0.131	2	7	NS	----
Vegetables and Ground Fruit	Watercress	Foliar (aerial, ground)	0.18	NS	NS	NS	Max annual rate assumed to be 0.36 lbs a.i./A at 2 applications per year based on other similar use cases
Non-Agricultural Uses							
Developed, Open Space Developed, Other Crops	Turfgrass (sod farms, athletic fields, golf courses and commercial and residential lawns)	Foliar (ground)	0.54	1	--	0.54	----
Open Space Developed, Developed	Ornamental plants in residential and landscaped areas, parks, recreational areas, fields, commercial/ industrial buildings.	Foliar (ground)	0.50	1	--	0.50	Foliar: Do not apply during bloom
		Soil (drench, soil injection, irrigation equipment))	0.54	1	--		
Field Nurseries	Ornamental plants, fruit and nut trees (non-bearing), and forest seedlings in greenhouses, lath and shade houses, containers, field nurseries and interiorscapes	Foliar (ground)	0.50	1	--	0.50	Foliar: Do not apply during bloom
		Soil (ground)	0.54	1	--	0.54	
Open Space Developed, Developed	Urban Use- commercial-premises/equipment (outdoor), food processing plant premises, household outdoor, and mosquito applications.	Foliar (ground)	0.6	NS	NS	NS	----
Christmas Trees	Christmas Tree and Forestry (soil drench, soil injection, irrigation equipment)	Foliar/Soil (ground)	0.54	1	--	0.54	Do not apply to *Tilia spp*.

2.4 Label Uncertainties

Missing application rate information on some labels introduces uncertainty in how the pesticide may be applied to agricultural and non-agricultural use sites. For example, a maximum annual application rate of 0.54 a.i./acre/yr is on the labels but the number of applications is not always specified. For these cases, the highest single application rates with the lowest total number of applications are used for a conservative analysis.

2.5 Characterization of Dinotefuran Usage

Usage data for dinotefuran are available from the Office of Pesticide Programs' Biological and Economic Analysis Division (BEAD) (USEPA, 2022[8]).

Agricultural Usage

Agricultural usage of dinotefuran, based on available data from 2006 to 2020, shows steady increases overall in pounds of active ingredient (lbs a.i.) and total acres treated (TAT) from 2006 to 2017, with a peak in usage from 2015 to 2017, followed by a decrease in lbs a.i. and TAT usage (~ 30%) from 2018 to 2020. During the 2006 to 2020 time period, the majority of dinotefuran usage in terms of lbs a.i. and TAT (65% and 67%, respectively) were attributed to applications on cantaloupes, grapes (grown for wine), rice, and tomatoes.

During the most recent five years of available dinotefuran data (2016 to 2020), on average 28,000 lbs a.i. were applied annually to treat approximately 206,000 acres. The majority of dinotefuran usage in terms of lbs a.i. and TAT (70% and 72%, respectively) BEAD attributed to applications on cantaloupes, grapes (grown for wine), rice, and tomatoes, as well as cotton primarily in the western and southern regions of the U.S.

Non-agricultural Usage

Based on the analysis by BEAD, available non-agricultural dinotefuran usage data show that the majority of dinotefuran (approximately 40,000 lbs a.i.) was reported to be applied by pest management professionals in food handling establishments. In addition, approximately 400 lbs of dinotefuran was reported to be applied in forestry. There are no other recent reports from reliable data sources of dinotefuran non-agricultural usage currently available. The absence of such data should not be interpreted as lack of usage.

2.6 Summary of Previous Agency Assessments and Effects Determination

In 2017, EPA issued its Draft Assessment of the Potential Effects of Dinotefuran on Bees (USEPA, 2017a) that evaluated agricultural uses of dinotefuran. In 2017 EPA also issued the FIFRA Preliminary Ecological Risk Assessment (excluding terrestrial invertebrates) for the Registration Review of Dinotefuran (ERA; USEPA, 2017). Following the receipt of public comments on both of the 2017 assessments and additional

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[8] Dinotefuran (044312) National and State Summary Use and Usage Matrix. October 26, 2022

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data, the Agency completed a Final Bee Risk Assessment to Support the FIFRA Registration Review of Dinotefuran (USEPA, 2020). The 2017 ERA concluded that there was a potential for direct adverse effects to aquatic invertebrates on an acute and chronic exposure basis, and acute risk to birds from one soil spray exposure screening analysis which includes all routes of exposure combined (*i.e.*, diet, inhalation, drinking water and dermal) (the LD_{50}/ft^2 analysis[9]). The LD_{50}/ft^2 analysis resulted in no risk exceedances when "light" soil incorporation is used. When considering dietary exposure only (*i.e.,* exposure to residues through consumption of contaminated arthropods), the dietary-based risk quotient (RQ[10]) values are less than the acute risk level of concern (LOC). The conclusions of the final bee assessment indicated risk beyond individuals (*i.e.,* colony-level). The uses that fell into "strongest" evidence for colony-level risk include: cotton (foliar), stone fruit and berries (foliar, pre-bloom), pollinator-attractive fruiting vegetables (foliar), and pollinator-attractive ornamentals and forest trees (foliar, soil, trunk injection). Multiple lines of evidence have in the past and continue to inform EPA's understanding of the potential magnitude of effect on non-target species. These lines of evidence include registrant-submitted data and data from the open literature as well as monitoring and incident data. The RQs and other lines of evidence summarized in these earlier assessments are used to identify potential risks of concern for listed species.

2.7 Identification of Residues of Concern

Dinotefuran may degrade into various products through multiple pathways. There are six major transformation products identified in the laboratory studies; these degradates include MNG (1-methyl-2- nitroguanidine), DN (1-methyl-3- (tetrahydro-3- furylmethyl)guanidinium dihydrogen phosphate), UF (1-methyl-3- (tetrahydro-3-furymethyl)urea), MG-HCI (1-methylguanidinium chloride), DN-2-0H (Bis[1-(2- hydroxyetrahydro-2-furymethyl)-3-methylguanidinium]terephthalate), DN-3-0H (Bis[1-(3-hydroxyetrahydro-3-furymethyl)-3-methylguanidinium]terephthalate), and BCDN (succinate (2-(methylamino)-9- oxa-2-aza-4- azoniabicyclone-3-ene hydrogen succinate). The degradate MNG was identified as a major product in aerobic soil metabolism and in the terrestrial field dissipation studies. The degradate, DN, was identified as a major product in anaerobic soil metabolism and aerobic aquatic metabolism studies. The other degradates were mostly photo-transformation products.

The degradates MNG, DN, UF, and DN-2-OH + DN-3-OH contain the nitroguanidine structure and, therefore, could possess similar toxicity as the parent to some taxa. Based on structure-activity relationship (SAR) analysis conducted by EPA, these transformation products could have similar toxicity as parent dinotefuran across taxa. Moreover, using EPA's predictive model ECOSAR (version 2.2[11]), the reported toxicity values for dinotefuran are similar for the taxa for which empirical data are available and are included in ECOSAR. The chemical structures of the remaining transformation products are considerably different from parent dinotefuran. As such, the toxicity profile is expected to be different than dinotefuran and are not considered as residues of concern. For the purposes of this assessment

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[9] LD_{50}/ft^2 represents the lethal dose for 50% of the organism tested per square foot of forage area.

[10] The risk quotient (RQ) is the ratio of point estimates of the estimated environmental concentration (EEC) to a toxicity endpoint (*e.g.*, the subacute dietary lethal concentration to 50% of the organisms test; LC_{50}).

[11] Ecological Structure Activity Relationships (ECOSAR) Predictive Model; https://www.epa.gov/tsca-screening-tools/ecological-structure-activity-relationships-ecosar-predictive-model#:~:text=The%20Ecological%20Structure%20Activity%20Relationships,system%20that%20estimates%20aquatic%20toxicity.

aquatic EPA estimated EECs based on total toxic residues (TTR). The TTR includes dinotefuran, MNG, DN, UF, DN-2-OH, and DN-3-OH. For terrestrial vertebrates, EPA used the default 35-day foliar dissipation half-life based on Willis and McDowell (1987) and EPA considers this value as protective of any transformation products. The Agency also assumed equivalent toxicity across each of the degradates and parent compound based on their structural similarity.

3 Methods

3.1 Assessment Methodology Overview

In this effects determination,[12] EPA evaluated whether the current registrations of dinotefuran pose discernible effects to listed species and CH[13] that are within the action area.[14] The listed species and CHs were current as of February 16, 2022. In making the effects determinations for species, EPA considered direct and indirect effects using the best available scientific information. The term "direct effects" refers to decreases in the survival, growth or reproduction of individuals of a listed species due to exposure to dinotefuran. The term "indirect effects" refers to impacts on the listed species that may be the result of the effects of dinotefuran on organisms on which the listed species depends for prey, pollination, habitat and/or dispersal (PPHD). When making effects determinations for designated CHs, EPA considered whether there may be potential effects to listed species within the CH or effects to the physical or biological features (PBFs) of the CH as defined by the Services. When PBFs were not defined, the assumption was that the critical habitat had to support the needs of the species providing no impacts to the species or its PPHD.

EPA determined whether currently registered dinotefuran uses will have "No Effect" (NE) on a given listed species or CH or "May Affect" (MA) the species or CH. The standard used by EPA for NE is that an effect is "not reasonably certain to occur." For those species and designated CH that EPA determined MA, EPA further determined whether the action: "may affect but is not likely to adversely affect" the listed species or CH (NLAA); or "may affect and is likely to adversely affect" the listed species or CH (LAA). For NLAA, the standard is that an effect is discountable, insignificant or wholly beneficial where discountable is defined as "extremely unlikely to occur" and insignificant is defined as the effects cannot be meaningfully detected, measured, or evaluated, and should never reach the scale where take[15] occurs. An LAA determination for this action means that there is a discernible adverse effect to one or

[12] 50 CFR 402.40(b) states: Effects determination is a written determination by the U.S. Environmental Protection Agency (EPA) addressing the effects of a FIFRA action on listed species or critical habitat. The contents of an effects determination will depend on the nature of the action. An effects determination submitted under § 402.46 or § 402.47 shall contain the information described in § 402.14(c) and a summary of the information on which the determination is based, detailing how the FIFRA action affects the listed species or critical habitat.

[13] This assessment focuses upon current federally listed endangered and threatened species and their designated critical habitats. During consultation, EPA may confer with the Services to identify any additional listed species or critical habitats that are relevant to this action.

[14] The action area includes an exposure area extending from each pesticide use site found across use data layers (UDLs) in all directions out to this distance.

[15] Take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct. [ESA §3(19)] Harm is further defined by FWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by FWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. [50 CFR §17.3]

more individuals of a listed species or their CH. As a federal action agency, it is EPA's obligation under Section 7 of the Endangered Species Act (ESA) to ensure that the federal action (*i.e*., the registration review of dinotefuran uses) does not jeopardize the continued existence of listed species or adversely modify CH. To inform consultation with the Services, for those species and CHs with LAA determinations, EPA also predicted whether there is a likelihood that use of dinotefuran could lead to jeopardy of listed species or adverse modification of designated CH.[16]

This assessment uses the best available scientific information on the use, usage, environmental fate and transport, and ecological effects of dinotefuran including reported ecological incidents and monitoring data. Using this information, the Agency begins its listed species and CH effects determination with a screening-level, taxa-based risk assessment. The taxa-based methodology is then refined as needed to consider species-specific information and determine if there are potential effects to a species or its CH. The taxa-based method is not spatially explicit and does not rely upon an overlap analysis (*i.e*., does not consider species/habitat location/occurrence); however, an overlap analysis is needed for a species-specific analysis.

EPA's taxa-based FIFRA assessments (USEPA, 2017, USEPA, 2020, UEEPA, 2020a,b) are used to focus the species-specific analysis on types of direct or indirect effects that may be relevant to listed species or critical habitats. When EPA's screening-level assessment shows that a risk quotient (RQ) exceeds a listed species' levels of concern (LOC), it does not automatically mean that the action may affect a taxon representing a listed species. Instead, it means further species-specific review is needed to determine whether the action may affect a listed species or its designated CH. Also, when an RQ does not exceed the listed species LOC for a taxon representing a listed species, it does not necessarily mean that the determination is NE, because potential indirect effects (effects to PPHD) also need consideration. Therefore, EPA considered the life history, distribution of the species, and effects of dinotefuran on organisms on which the listed species depends for PPHD (*i.e.,* indirect effects) before making effects determinations. The sections below discuss the approach EPA used to make effects determinations for listed species and designated CHs.

3.2 Environmental Exposure Methods

3.2.1 Measures of Aquatic Exposure

Maximum application rates and minimum application retreatment intervals are modeled to estimate the exposure to dinotefuran based on the registered labels and reflect the modeling in the dinotefuran new use assessment (USEPA 2020a) and its addendum (USEPA 2020b). The general approaches used in determining potential aquatic exposure are described below.

3.2.2 Aquatic Exposure Models

EPA used environmental fate models to generate estimated environmental concentrations (EECs) for pesticide concentrations in surface water. The primary model used in for aquatic exposure are the

[16] 50 CFR 402.40(b)(1) provides that EPA may describe in its effects determination a conclusion whether jeopardy to a listed species or adverse modification of any designated critical habitat is likely.

Pesticide Root Zone Model (PRZM5) and the Variable Volume Water Model (VVWM)[17] contained within the Pesticide in Water Calculator (PWC; version 2.001). The PWC is used to estimate pesticide concentrations for terrestrially applied pesticides in agricultural and non-agricultural environments. EECs resulting from direct applications to water from the use of dinotefuran on rice and watercress were derived using the Pesticide in Flooded Application Model (PFAM; version 2).

For PWC modeling, the scenarios used in this assessment were those that were updated in 2020 to be more spatially comprehensive and to better reflect environmental conditions (USEPA, 2020c). These scenarios were used in all cases except for uses that are not represented by them (e.g., non-agricultural uses such as turf/ornamentals). For these cases, older PWC scenarios are used.

3.2.3 Aquatic Bin Discussion

Aquatic exposures are quantitatively estimated for ten generic habitat types (*i.e*., aquatic bins 1-10) nine of which are aquatic, and one is a semi-aquatic habitat (or aquatic-associated terrestrial habitat). Aquatic bins have been defined by the Services to facilitate the estimation of pesticides in surface water for comparison to relevant toxicity endpoints for listed species assigned to the appropriate bin, based on habitat requirements. Each bin varies in depth, volume, and flow; **Table 3-1** summarizes the bins. It should be noted that the same waterbody used in PWC may be used as a surrogate to represent multiple bins defined by the Services. As such, the PWC bin number (*i.e.*, specified in the model input file) may differ from the aquatic bin number that the modeling represents.

Aquatic bin 1 is intended to represent riparian habitats or other land-based habitats adjacent to waterbodies that may occasionally be inundated with surface water (such as wetlands) and provide habitat or influence the water quality for aquatic and semi aquatic organisms.

Aquatic bins 2, 3, and 4 are used to simulate flowing waterbodies for which Bin 2 represents low flow, bin 3 represents moderate flow, and bin 4 represents high flow. Bins 5, 6, and 7 are used to simulate static waterbodies with low, medium and high volumes. Bin 5 represents low volume, bin 6 represents moderate volume, and bin 7 represents high volume.

EPA relies on two standard conceptual model waterbodies which have been traditionally used to estimate pesticide concentrations in water using PWC. The standard farm pond[18] is used to develop EECs for the medium and large static bins (*e.g.*, bins 6 and 7) and the medium and large flowing bins (*e.g.*, bins 3 and 4). For the smallest flowing and static bins (aquatic bins 2 and 5), EPA derived edge-of-field estimates from the PRZM5 daily runoff file (*e.g.*, ZTS file) to be protective of concentrations in a headwater stream or a standing puddle that receives runoff at the edge of a treated field.

Bins 8, 9, and 10 represent estuarine/marine habitats, but EFED does not currently have standard conceptual models to estimate EECs for these environments. EPA and the Services[19] have assigned

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[17] The exposure models can be found at: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment

[18] This "standard farm pond" scenario assumes that rainfall onto a treated 10-hectare agricultural field causes pesticide-laden runoff into a one hectare water body which is 2-meters deep (total volume: 20,000 cubic meters).

[19] NAS, 2013. Assessing Risks to Endangered and Threatened Species from Pesticides. The National Academies Press. 2013. (https://www.nass.usda.gov/AgCensus/).

surrogate freshwater flowing or static systems to evaluate exposure for these estuary and marine bins. Aquatic bin 5 is used as surrogate for pesticide exposure to species in tidal pools (bin 8); aquatic bins 2 and 3 are used for exposure to species at low and high tide (bin 8 and 9), and aquatic bins 4 and 7 are used to assess exposure to marine species that occasionally inhabit offshore areas (bin 10).

Table 3-1. Aquatic Bin, Modeled Waterbody Crosswalk

Aquatic Bin	Description	Width (m)	Length (m)	Depth (m)	Flow (m^3/s)	Waterbody Used for Modeling
1	Wetland	64	157	0.15	Variable[1]	Custom
2	Low-flowing waterbody	2	Field[2]	0.1	0.001	Edge-of-field
3	Medium-flowing waterbody	8	Field[2]	1	1	Farm pond
4	High-flowing waterbody	40	Field[2]	2	100	Farm pond
5	Low-volume, static waterbody	1	1	0.1	N/A	Edge-of-field
6	Medium-volume, static waterbody	10	10	1	N/A	Farm pond
7	High-volume, static waterbody	100	100	2	N/A	Farm pond
8	Intertidal nearshore	50	Field[2]	0.5	N/A	Edge-of-field
9	Subtidal nearshore	200	Field[2]	5	N/A	Farm pond
10	Offshore marine	300	Field[2]	200	N/A	N/A

[1] The depth and flowrate in this waterbody is variable, depending on rainfall.
[2] The habitat being evaluated is the reach or segment that abuts or is immediately adjacent to the treated field. This habitat is assumed to run the entire length of the treated area.

3.2.4 HUC and Use Site Crosswalk

EPA utilized the USDA National Agricultural Statistics Service (NASS) Census of Agriculture[20] 2012 data along with the NASS Cropland Data Layer (CDL[21]) to determine which crops would be modeled within each represented 2-digit HUC. Additionally, when determining what rates would be simulated for different HUC 2 regions, EPA considered specific geographic limitations on how a product may be applied to particular crops.

If the NASS data indicated any acreage of a crop was grown in a specific HUC 2 region, EPA assumed that the crop was grown in that HUC 2 region, and aquatic EECs were generated for these HUC 2 regions for that crop. If there were no reported NASS cropped acres grown within a particular HUC 2 region, aquatic EECs for that HUC 2 region and use pattern were not determined. Limited NASS data are available for Alaska (AK), Hawaii (HI), and Puerto Rico (PR). **Figure 3 - 1** provides the HUC 2 regions.

[20] The USDA NASS Census of Agriculture is a complete count of U.S. farms and ranches. The census is taken once every 5 years and focuses on land use and ownership, operator characteristics, and production practices (https://www.nass.usda.gov/AgCensus/).
[21] The NASS Cropland Data Layer is an annual raster, geo-referenced, crop-specific land cover data layer with a ground resolution of 30 or 56 m depending on the state and year; the data layer is aggregated to a possible 85 standardized categories (https://datagateway.nrcs.usda.gov/catalog/productdescription/nass_cdl.html).

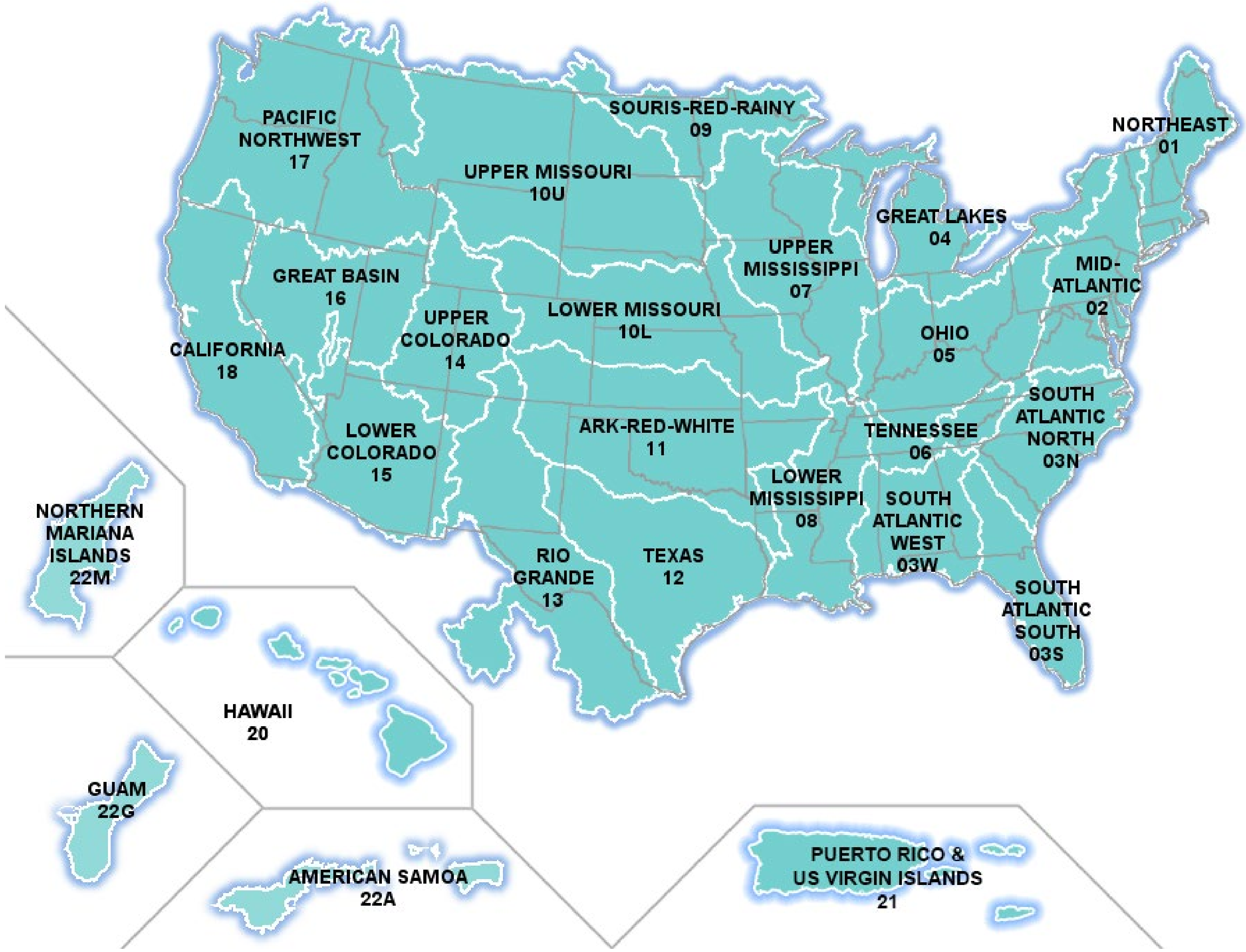


Figure 3 - 1. Hydrologic Unit Code (HUC) 2-Digit Regions and Associated Metrological (Met Station) Data (NHDPlus Hydroregions; USGS, 2020)

3.3 Agricultural Considerations

During application of pesticides, methods of application as well as product formulation used by an applicator can impact the magnitude of off-site transport of the active ingredient. EPA considered label directions (*e.g*., spray drift buffers, application equipment, and droplet size restrictions) as well as product formulation as part of the development of the use scenario modeled.

Dinotefuran is formulated as granules, emulsifiable concentrate, ready-to-use solution, and as a pressurized liquid. It can be applied to crops via a variety of methods including aerial and ground foliar sprays, soil sprays to bare soil (drench, chemigation, soil injection, in furrow sprays), and tree trunk drench or tree trunk injection. Many of the labels allow for repeated or multiple applications within the same growing season provided the maximum annual rate is not exceeded. Many of the uses can be applied as a foliar or soil application, however, for some uses these application methods cannot be combined. Additionally, for soybean application (pending new use), there is a mandatory 150 ft aerial and 25 ft ground buffers. A detailed summary of registered agricultural and non-agricultural uses as well as restrictions and requirements are presented in **Section 1**.

3.4 Aquatic Exposure Summary

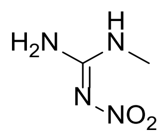
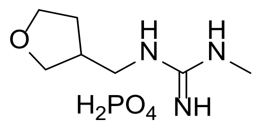
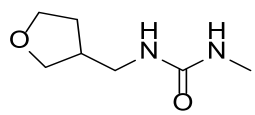
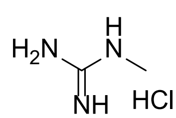
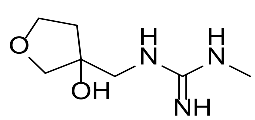
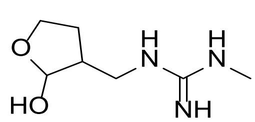
Potential routes of dissipation for dinotefuran in the environment include aqueous photolysis, soil metabolism, leaching, and runoff. Dinotefuran is stable to abiotic hydrolysis, but rapid photolysis was observed in water (half-life = 1.8 days). Major transformation products (>10% applied radioactivity) include UF, MG hydrogen chloride, DN-2-OH and DN-3-OH, BCDN succinate. DN is a minor photodegradation product (<10% applied radioactivity).

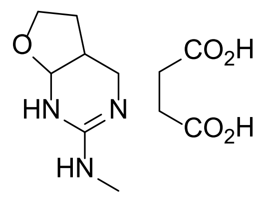
Dinotefuran is moderately persistent in soil under both aerobic (half-life = 9 to 113 days) and anaerobic (half-life = 62 days) conditions based on Goring persistence scale (Goring *et al*., 1975). Dinotefuran is highly mobile with organic carbon (oc) normalized soil partition (sorption) coefficent (Koc) values ranging between 6 to 45 mL/g-oc in soil based on the Food and Agricultural Organization of the United Nations standard mobility classification (FAO, 2000); however, dinotefuran was observed to partition to sediment in the aerobic aquatic metabolism studies. Because dinotefuran has low sorption coefficients in soil, it has a high potential to leach and runoff from the application site.

The fate of dinotefuran in aquatic environments depends on the type of waterbody. Aqueous photolysis should be an important transformation pathway for dinotefuran in clear and shallow waterbodies; however, in deep ponds, lakes or reservoirs, aquatic metabolism (approx. 60 days) is expected to dominate the dissipation processes. Dinotefuran was moderately persistent under actual use conditions in California, New York, and Georgia terrestrial field dissipation studies (half-life = 26 to 65 days). The major transformation product, MNG, was identified in all the field studies. Quantifiable concentrations of dinotefuran were detected at soil depths up to 30 cm. MNG was detected at depths up to 30 cm; however, quantifiable concentrations were only detected at depths up to 15 cm.

The degradation products of dinotefuran are shown in **Table 3-2** MNG is the major degradation product in soil. DN, UF, MG hydrogen chloride, DN-2-OH+DN-3-OH, and BCDN succinate are major degradation products in aquatic environments. These degradation products are formed through metabolism (*i.e.,* DN) or photodegradation (*i.e.*, DN, UF, MG hydrogen chloride, DN-2-OH + DN-3-OH, and BCDN). As noted earlier, the DN and DN-2-OH + DN-3-OH are structurally similar to the parent and MNG also retains the nitroguanidine moiety. The chemical structures of the remaining transformation products are considerably different from dinotefuran.

Table 3-2. Dinotefuran Degradates Identified in Environmental Fate Studies

Code Name/Chemical Identification	Structure	Study Name	Results
MNG **IUPAC:** 1-methyl-2-nitroguanidine **CAS:** N-methyl-N'-nitro-guanidine **CAS No.:** 4245-76-5		Aerobic Soil Metabolism	Maximum 23.96% at 42 days (preliminary study) Maximum 13.7% at 225 days (conducted on radiolabeled parent), study termination
		Terrestrial Field Dissipation	Maximum 31.5% at 45 days after 2nd application; study termination at 170 days after 2nd application
DN phosphate **IUPAC:** 1-methyl-3-(tetrahydro-3-furylmethyl)guanidinium dihydrogen phosphate		Anaerobic Soil Metabolism	Maximum 29.2% at 120 days in Switzerland soil
		Aerobic Aquatic Metabolism	Maximum 23.1% at 180 days in river system and 32.6% at 103 days in pond system
		Photolysis in Water	Maximum 7.5% at 11 days
UF **IUPAC:** 1-methyl-3-(tetrahydro-3-furymethyl)urea		Photolysis in Water	Maximum 10.6% at 13.8 days (last test interval)
MG hydrogen chloride or MG **IUPAC:** 1-methylguanidinium chloride or 1-methylguanidine		Photolysis in Water	Maximum 10.2% at 1.8 days, and 0.8% at 13.8 days (final sampling interval)
DN-3-OH[a] **IUPAC:** Bis[1-(3-hydroxyetrahydro-3-furymethyl)-3-methylguanidinium]terephthalate		Photolysis in Water	Maximum 28.2% at 13.8 days (study termination)
DN-2-OH[a] **IUPAC:** Bis[1-(2-hydroxyetrahydro-2-furymethyl)-3-methylguanidinium]terephthalate			

Code Name/Chemical Identification	Structure	Study Name	Results
BCDN Succinate **IUPAC:** 2-(methylamino)-9-oxa-2-aza-4-azoniabicyclo[4.3.0]non-3-ene hydrogen succinate		Photolysis in Water	Maximum 16.1% at 1.8 days and 4.5% at 13.8 days (study termination)

a. The analytical methods were not capable of separating DN-2-OH and DN-3-OH (M14) which chromatographed together in the High Performance Liquid Chromatography (HPLC) system. Identification of these compounds was based only on comparison of the retention times.

3.5 Aquatic Modeling and Input Parameters

The following sections discuss methods used for aquatic modeling. Summaries of the environmental fate model input parameters used in the PWC for the modeling of dinotefuran EECs are presented in **Table 3-3.** Input parameters are selected in accordance with the following EPA guidance documents:

- Guidance for *Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides*, Version 2.1[22] (USEPA, 2009),
- *Guidance on Modeling Offsite Deposition of Pesticides Via Spray Drift for Ecological and Drinking Water Assessment*[23] (USEPA, 2013)

EPA derived the input parameters (**Table 3-3**) used in aquatic modeling from registrant-submitted studies and based on labelled uses. EPA based aquatic EECs on dinotefuran total toxic residues (parent plus DN, UF, DN-2-OH and DN-3-OH). The EECs were generated based on the use scenarios described in **Appendix I** and were developed in consultation with the Biological and Economic Analysis Division (BEAD). The maximum application rates on the registered labels as well as proposed label for use on soybean; these rates are specific to the cropping season as well as year. In this assessment, EPA assumed one cropping season per year. Crops with multiple cropping seasons are limited by the maximum annual application rates.

EPA selected the PWC and PFAM scenarios from EFED's standard suite of scenarios using the maximum application rate and crop management practices for the currently registered use sites. For PWC, scenarios used in this assessment were updated in 2020 to be more spatially comprehensive and to better reflect environmental conditions (USEPA, 2020c). These scenarios were used in all cases except for uses that are not represented by them (*e.g.*, turf/ornamentals and rice/watercress). For these cases, older PWC and PFAM scenarios are used.

EPA used some non-standard PWC scenarios (labelled with a qualifier OP, NMC, or RLF, which are abbreviations for organophosphate, n-methyl carbamate, and Red-legged Frog [*Rana draytonii*], respectively) for some crops where standard scenarios were not available. These scenarios were developed to address specific issues, such as refinements of assessments for endangered species, or for

[22] https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/guidance-selecting-input-parameters-modeling (accessed January 2020)
[23]The draft guidance is available at www.regulations.gov docket number: EPA-HQ-OPP-2013-0676

a specific class of chemicals. These are not necessarily vulnerable locations or areas representing major crop-growing areas for any particular crop. This is consistent with previous assessments where these scenarios were developed to support the registration review of organophosphate and n-methyl carbamate insecticides or the Red-legged Frog endangered species assessments and are consistent with EPA's practice of generating protective aquatic exposure estimates.

EPA developed a watercress scenario for PFAM assuming a water depth of 0.5 inch (0.0127 meters)[24] as well as to mimic a flowing water condition with a weir height of 0.0381 meters. EPA utilized a turnover rate of 8.03 days.[25,26] **Attachment 7** includes the batch input file used for PRZM-VVWM simulations.

For foliar uses, EPA selected application dates within the wettest month with the crop on the field for at least 20 days. Pre-plant applications were simulated based on a 7-day pre-emergence estimation. For more details on the scenario development for each use, see **Appendix I**.

Table 3-3. Dinotefuran and Total Toxic Residue (TTR) Input Values Used for Surface Water Modeling with Pesticide in Water Calculator (PWC; version 2.001)

Parameter (units)	Value		Source	Comments
	Dinotefuran	TTR		
Organic-carbon Normalized Soil-water Partitioning Coefficient (K_{OC} (L/kg-$_{OC}$))	31.4	17	MRID 45640114	The mean K_{oc} value is used for modeling. Dinotefuran: K_{oc} values = 6, 22, 42, 42,45 mL/g-oc TTR: MNG K_{oc} values = 8, 16, 31, 8, and 24 mL/g-oc; DN K_{oc} values = 270, 413, 87, 58, and 2502 and 24 mL/g-oc
Water Column Metabolism Half-life or Aerobic Aquatic Metabolism Half-life (days) 20 ˚C	63.6	142	MRID 45640117	The 90th percentile confidence bound on the mean half-life value determined following the NAFTA kinetics guidance is used for modeling. Dinotefuran: Input $t_{½}$ = 60.1 + [(3.078 x 1.6)/√2)] = 63.6 days (n=2; 58.9 (SFO), 61.2 (SFO)) TTR: Input $t_{½}$ = 109.7 + [(3.078 x 15)/√2)] = 142 days [n=2; 120 (SFO), 99.3 (SFO)]
Benthic Metabolism Half-life or Anaerobic Aquatic Metabolism Half-life (days) 20°C	86.3	985	MRIDs 48680002 45891616	The 90th percentile confidence bound on the mean dinotefuran half-life value determined following the NAFTA kinetics guidance is used for modeling. Dinotefuran: Input $t_{½}$ = 56.6 + [(1.886 x 27.3)/√3)] = 86.3 days [n=3; 25.6 (SFO), 66.9 (SFO), 77.2 (SFO)]

[24] http://ipmcenters.org/ cropprofiles/docs/HIwatercress.pdf
[25] Flow rate of water – 10,000 gallons/day (378.5 m^3/day) [Hutchinson, 2005; see footnote 26]
Volume of water in watercress field, assumed 1 acre field and 0.5 inches of water column in the field watercress bed 4046.8 m^2*0.0127 m = 51.4 m^3
Therefore, turnover /day = 378.5/51.4 = 7.4
[26] Hutchinson, L. 2005. Ecological Aquaculture: A sustainable Solution. Permanent Publications, Hyden House Ltd, East Meon, Hampshire, England

Parameter (units)	Value		Source	Comments
	Dinotefuran	TTR		
				TTR: Input $t_{½}$ = 537 + [(1.886 x 411.9)/√3)] = 985.2 days (n=3; 1007 (SFO), 363 (SFO), 240 (SFO)
Aqueous Photolysis Half-life at pH 7 (days) and 40° Latitude, 25°C	1.8	0	MRID 45640105	TTR are assumed to be stable because concentrations of DN-2-OH+DN-3-OH and UF are increasing at study termination. Moreover, kinetic analysis of the total residues shows a biphasic pattern with leveling off over the last four of ten sampling periods. There are also several unknown compounds noted.
Hydrolysis Half-life (days)	0	0	MRIDs 45640102 45640102	Dinotefuran is stable to hydrolysis.
Soil Half-life or Aerobic Soil Metabolism Half-life (days) and 25°C	155.7	243	MRIDs 46751101, 45640112, 46711201	The 90th percentile confidence bound on the mean dinotefuran half-life value determined following the NAFTA Guidance for Evaluating and Calculating Kinetics in Environmental Media is used for modeling. Dinotefuran: Input $t_{½}$ = 43.6 + [(3.078 x 51.5)/√2)] = 155.7 days [n=2; 80 (SFO), 7.1 (IORE)] TTR: Input $t_{½}$ = 75.6 + [(3.078 x 76.9)/√2)] = 243 days [n=2; 130 (SFO), 21.2 (IORE)] Note: one half-life value (10-days at 20 °C) was adjusted to 7.1-days at 25 °C before the model input value was calculated.
Molecular Weight (g/mol)	202.2	202.2	MRID 45640101	Parent value
Vapor Pressure (Torr) at 25 °C	3.8×10^{-7}	3.8×10^{-7}	MRID 45640117	Parent value
Solubility in Water at 25 °C (mg/L)	39,830	39,830	MRID 45640112	Parent value
Foliar Half-life (days)	0	0	PWC User Guidance[a]	Default values (stable)
Application Efficiency	0.99 (ground) 0.95 (aerial)		Spray drift Guidance[b]	Default values for PRZM-VVWM.
Application Drift	0.062; 0.027 (ground; 25ft buffer) 0.125; 0.039 (aerial; 150ft buffer)			Default values

a. https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment

b. U.S. EPA Guidance on Modeling Offsite Deposition of Pesticides via Spray Drift for Ecological and Drinking Water Assessment, December 20, 2013 (https://downloads.regulations.gov/EPA-HQ-OPP-2013-0676-0002/content.pdf).

OC=organic carbon; SFO=single first order; IORE=indeterminate order; MRID=Master Record Identification number; NAFTA=North American Free Trade Agreement; PRZM-VVWM=Pesticide Root Zone Model-Variable Volume Water Model.

Residue of concern include dinotefuran, and the transformation products MNG, DN, UP, and DN-2OH+DN-3-OH. These residues are referenced as total toxic dinotefuran residues (TTR).

3.6 Aquatic Modeling Results

Table 2-1 summarizes the EECs derived from the PWC modeling for dinotefuran TTR based on maximum labeled use rates. The PWC runs and residential post-processed results for all uses and scenarios are provided in **Attachment 7**. For a conservative estimate, turf and ornamental use were modeled as if they were used at their maximum annual rates within the same residential lot. These EECs were modeled separately and combined for a single EEC estimate. For additional details on residential modeling and EEC estimation, see **Appendix H.** Only the scenario resulting in the highest EECs for each use are presented in the table below.

Edge-of-field estimates were also estimated with the edge-of-field calculator to determine the EECs in a headwater stream or a standing puddle that receives runoff at the edge of a treated field, representing bins 2, 5 and 8. See **Section 3.2.3** for discussion on the various aquatic bins. Refer to **Table 3-5** for the EECs derived from the edge-of-field calculator. **Attachment 8** contains the input and output files used for edge-of-field analysis.

Table 3-4. Summary of Surface Water Dinotefuran Total Toxic Residue Estimated Environmental Concentrations (EECs) Resulting from Current Dinotefuran Labels.

Use	1-in-10-year Concentration (µg/L)[1]					
	1-d Average Water Column	4-day Average Water Column	21-day Average Water Column	60-day Average Water Column	Peak Average Pore Water	21-day Average Pore Water
Foliar Applications						
Christmas Tree/Forestry	5.8	5.8	5.6	5.3	4.3	4.3
Crop Group 1 (Potato)	17.0	17.0	16.7	16.3	15.9	15.0
Crop Group 13-07 (Grapes, Berries)	7.3	7.3	7.1	6.9	6.7	6.6
Crop Groups 12 and 14 (Orchard)	7.8	7.8	7.6	7.2	6.2	6.2
Crop Groups 4, 5, 8, and 9 (Vegetables)	16.8	16.8	16.7	16.5	16.2	15.4
Crop Subgroup 20C (Cotton)	5.9	5.8	5.6	5.1	4.4	4.4
Soybean	5.4	5.4	5.2	5.0	4.4	4.3
Soil Applications						
Crop Group 1 (Potato)	32.1	32.0	31.8	31.9	30.5	29.3
Crop Group 13-07 (Grapes, Berries)	6.1	6.1	6.0	6.0	5.8	5.8
Crop Groups 12 and 14 (Orchard)	6.1	6.0	5.8	5.4	4.5	4.5
Crop Groups 4, 5, 8, and 9 (Vegetables)	38.7	38.5	37.2	33.7	24.6	24.5
Soybean	3.2	3.2	3.1	2.7	2.0	2.0
Ornamentals	8.0	8.0	7.9	7.7	6.5	6.5
Combined Foliar + Soil Applications						
Crop Group 13-07 (Grapes, Berries)	10.8	10.7	10.7	10.6	9.4	9.2
Residential[2]						
Turf + Ornamentals	6.9	N/A	6.7	6.5	N/A	N/A
Other						
Rice	349	332	252	156	97.3	96.3
Watercress	65.2	16.3	6.2	2.2	2.1	1.8

[1]For applications that can be applied through both air or ground broadcast, and during either pre or post-emergence, only the method combination that results in the highest EECs are presented.

[2]Residential EECs are modeled for turf and ornamental applications combined, representing the resulting concentrations if residential users were applying to both concurrently. EECs from residential uses are estimated from 30-year weather data. See **Appendix H.** for more details.

Table 3-5. Summary of Aquatic Edge-of-Field Dinotefuran Total Toxic Residue Estimated Environmental Concentrations (EECs) Resulting from Current and Proposed Dinotefuran Labels.

Crop	Application Method	1- day Edge-of-Field Water Column EECs µg/L (Minimum)	1-DAY Edge-of-Field Water Column EECs µg/L (Maximum)
Christmas Trees	Aerial	N/A	N/A
Crop Group 1 (Potato)	Aerial	14.2	109.9
Crop Group 13-07 (Grapes, Berries)	Aerial	16.8	71.3
Croup Group 12, 14 (Orchard)	Aerial	12.6	64.5
Crop Groups 4, 5, 8, 9 (Vegetables)	Aerial	6.0	185.2
Crop Subgroup 20C (Cotton)	Aerial	40.4	95.6
Soybeans	Aerial	32.1	70.7
Ornamentals	Aerial	N/A	N/A
Christmas Trees	Ground	67.2	156.2
Crop Group 1 (Potato)	Ground	8.9	358.2
Crop Group 13-07 (Grapes, Berries)	Ground	4.1	115.3
Croup Group 12, 14 (Orchard)	Ground	13.1	171.4
Crop Groups 4, 5, 8, 9 (Vegetables)	Ground	1.0	483.5
Crop Subgroup 20C (Cotton)	Ground	42.1	99.7
Soybeans (proposed)	Ground	34.0	73.7
Ornamentals	Ground	N/A	194.2

N/A=not applicable.

2.1 Monitoring Data

EPA examined several different water monitoring programs as well as open literature for monitoring data for parent dinotefuran. Residues of concern other than parent dinotefuran were not evaluated in any monitoring programs.

Water monitoring data were obtained from the water quality portal[27]. A summary of these data are provided in **Table 3-6**. These data represent ambient water quality monitoring programs for sampling of dinotefuran (parent only). Results for surface water as well as groundwater are reported. While groundwater is generally not habitat for aquatic species included in the ecological assessment (and not modeled in this assessment) there are many locations in the United States where groundwater provides direct recharge to surface water or is used for irrigation purposes and could runoff to aquatic habitats.

[27] The Water Quality Portal (WQP) is a cooperative service sponsored by the United States Geological Survey (USGS), the Environmental Protection Agency (EPA), and the National Water Quality Monitoring Council (NWQMC). It serves data collected by over 400 state, federal, tribal, and local agencies. Accessed 9/28/23.

Table 3-6. Monitoring Data Summary for Dinotefuran in Groundwater and Surface Water

Monitoring Program	Water Type	Number of Samples	Sites	Detection Number	LOQ[a] (µg/L)	Maximum Dinotefuran Concentration (µg/L)
National Water Information System (NWIS)[b]	Surface Water	748	121	45	0.0045-0.0055	1.9
	Groundwater	37	9	1	0.0045	0.0283
Storage and Retrieval (STORET)[a]	Surface Water	8041	137	505	0.025	11.7
	Groundwater	2640	1286	8	0.0005-0.025	0.30

a. The limit of quantification (LOQ) is provided for the methods or programs reported in the two datasets.
b. Data downloaded from the Water Quality Portal on September 28, 2023

Based on the available surface water monitoring data, the highest concentration of dinotefuran is reported in Storage and Retrieval (STORET) at 11.7 µg/L. This value was reported by the Minnesota Department of Agriculture (MSDA) for a routine grab sample taken June 21, 2013 at a Fish Creek just upstream of the US-61 in Newport (location identifier: MNDA_PESTICIDE-S005-376). Other high (>1 µg/L) concentrations of dinotefuran have also been observed at this site by MSDA and range from 1.31 to 6.33 µg/L and all were collected in 2013. Reported detections mainly occur within the states of Minnesota and California, as these two states have active water quality monitoring programs; however, other detections are reported in states across the country where (United States Geological Survey) USGS conducts routine sampling including Georgia, Iowa, Oklahoma, Oregon, and Texas.

Available groundwater monitoring data suggest that dinotefuran may leach to groundwater. This is consistent with the environmental fate properties (*e.g.*, mobility). The highest concentrations detected in groundwater to date (<1.0 µg/L) are lower than those observed in surface water.

In addition, EPA evaluated monitoring data from the Washington State Department of Ecology and Agriculture Cooperative Surface Water Monitoring Program (WSDA).[28] Sampling focused on salmon-bearing streams in five different basins within Washington. Primarily weekly sampling was conducted during the pesticide use season; however, some daily sampling was also conducted. While monitoring did not specifically target dinotefuran use, nor did the report provide pesticide use information, some pesticide use survey data were obtained from WSDA. In addition, the report included information on the percent cropped area (PCA) for each of the basins included in the report. The program began to monitor for dinotefuran in 2014. A summary of the results are provided in **Table 3-7**. The highest concentration measured was 6.70 µg/L.

[28] Sandison D. 2021. Surface Water Monitoring Program for Pesticides in Salmonid-Bearing Streams, 2019 Data Summary. Data summary: a cooperative study by the Washington State Departments of Ecology and Agriculture. Access at: https://cms.agr.wa.gov/WSDAKentico/Documents/Pubs/629-SWMP-TechnicalReport-2019.pdf

Table 3-7. Monitoring Data Summary for Dinotefuran in Salmon-Bearing Streams in Washington State (WSDA)

Monitoring Program	Number of Detections	Detection Frequency (%)	LOQ (µg/L)	Maximum Concentration (µg/L)
2014	49	12	0.01	6.70
2015	36	11	0.01	0.88
2016	38	14	0.01	0.79
2021	51	19	0.01	0.97

LOQ=limit of quantification

Taken together, these data support EPA's understanding that dinotefuran may runoff to surface water as well as leach to groundwater. It is unlikely that the ambient monitoring data captured the peak dinotefuran concentrations present in the environment since monitoring is not conducted daily and are not targeted to dinotefuran use. In general, EPA considers monitoring data more informative on chronic values rather than peak values.

Other than parent dinotefuran, the monitoring data do not include the other residues consider as TTR. Because of this, the measured monitoring concentrations likely underestimate the concentrations of TTR results from dinotefuran use. The highest measured parent concentration in the monitoring data (*i.e.*, 6.7 µg/L) is below the range of the TTR EECs.

3.7 Measures of Plant Aquatic-Terrestrial Exposure

The Plant Assessment Tool (PAT)[29] is a mechanistic model that incorporates fate (*e.g.*, degradation) and transport (*e.g.*, runoff) data that are typically available for conventional pesticides, to estimate pesticide concentrations in terrestrial, wetland, and aquatic plant habitats. This assessment did not utilize the PAT model because of the lack of effects to terrestrial plants. Aquatic plants are also not impacted based on the lack of effects at the estimated exposures.

3.8 Measures of Terrestrial Exposure

Terrestrial animals may be exposed to dinotefuran through multiple routes of exposure, including diet, drinking water, dermal and inhalation exposure. Terrestrial dietary items may consist of plants, invertebrates or vertebrates (*i.e.*, amphibians, reptiles, birds or mammals) that inhabit terrestrial areas or aquatic dietary items (*i.e.*, fish, amphibians, aquatic invertebrates or aquatic plants). EPA determined the potential for dinotefuran to bioaccumulate in living tissues to be low based on its octanol-water partition coefficient (Kow) of 0.283 @25°C.

Two major parameters are used in terrestrial exposure modeling to characterize a species: body weight and diet. Estimates of body weights are necessary to estimate dose-based exposures through diet, drinking water, inhalation and dermal exposure routes. Information on the dietary requirements of listed species are necessary to determine relevant exposures through consumption of contaminated

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[29] https://www.epa.gov/endangered-species/provisional-models-and-tools-used-epas-pesticide-endangered-species-biological#pat

prey. Species-specific assumptions related to diet and body weight are provided within the Terrestrial Residue Exposure (T-REX) model. The foliar dissipation half-life of the chemical can also impact the duration of exposure to predicted terrestrial EECs, and the default 35 day value was used to be protective of parent and degradate formation.

As a general note, for dinotefuran, based on the risk profile, there are only impacts to terrestrial and aquatic invertebrates for direct effects. Thus, the focus is on those taxa with direct effects and any species that rely on them for indirect effects.

4 Ecological Effects Characterization

Toxicity data available for dinotefuran are divided into major taxonomic groups. For each of these groups, endpoints are determined for each taxon for mortality (animals only) and sublethal effects (*i.e.,* growth or reproduction). These endpoints are used to establish thresholds, which are then used in conjunction with exposure data to make effects determinations based on the taxon with which they are associated. These data are described more fully in each relevant toxicity section below.

4.1 Terrestrial Taxa

4.1.1 Birds

Dinotefuran was tested on various species of birds including the passerine Zebra finch (*Taeniopygia gutta*), Galliform Japanese quail (*Coturnix japonica*) and Northern Bobwhite quail (*Colinus virginianus*), and the Anseriforme Mallard duck (*Anas platyrhynchus*) for acute oral and dietary studies; and, Bobwhite quail and Mallard duck for chronic reproduction studies. The parent compound is categorized as moderately toxic to Zebra finch with an LD_{50} of 334 milligrams of active ingredient per kilogram of bodyweight (mg a.i./kg-bw), and practically nontoxic to Japanese quail (LD_{50} > 2,000 mg a.i./kg-bw; MRID 45639720) and Bobwhite quail (LD_{50} > 2,250 mg a.i./kg-bw; MRID 47353601) on an acute oral exposure basis. On a subacute (5-day) dietary exposure basis, dinotefuran is categorized as practically non-toxic to the Mallard duck (LC_{50} > 5,000 mg a.i./kg-diet; MRID 45639722) and Japanese quail (LC_{50} > 5,000 mg a.i./kg-diet; MRID 45639721). Although there appeared to be no statistically significant treatment-related reproductive effects on Bobwhite quail (MRID 45639724), chronic testing on Mallard duck (NOAEC = 2,150 mg a.i./kg-diet; MRID 45639723) showed statistically significant ($p<0.05$) reductions (32%) in the percentages of number of hatchlings/eggs laid, eggs set, and 14-day old survivors at the LOAEC of 5,270 mg a.i./kg-diet test concentration.

4.1.2 Mammals

Dinotefuran is categorized as slightly to practically nontoxic on an acute basis to mammals based on an LD_{50} of 2000 mg/kg-bw (MRID 45639823) for females rats (*Rattus norvegicus*). Chronic studies indicated effects on rats and rabbits. A 2-generation reproduction study for MTI-446 (dinotefuran) technical on the rat indicated a NOAEC of 3,000 mg/kg-diet (MRID 45639913) based on decreased based on ~15% decreased body weights for F1 and F2 offspring at the LOAEC (10,000 mg/kg-diet).

Avian and mammalian toxicity data are not available for the transformation products and this assessment assumes the 35-day half-life used in modelling covers the parent dinotefuran and the transformation products discussed in **Section 2.7 (Identification of Residues of Concern)**.

4.2 Aquatic Taxa

The data submitted by the registrant show that dinotefuran is categorized as practically nontoxic on an acute exposure basis for freshwater and estuarine/marine fish with LC_{50} > 99 mg a.i./L, as well as to freshwater invertebrates (*Daphnia magna* 48-hour LC_{50} > 968.3 mg a.i./L; MRID 45639709) and saltwater mollusks including the Eastern oyster (*Crassostrea virginica*) with a 96-hr EC_{50} > 141 mg a.i./L (MRID 45639711). The degradate of dinotefuran (DN phosphate) is also categorized as practically non-toxic to the freshwater invertebrate (*D. magna* 48-hour LC_{50} > 110.6 mg a.i./L; MRID 45639710) on an acute exposure basis. However, on an acute exposure basis dinotefuran is categorized as highly toxic to the estuarine/marine invertebrates with a mysid shrimp (*Americamysis bahia*) LC_{50} = 0.79 mg a.i./L; MRID 45639713).

Chronic toxicity testing on freshwater Rainbow Trout (*Oncorhynchus mykiss*; MRID 45639719) and invertebrates (*D. magna*; MRID 45639718) showed no treatment-related effects and NOAECs of 6.36 mg a.i./L and 95.3 mg a.i./L, respectively. Since estuarine/marine chronic toxicity studies were not submitted for this compound, there is uncertainty regarding chronic toxicity to estuarine/marine fish. However, impacts to estuarine/marine fish are not anticipated given the lack of observable toxicity to fish at concentrations as high as 6.36 mg ai/L (6,360 µl/L). For the purposes of risk assessment, the toxicity data for freshwater fish are used to represent the potential toxicity to estuarine/marine fish. For estuarine/marine invertebrates, a chronic toxicity study with *A. bahia* (MRID 48680006) indicated treatment-related effects on male length (↓6%) and female dry weight (↓17%) at the lowest concentration tested (NOAEC and LOAEC of <0.044 and 0.044 mg a.i./L, respectively). Based on the available data, estuarine/marine invertebrates are more sensitive to dinotefuran than freshwater invertebrates on both an acute and chronic exposure basis.

Registrant-submitted data for the daphnid suggests that freshwater invertebrates are relatively insensitive to dinotefuran. However, as described in the "Preliminary Aquatic Risk Assessment to Support the Registration Review of Imidacloprid" (DP Barcode 435477; signed December 22, 2016), numerous reviews of imidacloprid toxicity have recently been published (Anderson *et al.,* 2015; EFSA, 2015; BCS, 2016; Morrissey *et al.,* 2015; PMRA, 2016; Pisa *et al.,* 2015; Smit *et al*., 2015) suggesting aquatic insect species are highly sensitive compared to other classes of arthropods or other phyla. The authors suggest, that part of the high sensitivity of insects to imidacloprid may result from its interaction with the nicotinic acetylcholine receptors which vary in composition among various taxa (Ihara *et al.,* 2007; Lalone *et al.,* 2016). Given that dinotefuran also interacts with the nicotinic acetylcholine receptors, it is likely that aquatic insect species are also relatively sensitive compared to other aquatic invertebrates. The limited open literature for dinotefuran supports this suggestion.

In addition to the open literature, data on the acute and chronic toxicity of dinotefuran to the freshwater midge (*Chironomus riparius*), submitted to the EPA, supports the assertion that aquatic insects are relatively sensitive compared to other aquatic invertebrates. The studies evaluated the 48-hr and 27-d toxicity of technical grade dinotefuran (97.3% purity) to first-instar larvae of *C. riparius* using the OECD Test Guideline (TG) 202 (water column test) and draft OECD TG 219 (sediment-water toxicity test using spiked water) guidelines. The resulting acute 48-hr LC_{50} value was 0.0721 mg a.i./L with NOAEC and LOAEC values for mortality of 0.022 and 0.046 mg a.i./L, respectively. The NOAEC and LOAEC for the 27-d toxicity test were 0.003 and 0.0059 mg a.i./L, respectively, based on a statistically significant ($p<0.05$) decrease in emergence.

After the draft ecological risk assessments for the nitroguanidine-substituted neonicotinoids were posted to the docket in 2017[30], two studies were published focusing on the toxicity of these compounds to aquatic invertebrates (Raby *et al*. 2018a and Raby *et al*. 2018b). EFED reviewed these two studies and determined that their results may be used quantitatively for risk assessment purposes (*i.e.*, to derive risk quotients RQs). A complete discussion of the comparative risk of the four nitroguanidine-substituted neonicotinoids can be found in the memorandum "Comparative analysis of Aquatic Invertebrate Risk Quotients Generated for Neonicotinoids using Raby *et al*. (2018) Toxicity Data" (USEPA, 2020e). **Table 4-1**. provides the most sensitive endpoints for aquatic invertebrates used in this BE.

Table 4-1. **Most Sensitive Quantitative Dinotefuran Freshwater Invertebrate Acute and Chronic Toxicity Endpoints**

Study Type (test species)	Endpoint	Toxicity Value	Toxicity Classification[1]	MRID	Classification
Acute and Chronic Freshwater Invertebrate Mayfly (*Neocloeon triangulifer*)	LC_{50}	9.8 µg a.i./L	Very highly toxic	50776401/ E392452	Quantitative
	NOAEC/ LOAEC	4.0/8.0 µg a.i./L based on 100% decrease in survival at 8 µg a.i. /L			
Acute and Chronic Freshwater Invertebrate (Midge *(Chironomus dilutus*)	LC_{50}	31.9 µg a.i./L	Very highly toxic	50776201/ E178288	Quantitative
	NOAEC/ LOAEC	3.1/ 6.3 µg a.i./L based on 29% decrease in emergence at 6.3 µg/L	--		

[1]Based on EC50 (mg/L): < 0.1 very highly toxic; 0.1-1 highly toxic; >1-10 moderately toxic; >10-100 slightly toxic; >100 practically nontoxic
LC_{50}=lethal concentration to 50% of the organisms tested; NOAEC=no-observed adverse effect concentration

4.3 Terrestrial and Aquatic Plants

4.3.1 Terrestrial Plants

Terrestrial plant testing (Tier I seedling emergence OPPTS 850.4100, MRID 45639729, and vegetative vigor OPPTS 850.4150, MRID 45639730) on ten species including monocotyledonous (monocot) and dicotyledonous (dicot) plants indicated no effects as a result of a single application of the formulated end-use product LX1414-01 MTI-446 20% SG (20% dinotefuran) at a rate of 0.54 lbs a.i./A, the maximum application rate allowed for any use. The 14-day concentration resulting in a 25% inhibition of the test species (EC_{25}) and NOAEC for both studies were >0.54 lbs a.i./A and 0.54 lbs a.i./A, respectively, thus, dinotefuran exhibits low plant toxicity.

[30] Imidacloprid Registration Review Docket (EPA-HQ-OPP-2008-0844); Clothianidin Registration Review Docket (EPA-HQ-OPP-2011-0865); Thiamethoxam Registration Review Docket (EPA-HQ-OPP-2011-0581); Dinotefuran Registration Review Docket (EPA-HQ-OPP-2011-0920)

4.3.2 Aquatic Vascular and Non-Vascular plants

Toxicity testing on the aquatic vascular plant duckweed (*Lemna gibba:* MRID 45639731) showed no treatment-related effects yielding 7-day EC_{50} and NOAEC values of >110 mg a.i./L and 110 mg a.i./L, respectively. For non-vascular plants, testing with the technical grade active ingredient (TGAI) indicated a statistically significant ($p<0.05$) significant reduction in cell density for the freshwater green alga *Raphidocelis subcapitata* at the two highest test concentrations (↓8.7% and ↓10.8% at 50 and 97.6 mg/L, respectively) yielding a 96-hour NOAEC of 25 mg a.i./L; the EC_{50} for cell density, biomass, and growth rate endpoints, however, is >97.6 mg a.i./L (the highest concentration tested). Dinotefuran exhibits low toxicity to both vascular and nonvascular aquatic plants and the NOAEC of 25 mg a.i./L is used for quantitative assessment of effects for aquatic plants.

Data from the degradates show equal to lesser toxicity to plants. Non-vascular plant *(R. subcapitata)* acute toxicity testing with two degradates MNG (MRID 45639733) and DN (DN-phosphate; MRID 45639734) also showed no treatment-related effects and thus 96-hour EC_{50} and NOAEC values of >98.7/ 98.7 mg a.i./L and >100.4 / 100.4 mg a.i./L, respectively.

4.4 Terrestrial Invertebrates

What follows is a summary of the available toxicity studies to characterize the acute and chronic effects to *Apis* and non-*Apis* adult bees and larvae. The studies are organized by duration (acute or chronic), and route of exposure (contact or oral). An open literature search of the ECOTOXicology (ECOTOX[31]) Knowledgebase completed in June 2022, did not identify any additional *Apis* or non-*Apis* dinotefuran toxicity studies than listed below; therefore, honey bees are used in this assessment as a surrogate for the sensitivity of terrestrial invertebrates to dinotefuran and its residues of concern.

The Tier I effects dataset for dinotefuran is considered complete. Dinotefuran is categorized as highly toxic to adult bees on an acute contact and oral exposure basis. Dinotefuran is more toxic via dietary exposure than contact. **Table 4-2** provides an overview of the acute and chronic endpoints for terrestrial invertebrates.

4.4.1 Adult Acute Contact Toxicity

Dinotefuran TGAI is categorized as highly toxic to honey bees on an acute contact exposure basis (48-hr LD_{50} = 0.047 µg a.i./bee; MRID 45639725). Similarly, the dinotefuran formulated end-use product MTI-446 20%WG (20% ai) is also categorized as highly toxic to honey bees on an acute contact exposure basis with 48-hr LD_{50} ranging between 0.024 to 0.062 µg a.i./bee (MRIDs 45639727 and 45639726).

The RT_{25} (or residual time to cause at least 25% mortality) was derived from a study evaluating the mortality after an exposure to 3-, 8-, 24- or 48-hr field aged residues on alfalfa (MRID 45639728) with the formulated end-use product MTI-446 20% WG. Results indicate that bees were most sensitive to residues aged 24-hrs or less (RT_{25} values were less than 24-hr), with the shortest RT_{25} at 4.6-hr following

[31] ECOTOX is a source for locating single chemical toxicity data for aquatic life, terrestrial plants and wildlife. The knowledgebase integrates three previously independent databases - AQUIRE, PHYTOTOX, and TERRETOX - into a unique system which includes toxicity data derived predominately from the peer-reviewed literature, for aquatic life, terrestrial plants, and terrestrial wildlife, respectively (https://cfpub.epa.gov/ecotox/help.cfm).

exposure to 8-hr residues. After residues were field aged for 48-hr or 72-hr the RT_{25} increased to 24-hr and 90-hr, respectively.

4.4.2 Adult Acute Oral Exposure

Dinotefuran TGAI (MRID 45639725) is categorized as highly toxic to honey bees on an acute oral exposure basis (48-hr LD_{50} = 0.023 µg a.i./bee). Similarly, the dinotefuran formulated end-use product MTI-446 20% WG (MRIDs 45639726 & MRID 45639727) is also categorized as highly toxic to honey bees on an acute oral exposure basis (48-hour LD_{50} = 0.032 µg a.i./bee and 0.0076 µg a.i./bee, respectively).

4.4.3 Adult Chronic Oral Toxicity

One study is available that examines the chronic toxicity of dinotefuran through dietary exposure for adult honey bees (MRID 49775901). The NOAEL based on reduced food consumption is 0.0015 µg a.i/bee/day representing a NOAEC of 0.064 mg a.i./kg diet and is used in assessing effects. The LOAEL is based on a 17% reduction food consumption at the 0.0035 µg a.i/bee/day, representing a NOAEC of 0.160 mg a.i./kg diet.

4.4.4 Larval Acute and Chronic Oral Toxicity

In an acute toxicity study (MRID 49753601), individual honey bee larvae (first instar) were exposed to dinotefuran. The 72-hr NOAEC and LC_{50} were determined to be 111 and >111 mg a.i./kg diet, respectively, and the 72-hr NOAEL and LD_{50} were 3.3 and >3.3 µg a.i./larva, respectively. Based on these data, dinotefuran is classified as no more than moderately toxic to honey bee larvae on an acute (single dose dietary) exposure basis.

In a larval chronic 21-day study (MRID 49860001) individual honey bee larvae were exposed to technical grade dinotefuran, differences in cumulative larval mortality (Days 3-8) between dinotefuran-treated and controls were statistically significant ($p<0.05$) at all doses, however, the dose response spanning over two orders of magnitude is not well defined. There were no statistically significant differences between dinotefuran-treated and control bees during the pupal development stage from Days 9 to 15 (pupal stage). No statistically-significant differences were indicated at any dinotefuran treatment level compared to the control at study termination based on adult bee emergence and emerged adult bee weight. Since cumulative larval mortality from D4 – D8 and through D22 were less than 50%, the D8 and D22 LD_{50} values are greater than the highest dose tested (*i.e.*, LD_{50}>15 µg a.i./larva).

Table 4-1. Terrestrial Invertebrates- Summary of Acute and Chronic Endpoints for Dinotefuran

Study Type	Endpoint [a]	Reference	Classification
Adult Acute Contact Toxicity	48-hr LD_{50}: 0.024 µg a.i/bee	MRID 45639727	Acceptable
Adult Acute Oral Toxicity	48-hr LD_{50}: 0.0076 µg a.i/bee	MRID 45639727	Supplemental Quantitative
Adult Chronic Oral Toxicity	10-day NOAEL/LOAEL (food consumption): 0.0015/0.0035 µg a.i/bee/day	MRID 49775901	Acceptable
	10-day NOAEL/LOAEL (mortality, body weight): 0.0035/0.0083 µg a.i/bee/day		

Study Type	Endpoint [a]	Reference	Classification
Larval Acute (single dose)	72-hr LD_{50}: >3.3 µg a.i./larva 72-hr LC_{50}: >111 mg a.i./kg diet	MRID 49753601[c]	Acceptable
Larval Chronic (repeat dose)	8-day NOAEL/LOAEL: 3.75/>3.75 µg a.i./larva/day 21-day NOAEL/LOAEL: 15/>15 µg a.i./larva	MRID 49860001	Supplemental Quantitative- (re-reviewed dose response)
Toxicity of Residues on Foliage[b] (OCSPP 850.3030[c])	RT_{25} = 48 hrs	MRID 45639728	Acceptable

LD_{50}= dose resulting in 50% lethality among organism tested; MRID=master record identification number; NOAEL=no observed adverse effect level; RT25 =time for residue to drop below 25% toxicity to bees in contact with residues on treated foliage.
[a] Represents the most sensitive (*i.e.* lowest) of all endpoints within a particular study type for studies for which raw data (to allow for independent statistical verification of the endpoint) are available.
[b] Although cited in 40 CFR Part 158 as an EPA testing requirement, the results of this study are not used for risk estimation.
[c] This MRID is a correction to the MRID referenced as 49751901 in the preliminary bee risk assessment (USEPA, 2020).

4.4.5 Acute and Chronic Toxicity of the Degradation Products of Dinotefuran

As discussed in Section 3, dinotefuran can degrade into various products both within the plant as well as in the environment. Specifically, dinotefuran breaks down into its major degradates DN, UF, NG and MNG. There are four adult honey bee acute oral toxicity studies available to characterize the toxicity of these metabolites. However, there are no additional data to evaluate the relative toxicity of these compounds to parent dinotefuran with regard to their acute toxicity to larvae or chronic toxicity to either adults or larvae. In each of these studies, there were reported mortalities in treatments; however, the mortalities were not in a dose responsive manner and did not appear to be a response to the test chemicals. The studies did not result in mortalities greater than 30 percent, so no definitive LD50 values are available for quantitative evaluation of effects. In summary, the degradate toxicity data indicate the parent alone is the stressor of concern for the assessment.

4.4.6 Foliar Application Residue Studies

There are eight-registrant submitted foliar application studies (*i.e.*, blueberry, cherry, cotton, cranberry, cucumber, peach, pumpkin, and tomato) available to characterize the total residues of parent dinotefuran and the metabolites DN and UF in pollen, nectar and leaf tissue. There was also a study available from the open literature that examined residues on crops following foliar applications of dinotefuran. Details of the studies are provided in the Final Bee Risk Assessment to Support the Registration Review of Dinotefuran (USEPA, 2020; Table 3-6). In addition, there is a field residue study on soybean (50636017). These foliar application residue studies are not used in refinement because the primary exposure to the specific listed terrestrial invertebrates at the J/AM stage is not from the crop pollen and nectar exposure route.

4.4.7 Soil Application Residue Studies

There are six registrant-submitted studies on soil applications to various crops (*i.e.*, bell pepper, cantaloupe, cucumber, potato, pumpkin, and tomato) available to characterize the total residues of parent dinotefuran and the metabolites DN and UF in pollen, nectar and leaf tissue. There were also two studies available from the open literature that examined residues following soil applications of dinotefuran. Details of the studies are provided in the Final Bee Risk Assessment to Support the Registration Review of Dinotefuran (USEPA, 2020; Table 3-7). These soil application reside studies are not used in refinement because the primary exposure to the specific listed terrestrial invertebrates at the J/AM stage is not from the crop pollen and nectar exposure route.

4.4.8 Hive monitoring studies

In addition to the crop monitoring studies discussed above, several studies are available from the open literature that survey residues in in-hive pollen, wax, nectar, and dead bee samples, for various chemicals, including dinotefuran. These studies serve to characterize the potential extent to which bees are exposed to dinotefuran in the field.

The available studies that survey various matrices for pesticide contamination, including in-hive pollen (bee bread), trapped pollen (pollen collected from bees as the bees enter the colony), honey, beeswax, and honey bee samples, provide a broad picture of the overall in-hive residues that result from use of dinotefuran and other chemicals. While the studies differed in the location of sampled hives, as well as the condition of the colony from which the samples originated, all studies had similar sampling procedures for a given matrix and appropriately low limits of quantification (LOQs) reported for the analytical methods used.

Stoner and Eitzer (2013) conducted a multi-residue study that evaluated concentrations of pesticides in honey bee-collected pollen in Connecticut. The data are from colonies located in mixed landscapes (generally suburban) that may reflect residential uses. They report detections of dinotefuran in only three out of 313 tested pollen samples, and peak and mean concentrations in pollen of 7.6 ng a.i./g and 4 ng a.i./g respectively. In another field trial, Lu et al. (2015) screened for dinotefuran (as well as other neonicotinoids) residues in pollen and honey samples from hives distributed across Massachusetts. Their report indicated that out of 219 pollen samples collected in 2013, there were 39 detections of dinotefuran, 12 (31%) of which were below the level of quantification (LOQ = 0.1 ng/g), and maximum residues were reported as 4.94 ng/g pollen. They also detected dinotefuran in 40 of 53 honey samples, 26 (65%) of which were below the level of quantification. The maximum residue reported for honey was 14.5 ng/g honey.

4.4.9 Non-*Apis* Bee Characterization

The risk profile of dinotefuran to *non-Apis* bees (*e.g.*, bumble bees [*Bombus spp*], solitary bees) may differ relative to honey bees due to differences in exposure and sensitivity to dinotefuran. Reported incidents involving bee kills, including *Bombus sp*. demonstrate that other bee species may be affected when exposed. While there is uncertainty in extrapolating the risk findings of this assessment to non-*Apis* bees, EPA's the 2014 Guidance on Assessing Pesticide Risks to Bees pollinator risk assessment framework used by the EPA indicates the honey bees are reasonable surrogates for other bee species. Therefore, conclusions from the weight of evidence for the honey bee can be used to help inform about potential risks to other non-*Apis* species.

4.4.10 Species Sensitivity Distribution

While there are insufficient data to conduct a SSD for dinotefuran, given the similarity in toxicity of imidacloprid and dinotefuran to terrestrial invertebrates (USEPA, 2020), the SSD available from the imidacloprid assessment serves a proxy for estimating population/community effects. The endpoints for acute mortality to terrestrial invertebrates resulting from dietary exposure expressed as mg a.i./kg-food are provided in the SSD (see **APPENDIX I** for details on the imidacloprid SSD from USEPA, 2022). In the imidacloprid SSD, a total of 10 insect species are represented from 3 Orders (7 Hymenoptera, 2 Diptera and 1 Lepidoptera). No suitable mortality data for acute dietary exposure of non-insect species were identified. As summarized in the Imidacloprid Jeopardy Analysis (USEPA, 2023), estimates of dietary exposure of listed terrestrial invertebrates are based on an SSD for acute dietary-based toxicity data, ranged from 0.13 to 643 mg/kg food. For dietary-based exposures to terrestrial invertebrates, the HC05 is 0.064 mg/kg food (95% CI: 0.0045-0.81 mg/kg food) and the HC_{25} is 0.78 mg/kg food (95% CI: 0.15-4.6 mg/kg food).

4.4.11 Incident Data

In the process of making effects determinations, EPA considered ecological incidents as a part of the weight of evidence when estimating impacts of dinotefuran on listed species. The Office of Pesticide Programs (OPP) Incident Data System (IDS) includes wildlife incidents reported to the Agency from a variety of sources. The sources of information for incidents include, registrant reports submitted under FIFRA §6(a)(2) reporting requirement, as well as reports from local, state, national and international-level government reports on bee kill incidents, news articles, and correspondence made to EFED by phone or via email (through beekill@epa.gov) generally reported by homeowners and beekeepers.

On 9/28/2023, the IDS data base was searched. There were four incidents in IDS and **Table 4-3** provides a summary of the incidents reported to the Agency that involved dinotefuran. All of the incidents are related to terrestrial invertebrates, specifically insects, involving lethality to social Apis and non-Apis bees. Also indicated in **Table 4-3** two of the four incidents, have a certainty index of probable or highly probable meaning there is a higher likelihood that dinotefuran was associated with the incident. One incident (not in the table), was attributed to a misuse and is not further discussed.

Pesticide registrants also report certain types of incidents to the Agency as aggregate counts occurring per product per quarter. Ecological incidents reported in aggregate reports include those categorized as “minor fish and wildlife” (W-B), “minor plant” (P-B), and “other non-target” (ONT) incidents. “Other non-target” incidents include reports of adverse effects to insects and other terrestrial invertebrates. For dinotefuran, there were three incidents reported in the aggregate reports [two minor plant and one minor wildlife (for a prescription flea product containing three AI’s)].

The number of actual incidents associated with any pesticide may be higher than what is reported to the Agency. Incidents can go unreported since side effects may not be immediately apparent or readily attributed to the use of a chemical.

Table 4-2. Summary of Dinotefuran Incident Reports in Incident Data System (IDS)

Incident Record	Date	Use Pattern	Product	Location	Legality	Certainty Index	App. Method	Comments
I026531-001	4/2014	Ornamental	Transect 70 WSP	CA	Unknown	Possible	Trunk Drench	Submitted under FIFRA 6(a)(2). In San Francisco, California three soil drench applications of Transect™ 70WSP (a.i. dinotefuran) were made by a professional tree service to 11 ngaio trees (*Myoporum laetum*) for control of Myoporum thrips. The applications were made on 6/13/13, 8/27/13 and 12/7/13. During the last application a total of 21 oz product was used for all 11 trees (3.2 0.6 oz packets per tree). It was reported that the trees were stressed from thrip damage prior to treatment. On April 18, 2014, Valent USA corporation was made aware of the observation of dead bumble bees and "a few other insects" located around or falling from the trees. Around 50 dead bees were first reported to the tree care company on April 9, with a few more in the days since and through April 21.
I027656-001	8/2015	Ornamental	Safari 2G	CA	Unknown	Probable	Spray	In San Francisco during the spring several ngaio trees were treated with Safari™ with active ingredient, dinotefuran (EPA Reg. No. 59639-149). Approximately 200 dead and dying bumblebees were observed under the treated trees. "Pentra-Bark" surfactant was also used to control thrips.
086203-00011-059639	8/2021	Ornamental	Safari 20SG	FL	Unknown	Possible	Unknown	In August 2021, the Florida Department of Agriculture and Consumer Services (FDACS) initiated an investigation into an alleged bee kill in Homestead, Florida. The claimant indicated that a nursery performed a pesticide application the first week of August with a giant fan creating a big mist, which engulfed their property and the neighborhood. Two days later, 13 bee colonies died. There were no bees collected. After an FDACS review, it appeared that the Beetle Trap Oil Stripes use was consistent with label directions. In the landing strip sample, 0.7 ug of diuron, diflubenzuron, and spinosyn A were detected, but below the lowest method standard level. Pesticide use inspections were also conducted at surrounding areas. They found that nearby farms and nurseries had all made pesticide applications [there are 14 AIs other than dinotefuran listed]. There were several violations found at multiple farms/nurseries that were unrelated to the bee incident (*e.g.*, insufficient personal protective equipment; PPE). The investigation also confirmed that there were no mosquito control applications. Overall the conclusion was that the claimants allegation that the bee kill was due to a pesticide application could not be confirmed. The exact date, application site, application rate, and application method were not provided.
I025373-002	03/2013	Ornamental	Safari 20SG	OR	Registered Use	Highly Probable	Spray	An incident was reported to Valent on Monday, June 23, in which bumble bee deaths were reported on several flowering linden trees (Tilia sp) in Hillsboro, Oregon. The City of Hillsboro reportedly treated approximately 200 street linden trees, including the subject trees, with a basal trunk application of Safari 20 SG Insecticide (a.i. dinotefuron) on March 26, 2013. Dead or dying bees were associated with a few trees (exact count not determined), and one tree associated with most of the mortality observed was reported as showing symptoms of stress. The Oregon Department of Agriculture (ODA) investigated this report of dead bumblebees under a single tree treated three months earlier. Although some of the treated active ingredient, dinotefuran, was found in bumble bees and foliage of treated lindens, the ODA found no indication of an application being made inconsistent with labeling or in a faulty, careless or negligent manner. Dinotefuran was detected in bumble bee tissue at 0.18 ppm (LD50 = 0.024 ug a.i./bee/contact

5 METHODS FOR EFFECTS DETERMINATION & INITIAL PREDICTION FOR LIKELIHOOD OF JEOPARDY/ADVERSE MODIFICATION

5.1 Methodology Overview/Analysis Plan

This analysis reflects the methodologies and principles described in both the ESA Revised Methods (USEPA, 2020d) and recent Biological Opinions (BiOps) prepared by the Services. Specifically, EPA used the final USFWS BiOp for malathion (USFWS, 2021) and the NMFS Draft BiOp (NMFS, 2022) as guides in this assessment to predict the likelihood of jeopardy to listed species from use of dinotefuran, as well as the likelihood of adverse modification of critical habitat. During the period following the Malathion BiOp, EPA has regularly met with FWS (to discuss the BIOP and other recent assessments) and those discussions helped inform this underlying methodology. The overall process and a general description of the major steps in the process are presented in **Figure 5-1.** Flowchart for Effects Dinotefuran Determination & Predicting Likelihood of J/AM and is described in additional detail below.

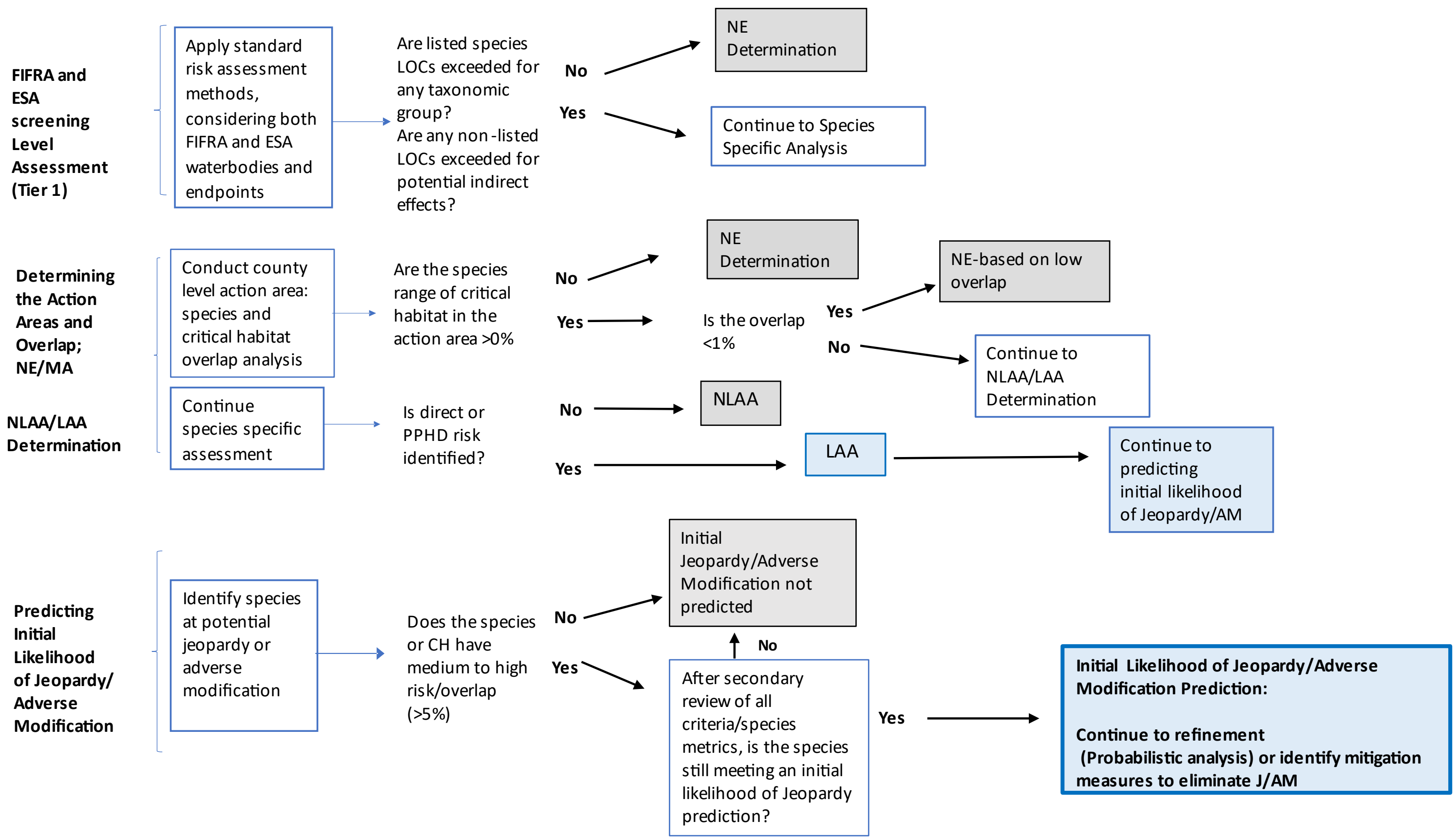

Figure 5-1. Flowchart for Effects Determinations and Predicting Likelihood of Jeopardy for a Listed Species and/or Adverse Modification of Designated Critical Habitat (J/AM) from Registered Uses of Dinotefuran.

5.1.1 Tiering

This methodology utilizes a tiered approach to provide timely assessments and use resources efficiently. The tiered approach identifies taxonomic groups and pesticide use patterns where, at lower tiers, risk assessors can identify when there is reasonable certainty that the likelihood of adverse effects can be considered insignificant based on the conservative assumptions and less complex models (*i.e.*, taxon-based, not species-specific). Where concerns are identified in Tier I for taxonomic groups and use patterns, additional refinements may involve reconsidering the conservative assumptions and uncertainties of Tier I. In brief, at Tier I, EPA identifies potential risk concerns using a deterministic (*i.e.*, point estimate-based) risk quotient (RQ), which is a ratio of the exposure concentration (*i.e.*, EEC) and the regulatory effect endpoint. RQs are then compared to the level of concern (LOC), which is EPA's interpretative policy used to analyze potential for adverse effects to non-target organisms. If the RQ exceeds the Tier I listed species LOC and is not mitigated, the assessment proceeds to Tier II for a species-specific assessment. Additionally, at Tier I the specific use sites that do not exceed the listed species LOC may also be excluded from additional analysis.

At the Tier II analysis stage, the assessment becomes more spatially explicit, and an analysis is conducted to determine the potential overlap of the use sites with the individual species range and CH. Unless the assessment is starting at a highly refined level (*e.g.,* highly refined geographic restrictions), the analysis is conducted with the Tier II overlap tools (i.e., UDLs and Census of Agriculture) for speed and efficiency in the analysis. At the Tier II stage the analysis considers species-specific dietary items, bodyweight, and habitat data for determining impacts based on uses that have overlap with species ranges and CH. If additional analysis is likely to be helpful for refinement, Tier III methods including probabilistic (*i.e.*, distribution-based) analysis methods or refinement to the overlap using more intensive spatially specific analysis using Geographic Information Systems (GIS-based) tools can be utilized as necessary and if resources allow. **Table 5-1** provides a summary of the tiers utilized for this assessment.

Table 5-1. Assessment Tiers for this Listed Species Assessment

Tier	Description
Tier I	FIFRA/Overview Document Approach: Risk Quotient is compared to Endangered Species LOC
Tier II	Overlap with Census of Agriculture (CoA) and Use Data Layer (UDL) tools Refined RQ or Exposure/Deterministic analysis
Tier III	Refined Exposure/Probabilistic analysis and/or use of refined overlap: GIS refinement

The tiered approach is used as the analysis proceeds through each step from NE to prediction of the likelihood of J/AM. **Table 5-2** summarizes the specific criteria used by EPA at each level of the determinations; these criteria are explained further below.

Table 5-2. Summary of Approach and Criteria for NE/NLAA/LAA/J-NJ/AM-NAM Determination

<table>
<tr><td colspan="4">Quantitative Species/CH Effects Determinations and J/AM predictions</td></tr>
<tr><th>Determination</th><th>Reason</th><th>Description</th><th><u>Risk Modifiers:</u></th></tr>
<tr><td rowspan="3">NE/MA</td><td>NE based on FIFRA RQ screen</td><td>Species RQs in entire taxa less than listed species LOC</td><td rowspan="13">Risk Modifiers may be applied at any point of the process to modify an effects determination. Risk modifiers are more qualitative in nature and may increase or decrease the predicted impacts to species. Some examples of risk modifiers include:

-Species habitat
-Species biology
-Variation in dietary items
-Species vulnerability
-Overlap refinements</td></tr>
<tr><td>NE based on no overlap or <1% overlap</td><td>Species range and/or critical habitat have <1% overlap with all use sites with appropriate drift/runoff buffers applied (drift buffers based on most conservative endpoints)</td></tr>
<tr><td>NE based on no toxicity</td><td>No toxicity anticipated based on screen of endpoints associated with species taxa and PPHD taxa against exposure values (based on relevant use site exposures and conservative endpoints)</td></tr>
<tr><td colspan="3">Species/CH not meeting above criteria are given MA determination and move on in analysis</td></tr>
<tr><td rowspan="2">NLAA/LAA</td><td>NLAA based on less than 1 individual exposed</td><td>Less than 1 individual is predicted to be exposed based on specific species parameters including likelihood of being on use site. (Not triggered for dinotefuran)</td></tr>
<tr><td>NLAA based on less than 1 individual impacted</td><td>Based on analysis of direct effects and effects to PPHD utilizing less conservative toxicity endpoints than the NE determination, and applying species-specific EECs based on use sites overlapping with species range. This may be analyzed using deterministic or probabilistic methods, depending on refinement needed.</td></tr>
<tr><td colspan="3">Species/CH not meeting above criteria are given LAA determination and move on in analysis</td></tr>
<tr><td rowspan="3">J/NJ – AM/NAM</td><td>NJ/NAM based on low overlap</td><td>Species range and/or critical habitat have <5% overlap with all use sites with appropriate drift/runoff buffers applied (drift buffers based on population relevant endpoints)</td></tr>
<tr><td>NJ/NAM based on low magnitude of effect</td><td>No effects are predicted based on EECs associated with any use site that has overlap with species and compared to population level toxicity endpoints[1]</td></tr>
<tr><td>NJ/NAM based on low extent of overlap with impacts</td><td>Species range and/or critical habitat have <5% overlap with all use sites (with appropriate drift/runoff buffers) where EECs exceed population level toxicity endpoints. This may be analyzed using deterministic or probabilistic methods, depending on refinement needed</td></tr>
<tr><td colspan="3">Species/CH not meeting above criteria are further evaluated for Jeopardy or Adverse Modification using weight of evidence and the application of any additional risk modifiers for final determination.
[1] Population-level endpoint may vary from those endpoints considered at the individual level (NE/NLAA/LAA determinations)</td></tr>
<tr><td colspan="4">Qualitative Species/CH Effects Determinations</td></tr>
<tr><td colspan="4">EPA could not evaluate a subset of species through quantitative methods based on species traits (e.g., deep ocean habitat) limiting the ability to quantitatively model pesticide exposure. For these species, EPA applied principles regarding exposure and effects similar to quantitative criteria above as much as possible to reach an NE/NLAA/LAA/J-AM/AM-NAM determination.</td></tr>
</table>

5.1.2 Dinotefuran Specific Methods and Analysis

For dinotefuran, EPA completed the effects determinations focusing on the foliar and soil spray applications. The effects determinations also included a separate analysis for the non-spray applications including a tree trunk injection and for terrestrial taxa that may consume granules (presented in **APPENDIX B**). For all effects LAA determinations, EPA considered the use of risk modifiers (*e.g.*, diet characterization, habitat, overlap refinement) during or after the quantitative analysis to further predict the likelihood jeopardy or adverse modification. The process for the dinotefuran analysis, following the methodology outlined above, is discussed further below. Results are detailed in **Chapter 6**.

5.1.3 Tier I Screen

In cases when a taxa or a specific use pattern is below the listed species LOC at Tier I (considering the highest EECs), EPA may streamline the analysis to remove those taxa from further analysis and/or focus on the uses that require further review. In Tier 1, the standard FIFRA risk assessment process is used as a screen to determine if there is potential direct effect on listed species by comparing RQs to endangered species LOCs (**Table 5-3**).

Table 5-3. Endpoints, Risk Quotients (RQs), and Tier 1 Acute and Chronic Levels of Concern (LOCs)

Taxon	Exposure duration	Listed/non-listed	RQ[1]	LOC[1]
Fish and aquatic-phase amphibians	Acute	Non-listed, general indirect effects	Daily EEC/LC_{50}	0.5
		Listed direct effects & obligate indirect effects	Daily EEC/LC_{50}	0.05
	Chronic	Listed and non-listed, general and obligate indirect effects	60-day EEC/NOAEC	1
Aquatic invertebrates	Acute	Non-listed, general indirect effects	Daily EEC/LC_{50}	0.5
		Listed direct effects & obligate indirect effects	Daily EEC/LC_{50}	0.05
	Chronic	Listed and non-listed, general and obligate indirect effects	21-day EEC/NOAEC	1
Birds, reptiles, terrestrial-phase amphibians,	Acute	Non-listed, general indirect effects	Upper-bound EEC/LC_{50} (Dietary) Upper-bound EEC /LD_{50} (Dose)	0.5
		Listed direct effects & obligate indirect effects	Upper-bound EEC /LC_{50} (Dietary) Upper-bound EEC /LD_{50} (Dose)	0.1
	Chronic	Listed and non-listed, general and obligate indirect effects	Upper-bound EEC /NOAEC	1
Mammals	Acute	Non-listed, general indirect effects	Upper-bound EEC /LD_{50} (Dose)	0.5
		Listed direct effects & obligate indirect effects	Upper-bound EEC /LD_{50} (Dose)	0.1
	Chronic	Listed and non-listed, general and obligate indirect effects	EEC[1]/NOAEC (Dietary) EEC[1]/NOAEL (Dose)	1
Terrestrial invertebrates	Acute	Non-listed, general indirect effects	EEC/LD_{50} (contact) EEC/LD_{50} (diet)	0.4[2]
		Listed direct effects & obligate indirect effects	EEC/LD_{50} (contact) EEC/LD_{50} (diet)	0.05[3]
	Chronic	Listed and non-listed, general and obligate indirect effects	EEC/NOAEC (diet)	1[2]
Aquatic plants	Not applicable	Non-listed, general indirect effects	Daily EEC/ IC/EC_{50}	1
		Listed direct effects & obligate indirect effects	Daily EEC/ NOAEC	1
Terrestrial plants	Not applicable	Non-listed, general indirect effects	EEC/ IC_{25}	1
		Listed direct effects & obligate indirect effects	EEC/ NOAEC	1

EC_{50}= 50% effect concentration; EEC=estimated environmental concentration; IC_{25}=Concentration resulting in 25% inhibition; LC_{50}=lethal concentration for 50% of the organisms tested; LD_{50}=lethal dose for 50% of the organisms tested; NOAEC=no-observed adverse effect concentration. [1]USEPA 2004.; [2]USEPA, PMRA, CDPR 2014.; [3]USEPA 2000

At Tier I, the assessment stops if there are no RQs above the listed species LOCs across all taxa and a No Effect (NE) determination is made. If, however, there is single taxon with RQs above the listed species LOCs, then the effects determination proceeds to Tier II for all taxa.

In this BE, EPA utilizes the results from the FIFRA Dinotefuran Preliminary Ecological Risk Assessment for the Registration Review of Dinotefuran (USEPA, 2017), the FIFRA Final Bee Risk Assessment to Support the Registration Review of Dinotefuran (USEPA, 2020), and new aquatic invertebrate data discussed in the Response To Comment document (USEPA, 2020b), for the Tier I screen. In addition to the standard models used for ecological risk assessment[32], EPA used the PWC Edge-of-Field (EoF) Calculator (version 2.1) to ensure a conservative screen at Tier I since the EoF represents the smallest flowing and static aquatic bins (*i.e.*, bins 2 and 5), which represent headwater such as springs, seeps, and floodplain areas.

The screening-level assessment for dinotefuran concluded that for non-listed taxa, there are potential risks to terrestrial and aquatic invertebrates. The screening-level indicated a potential for birds (which serve as surrogates for reptiles and terrestrial-phase amphibians) from soil spray applications based on the LD_{50}/ft^2 analysis, but EPA considers the likelihood of adverse effects to these taxa is low overall when considering the lines of evidence/characterization (birds are still fully assessed at Tier II). Based on the screening-level assessment, there is a low likelihood of direct adverse effects on listed and non-listed fish (for which freshwater fish serve as surrogates for aquatic-phase amphibians), aquatic and terrestrial plants, and mammals. The proposed new use for soybean has similar conclusions (risks to aquatic and terrestrial invertebrates).

Direct effects are anticipated for terrestrial and aquatic invertebrates and indirect effects are anticipated for taxa that rely on those taxa for prey, pollination, habitat and/or dispersal (PPHD). **Table 5-4** summarizes EPA's assessment regarding potential for adverse effects on non-listed and listed taxa from the use of dinotefuran.

Table 5-4. Summary of Potential Effects to Non-listed and Listed Species (Tier I) from Registered and Proposed Uses of Dinotefuran.

Taxa	FIFRA screen: Potential Risk to Non-listed Species[a]	ESA Screen: Potential Effects to Listed Taxa Via Direct or Indirect Effects[b]
Aquatic invertebrates	**Yes**	Direct: Yes* Indirect: Yes-from potential reductions in terrestrial invertebrate and aquatic insect prey abundance
Fish and aquatic-phase amphibians	No	Direct: No Indirect: Yes*-from potential reductions in terrestrial invertebrate and aquatic insect prey abundance
Mammals	No	Direct: No Indirect: Yes* from potential reductions in terrestrial invertebrate and aquatic insect prey abundance

[32] New Chemical assessment (USEPA, 2020 a,b). Models used: PWC version 1.52, AgDRIFT® version 2.1.1; T-REX version 1.5.2; BeeREX version 1.0; Terrplant. Available online at: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment.

Taxa	FIFRA screen: Potential Risk to Non-listed Species[a]	ESA Screen: Potential Effects to Listed Taxa Via Direct or Indirect Effects[b]
Birds (including terrestrial phase amphibians and reptiles)	**Yes** (Soil application-RQs based on the LD_{50}/ft^2 approach only and characterized as low for non-listed when considering field practices) No for foliar and granular	Direct: Tier I listed species LOC exceedance for soil spray and foliar uses but not anticipated based on refined species specific exposure. RQs based on the arthropod residues range from 0.02 to 0.17, narrowly exceeding the listed species LOC for small birds. Foliar applications, dose-based RQs range from <0.01 to 0.43. [No bird exceedances for soybean proposed use] Indirect: Yes*-from changes in terrestrial invertebrate and aquatic insect prey
Terrestrial Invertebrates	**Yes**	Direct: Yes*-from drift and systemic transport into pollinator attractive vegetation or via contact Indirect: Yes*
Aquatic plants (Vascular and non-vascular)	No	Direct: No Indirect: No
Terrestrial plants	No	Direct: No Indirect: Yes*-reduction in pollination services and dispersal

[a] Non-Listed species Level of Concern (LOC) Definitions: Terrestrial Vertebrates: Acute=0.5; Chronic=1.0; Terrestrial Invertebrates: Acute=0.4; Chronic=1.0; Aquatic Animals: Acute=0.5; Chronic=1.0; Plants: 1.0
[b] Listed species Level of Concern (LOC) Definitions: Terrestrial Vertebrates: Acute=0.1; Chronic=1.0; Terrestrial Invertebrates: Acute=0.05; Chronic=1.0; Aquatic Animals: Acute=0.05; Chronic=1.0; Plants: 1.0
*All listed taxa with "Yes" indicated potential effects are considered further in the Effects Determination (See Tier II)

5.1.4 Tier II

At Tier II, a more refined assessment includes species-specific metrics (*e.g.*, bodyweight, diet, and habitat) are used in the effects determination and the potential for population-level effects. In Tier II/Tier III, the species relationships (*e.g.*, whether the plant has an obligate relationship with a pollinator, *etc.*) are also linked, and species are removed that have no effects anticipated based on the screen of endpoints associated with species taxa and PPHD based on relevant use site exposures and endpoints).

5.2 Methods for Overlap Analysis

The next phase of the assessment begins with establishing an action area through an overlap analysis. At this stage, the potential overlap of the action area and individual species range or critical habitat is generated. There are two tools available for generating the overlap for listed species assessments: the Use Data Layer (UDL) overlap tool and the Census of Agriculture (CoA) overlap tool (these tools and background documents are available on the web[33]). These tools provide conservative overlaps with pre-processed elements to gain efficiency in assessing listed species; both provide different information relevant to the analysis based on different principles. The UDL overlap may provide greater spatial

[33] https://www.epa.gov/endangered-species/provisional-models-and-tools-used-epas-pesticide-endangered-species-biological

refinement of the species range/CH and general crop location but may offer less granularity depending on the crops within the UDL (versus using individual registered uses). In contrast, the CoA tool can allow for refinement of use sites by using census county crop acres that are differentiated on a smaller scale than the level of the grouped UDLs (*e.g.*, overlap for apples and peaches analyzed separately, rather than all being grouped in the Orchard UDL). However, the CoA is not as spatially refined as the Geographic Information System (GIS)-based UDL and includes conservative assumptions on crop acres and species location within a county (*e.g*., all crop acres are assumed to be within the species range in each county). For this BE, there are both agricultural and non- agricultural uses, thus, the UDL overlap tool serves as the basis for the overlap analysis. When needed, the CoA tool is used for refining (for grouped UDLs or species in the NL48). If the CoA data were used for refining the potential exposure there is a reference in the comments for the J/AM call as a modifier (CoA refinement).

The extent of overlap for dinotefuran uses with the species' range or designated CH integrates information on potential use sites with the species locations. This approach considers overlap of the species range or CH with areas of potential use (*i.e*., direct application to the site) and areas adjacent to the treated site receiving spray drift and/or runoff.

EPA makes NE determinations when the overlap across use sites is <1%, inclusive of the total exposure area out to the furthest distance to effect. EPA predicts that there is no likelihood of Jeopardy or Adverse Modification predictions when overlap of each individual use inclusive of the exposure area is <5%.

For the sod and forestry uses, EPA leveraged additional non-spatial datasets to support the evaluation of initial spatial overlap results. These additional datasets provide refinement to the location of potential use and potential treated area and provides qualitative refinement when interpreting the results. (See **Appendix G** for additional details on the characterization of these uses in comparison to the UDL).

This following section describes the approach for determining the extent of overlap, refinements made to the overlap to support the effects determination, and overall impacts of the spatial analysis. **Attachment 1** contains the detailed UDL tool scripts for reference.

5.3 Establishing an Action Area

Inclusive of all potential dinotefuran use sites (represented by UDLs) and exposure areas that extend out to the farthest distance (*e.g.,* due to spray drift and runoff transport) at which effects on listed species or CH are reasonably expected to occur; the action area sets the geographic extent of the federal action. The action area for dinotefuran may occur anywhere in the U.S. or its territories (Puerto Rico, Guam, American Samoa, US Virgin Islands, and Mariana Islands) where the chemical is registered for use.

EPA used the registered uses of dinotefuran (**Table 5-5**) to identify spatial data that represent potential application sites of dinotefuran. These data are referred to as Use Data Layers (UDLs). The UDLs represent the potential locations of dinotefuran applications in the CONUS and NL-48 (**Table 5-5**). The agricultural UDLs are based on 5 years of USDA's Cropland Data Layer (CDL), currently 2012-2017. EPA determined the extent of the off-site area by adding a buffer to the UDLs. This buffer represents the farthest distance from the treated sites where potential effects to listed species or designated CH are reasonably expected to occur from spray drift and/or runoff exposures.

Table 5-5. Crosswalk of the Use Data Layer (UDL) with the Crop Use Patterns Registered for Dinotefuran Use

Use Site/Location	CONUS Use Data Layer (UDL)	NL_48 Use Data Layer (UDL)
Agricultural Uses		
Peaches, Nectarines	Other orchards	NL_48 Ag
Cotton	Cotton	NL_48 Ag
Soybean (Proposed use)	Soybean	NL_48 Ag
Turfgrass (Sod Farms)	Other Crops	NL_48 Ag
Berries (including cranberry), Bushberry, Caneberry, Cucurbits and Fruiting Vegetables, Leafy Vegetables (brassica and non-brassica), Bulb Vegetables, Watercress, Potato, Corm and Tuberous Vegetables	Vegetables and Ground Fruit	NL_48 Ag
Rice	Rice	NL_48 Ag
Grapes	Grapes	NL_48 Ag
Non-Agricultural Uses		
Christmas trees	Christmas Trees	NL_48 Managed Forest
Forest Trees	Forest Trees	NL_48 Forest Trees
Turfgrass (Residential, Sports Complexes, Golf Courses), Ornamentals (landscaped and groundcover areas around residential, commercial, industrial, institutional, and public buildings; parks; recreational areas; athletic fields; interior plantscapes)	Open Space Developed	NL_48 Open Space Developed
Nurseries (Field, Conifer, Retail Nurseries, Forest Seedlings in Lath Greenhouses, and Shade Houses, nonbearing fruit and nut trees grown in greenhouses)	Field Nurseries	NL_48 Field Nurseries
Fly and cockroach bait and ornamentals in residential, commercial and industrial areas	Developed	NL_48 Developed

CONUS= Contiguous United State NL_48=Hawaii, Alaska and U.S. Territories

The action area is represented by the UDLs or the use sites shown in **Table 5-6.** These UDLs and uses were used as input for the respective tools for determining the foliar/soil spray use overlap. The action area also covers the granular and tree injections uses as the use sites are the same.

While not part of the Action Area Establishment with the UDL Overlap analysis, the CoA refinement is briefly introduced here to demonstrate the UDLs used and cases where the UDL includes agricultural uses outside of the labeled use, where a refinement using the CoA may be used on a case by case basis. **Table 5-6** shows where CoA provided a means of refinement. Non-agricultural crops are not included in the tool, thus, this refinement is for the agricultural uses only. For this BE, the CoA refinement was utilized on a limited basis at the J/AM step and is noted the comment fields of the determination. For this BE, based on the uses, the CoA refinement was helpful for the species in the NL48 as the CoA overlap tool identifies the specific crops (rather than the total Agriculture UDL) for Hawaii species refinement. Other Orchards is another UDL that includes far more acreage than registered uses and if a J/AM was driven high overlap with this UDL, the CoA may be utilized for refinement.

Table 5-6. Dinotefuran Uses Selected in the Use Data Layer (UDL) and Census of Agriculture (CoA) Overlap Tools

UDL Overlap Tool	CoA Overlap Tool - Use Site Selected
CONUS_Other Orchards	Nectarines and Peaches
CONUS_Other Crops (Sod)	No equivalent
CONUS_ Vegetables and Ground Fruit	Berries (including cranberry), Bushberry, Caneberry, Cucurbits and Fruiting Vegetables, Leafy Vegetables (brassica and non-brassica),

UDL Overlap Tool	CoA Overlap Tool - Use Site Selected
	Bulb Vegetables, Watercress, Potato, Corm and Tuberous Vegetables.
CONUS_Soybeans	Soybean
CONUS_RIce	Rice
CONUS_Cotton	Cotton
CONUS_Grapes	Grapes
NL48_Ag (Non-lower 48-all Agriculture)	CoA includes Non-lower 48 (NL48) by use for AK, HI, and PR
	Other territories (Guam, American Samoa, US Virgin Islands, and Mariana Islands are all Agriculture)

CONUS=contiguous United State; NL48=Hawaii (HI), Alaska (AK) and U.S. Territories; PR=Puerto Rico.

5.4 Overlap Screen for NE

In the early screen for NE (based on overlap), EPA made a NE determination for the species if the UDL-based overlap met the criteria for NE (i.e., <1%). This criterion of <1% is derived from the accuracy[34] of the available UDL overlap and. After the <1% screen, all remaining species (*i.e.,* species with range or critical habitat overlap greater than 0.44%) proceed on in the analysis.

5.5 Methods for NLAA/LAA Effects Determinations

A LAA determination is made when the dinotefuran may be used within a species' range, the species may be exposed, and that exposure is likely to lead to an adverse effect. As described above, the overlap of all use is determined for the species range and critical habitat. At this stage, when considering NLAA/LAA effects determinations, less conservative endpoints [*e.g.*, MATC value-the maximum accepted toxic concentration; here as the geometric mean of the NOAEC and LOAEC) are used for calculating off-site exposure distances due to drift, which is again calculated based on the endpoint. This overlap is then compared against the <1% threshold, for which an NE determination is made.

At the next step in the analysis, the remaining species are analyzed for NLAA/LAA determinations using a species-specific quantitative analysis that incorporates species PPHD relationships with other taxa and indicates if, based on deterministic analysis, one individual may be impacted, through effects on survival, growth, or reproduction, or if there are effects on PPHD on which listed species depend. provides an overview of the toxicity endpoints used for assessing effects to listed species and PPHD.

[34] EPA has used this 1% overlap criterion because a known source of error within spatial datasets is positional accuracy and precision. The National Standard for Spatial Data Accuracy outlines the accepted method for calculating the horizontal accuracy of a spatial dataset (FGDC, 1998). To prevent false precision when calculating area and the percent overlap it rounded to whole number to account for significant digits, where <0.44% is represented as 0 and 0.45% is represented as 1%.

Table 5-7. Tier II Endpoints Used for Aquatic and Terrestrial Animals

Taxa	Effects to listed species	Effects to Prey, Pollination, Habitat and/or Dispersal		
	Mortality	**Growth/Reproduction**	**Obligate relationship**	**General**
Birds/Reptiles* Mammals Fish/Amphibians** Aquatic Invertebrates Terrestrial Invertebrates	Lowest available LD_{50}/LC_{50} or 5th percentile LD_{50}/LC_{50} from SSD (if available)	Step 1: NOAEC from lowest LOAEC Step 2: MATC	Lowest available: • LD_{50}/LC_{50} or 5th percentile LD_{50}/LC_{50} from SSD (if available) • NOAEC/NOAEL (for growth or reproduction)	• LD_{50}/LC_{50} or 5th percentile LD_{50}/LC_{50} from SSD • LOAEC/LOAEL (for growth or reproduction)
Aquatic plants – nonvascular	Not applicable	Not applicable (No listed non-vascular plants)	Step 1: NOAEC^{+} from lowest LOAEC	Lowest EC_{50}
Aquatic plants – vascular		Step 1: NOAEC from lowest LOAEC Step 2: MATC	Step 2: MATC	Lowest $EC_{25}$$^{++}$
Terrestrial Plants				

EC_{25}= concentration resulting in a 25% effect in the organisms tested; EC_{50}=concentration resulting in a 50% effect in the organisms tested; LC/LD_{50}=lethal concentration/lethal dose for 50% of the organism tested; LOAEC= lowest-observed adverse effect concentration; NOAEC=no-observed adverse effect concentration; MATC= maximum acceptable toxic concentration; represents the geometric mean of the lowest quantitative NOAEC and LOAEC; SSD=species sensitivity distribution

* Same endpoints used to represent reptiles and terrestrial-phase amphibians, unless taxon-specific data are available.

**Same endpoints used to represent aquatic-phase amphibians, unless taxon-specific data are available.

$^{+}$ If a suitable NOAEC is not available for the most sensitive test species, an ECx value may be used instead to represent the level where no effects are detected.

$^{++}$ If sufficient toxicity data are available (*e.g*., for an herbicide), a SSD may be developed.

5.6 Use Area Expansion (Buffering) for Offsite Transport

EPA used the upper-bound EECs for terrestrial exposure based on species taxa and dietary items and for aquatic exposure, the maximum 1-in-10[35] year values for the pond and the edge-of-field (EoF). Endpoints used to compare against the exposure values are conservative for this step (*i.e*., the NOAEC value for sublethal effects or the most sensitive LC_{50} or HC_{05} for mortality).

The overlap tools also include drift and runoff distances as part of the action area. To define the spray drift zones, endpoints need to be established for the analysis and are provided in the Effects Characterization section. For terrestrial taxa, these endpoints are used to calculate drift distances for each species based on the relevant direct taxa endpoint (*e.g*., bird endpoints for the whooping crane) and any taxa endpoints that are relevant to the species based on PPHD (*e.g*., terrestrial plants, terrestrial invertebrates, aquatic invertebrates, and aquatic vertebrates for the whooping crane). EPA conducted a similar drift analysis for the aquatic species (using the aquatic spray drift estimator) based on the differing water body sizes and endpoints used.

[35] The revised methods utilize a 1-in-15 output year values for aquatic exposure. This assessment has adopted use of the 1-in-10 year as it is better aligned with the Tiering strategy.

5.6.1 Summary of Effect and Distance from Use Site (Use Area Expansion for Aquatic Taxa)

EPA used the conceptual model depicted in **Figure 5-2** for the aquatic exposure assessment; the conceptual mode is outlined in the Background Document: Aquatic Exposure Estimation for Endangered Species (**Attachment 2**). As shown in the **Figure 5-2**, for species in aquatic bins, runoff and drift from the use site are anticipated to impact species near the field and up to 30 m off-field, whereas drift is considered beyond that distance**.** For dinotefuran, the maximum buffer applied to any use site was 240 m. For NE determinations, all use sites, including the appropriate buffer, did not have overlap with the species range or critical habitat.

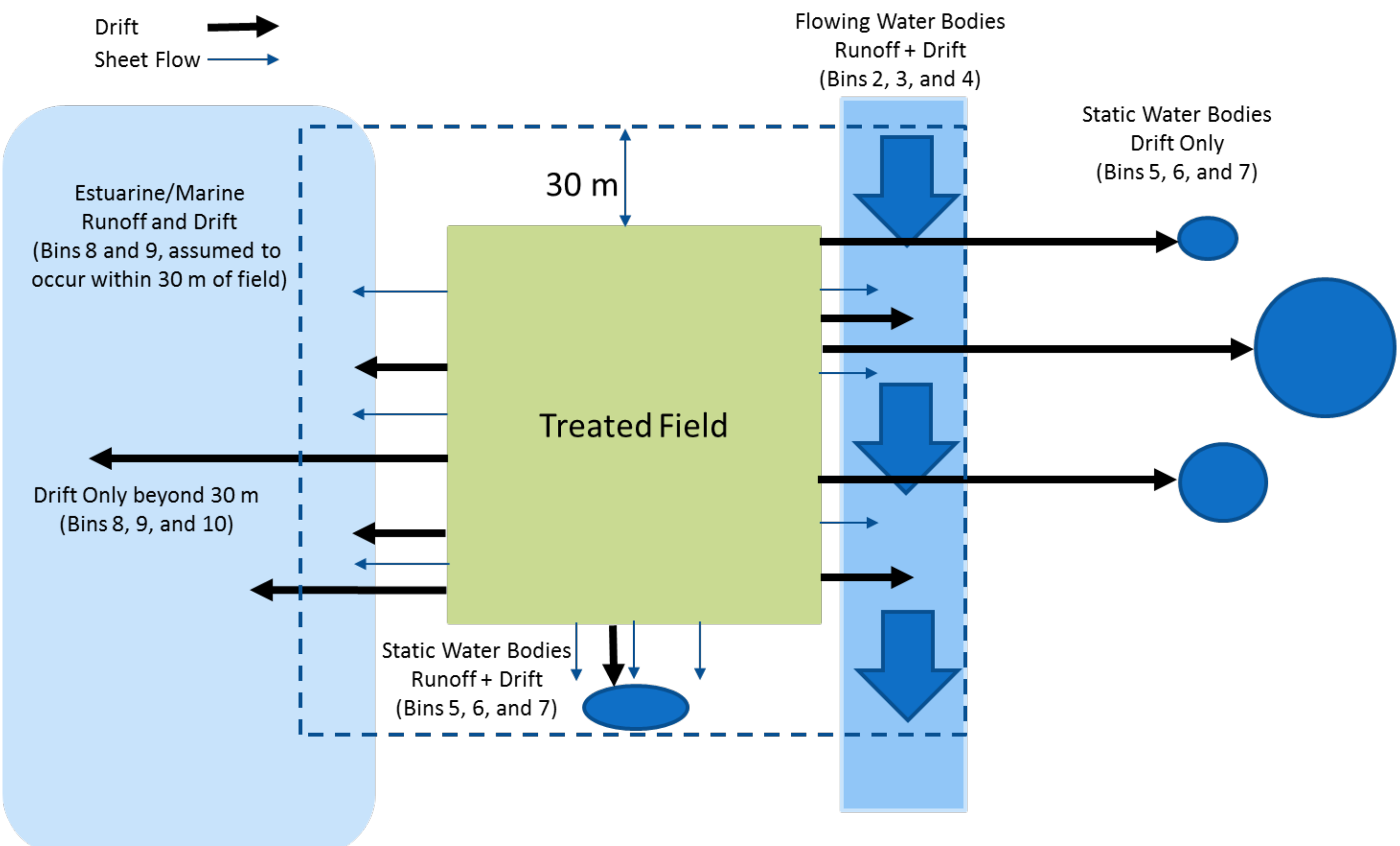

Figure 5-2. Conceptual model for estimating the aquatic exposure of endangered species to pesticides

For assessing the direct effects to a population, EPA used the maximum buffer of 120 m, and for assessing indirect effects to taxa that rely on aquatic invertebrates for PPHD (prey), the distance extends to 30 m.

Table 5-8. Maximum Use Area Expansion for Aquatic Taxa (focus on Aquatic Invertebrates) from Use of Dinotefuran.

Application Method	Maximum Spray Drift Distance for Making Individual Level Effects Determinations for (NE, NLAA, LAA) [a]	Spray Drift Distances for Making Population Level Effects Determinations (Based on Direct Effects)	Spray Drift Distances for PPHD- (Based on second lowest LD_{50})
Aerial/ Ground	240 m	120 m	30 m (indirect-prey)

LD_{50}=lethal dose to 50% of the organisms tested; LAA=Likely to Adversely Affect; NE=No Effect; NLAA=Not Likely to Adversely Affect; PPHD=prey, pollination, habitat, dispersal

[a] At this step- the maximum expansion distance for aerial is used (ground impacts extend to 120m)

5.6.2 Maximum Use Area Expansion for Terrestrial Taxa (focus on Terrestrial Invertebrates)

Terrestrial invertebrates may also be located in habitats adjacent to the treated fields and may be exposed to dinotefuran from the direct consumption of dietary items that receive drift. EPA relied on the most sensitive honey bee effects data for the evaluation of impact to other terrestrial invertebrate species (*e.g.*, beetles, butterflies, *etc*.). As described above, the adult acute toxicity honey bee endpoint (0.026 mg a.i./kg-diet) and chronic toxicity endpoint (0.064 mg a.i./kg-diet) were the most sensitive effects endpoint for dietary exposure at the individual level. For assessing risk at the individual level, EPA compared to upper-bound Kenaga T-REX EECs for tall grass and broadleaf plants to represent dietary exposures to terrestrial invertebrates at the individual level. Specifically tall grass and broadleaf plant foraging groups are presented as they are considered the most protective of other invertebrates including those that consume arthropods and fruits/pods and seeds without being overly conservative. The maximum buffer EPA applied to any use site was 792m. For NE determinations, all use sites, including the appropriate use expansion, have no overlap with the species range or critical habitat.

For population-level effects (as a final line of evidence) and as prey/pollinator indirect effects, EPA used the HC_{25} from the SSD (see further details in Section 4) as the primary endpoint. These endpoints were compared to the mean EECs to determine if population-level effects were likely. The mean EECs are used to represent population-level effects because exceedances of the mean are more likely representative of exposures to multiple individuals (representing a population).

Table 5-9. Maximum Use Area Expansion for Terrestrial Taxa (focus on Terrestrial Invertebrates) for Dinotefuran.

Application Method	Maximum Spray Drift Distance for Making Individual Level Effects Determinations for (NE, NLAA, LAA)[a]	Spray Drift Distances for Making Population Level Effects Determinations	Spray Drift Distances for Making Population Level Effects Determinations and for generalist PPHD (Based on SSD-HC_{25} for prey impacts)
Aerial/Ground	792 m	120m	30 m (indirect prey or pollination)

HC_{25}=25th percentile hazard concentration; LAA=Likely to Adversely Affect; NE=No Effect; NLAA=Not Likely to Adversely Affect; PPHD=pollination, prey, habitat, dispersal; SSD=species sensitivity distribution

[a] At this step- the maximum expansion distance for aerial is used (ground impacts extend to 305m)

5.6.3 Thresholds for Indirect Effects to Taxa that Rely on Terrestrial Invertebrates and Distance to Potential Population Effects

Terrestrial invertebrates may be exposed to dinotefuran via contact and dietary consumption. The direct effects to terrestrial invertebrates are used to inform the potential distance to indirect effects for listed species populations that depend upon invertebrates for prey, pollination, habitat and/or dispersal (PPHD). For PPHD, a less conservative endpoint than the most sensitive LD_{50}/LC_{50} (or the HC_{05} if a SSD is available) is selected, for example, the HC_{25} is useful for PPHD impacts. While there are insufficient data to conduct a SSD for dinotefuran, given the similarity in toxicity of imidacloprid and dinotefuran to terrestrial invertebrates (USEPA, 2020), the SSD available from the imidacloprid assessment serves a proxy for estimating population/community effects to establish a distance to effects.

Estimates for contact- and dietary-based exposures of terrestrial invertebrates are based on the HC_{25} value from the SSDs mentioned previously (see **APPENDIX I**). For contact exposure, the HC**$_{25}$** is 0.16 mg/kg-bw and 0.78 mg/kg diet- for dietary exposure. At the HC_{25}, 75% of all terrestrial invertebrate species are expected to experience less than 50% mortality. EPA believes that for exposures less than the invertebrate SSD-derived HC_{25} value, prey loss for insectivorous vertebrate populations would not likely result in population-level effects based on diet alone. In general, EPA considers this threshold as protective of a majority of listed species as terrestrial invertebrate populations are known to recover relatively quickly following pesticide exposures (*e.g*., through immigration, reproduction, mobility), non-insect prey are expected to be less sensitive than insects (see discussion in Section 4), and spatially, it is unlikely that entire ranges of prey base would be affected at the same time. Using this approach, EPA determined that there is most likely a population-level concern for indirect effects to taxa that rely on terrestrial invertebrates from dietary exposure (protective of contact exposure) within 30 m of treated sites.

The refined distances will be used for terrestrial vertebrate, plant, CH analyses. See more on exposure estimation for drift distances in **Section 6.3.**

5.7 Methods for J/NJ or AM/NAM Predictions

For any species determined to be LAA, that is, listed species and/or CH where EPA determined that dinotefuran is likely to adversely affect one or more individuals or the critical habitat, the analysis proceeds to the next stage to predict the likelihood of J to listed species from the use of dinotefuran as well as the likelihood of AM of critical habitat. To predict the likelihood of J or AM from dinotefuran use, EPA used the analyses and methodologies described within USFWS Draft Malathion BiOp (USFWS, 2021) and by the recent NMFS BiOp (NMFS, 2022), as a basis for these predictions at the population level. EPA also further refined the methods based on subsequent discussions with USFWS. For purposes of predicting whether the action is likely to jeopardize the continued existence of a species, EPA considered multiple factors, described below.

As described above, the overlap of all use sites is again utilized in the J/AM analysis, but with appropriate drift/runoff buffers based on population relevant endpoints. If the maximum percent of use sites associated with the species range was <5%, EPA assigned a low overlap designation and predicted no jeopardy/no adverse modification (NJ/NAM). If the single use maximum overlap with drift/runoff distance applied was between 5-10%, EPA assigned a medium overlap designation. If overlap was >10%, EPA assigned a high overlap designation. As an additional initial screen, if any EECs associated with the species range or critical habitat did not exceed a population-level endpoint (Endpoint 2 as defined below), EPA assigned a designation of low for the magnitude of effects and predicted NJ/NAM. If the maximum EEC exceeded the population-level endpoint, EPA assigned a designation of medium and if the EEC exceeded an even higher population-level endpoint (Endpoint 3, defined below), EPA assigned a designation of high to the magnitude of effect. Population-level endpoints utilized in the analysis are further described below.

In the USFWS malathion BiOp and similarly in the NMFS BiOp for the organophosphates, toxicity endpoints were considered based on varying levels of effects at different concentrations. To classify the potential magnitude of effect, these endpoints were compared against relevant EECs associated with use sites that overlap with the species range or CH and the percent of overlap that exceeded each endpoint was used to categorize each species as either a low, medium, or high overlap with impact designation. In the process of making effects determinations, EPA considered ecological incidents as a part of the weight of evidence when estimating impacts of dinotefuran on listed species. EPA considered reported deaths and reported residues as evidence of exposure, and evidence of the potential for take, as defined by the ESA. EPA considered incidents in the making the initial effects determinations. A similar approach was followed in this analysis. As previously discussed, the primary concern for dinotefuran is to aquatic and terrestrial invertebrates based on mortality as is described in **Section 4**. From these toxicity data, EPA extracted relevant endpoints for these taxa and applied in the analysis as shown below in **Table 5-10.**

Table 5-10. Terrestrial and Aquatic Invertebrate Toxicity Endpoints Used in Quantitative Analysis

Taxa	Endpoint	Mortality	Sublethal		Comments
		Concentration of endpoint	Concentration of endpoint	Relevant effect	
Terrestrial Invertebrates	Endpoint 1	Adult acute oral **LD_{50}=0.0076 µg ai/bee** [**0.026 mg ai/kg diet**] Most sensitive formulation	Adult oral NOAEL=0.0015 µg ai/bee **[0.064 mg ai/kg diet]**	NOAEC/0% mortality	Used to screen for NE determinations
	Endpoint 2		LOAEL: 0.0035 µg ai/bee **[0.16 mg ai/kg diet]**	LOAEL based on 17% reduction in consumption	Used to screen for NLAA-(Impacts to individual); Used in J/AM analysis (impacts to population)
	Endpoint 3	Adult acute oral **HC_{25}=0.78 mg ai/kg diet**]	Using Mean EECS	Alternative endpoint for bounding WOE.	Used in J/AM analysis for additional characterization and for calculating off-site risk for indirect effects to species that rely on terrestrial invertebrates.
Aquatic Invertebrates	Endpoint 1	**LC_{50}= 9.8 µg ai/L**; Mayfly	**NOAEC=3.1 µg/L**	NOAEC/0% mortality	Used to screen for NE determinations
	Endpoint 2		**MATC=4.4 µg/L**	MATC based on based GEOM Mean NOAEC/LOAEC	Used to screen for NLAA-Impacts to individual; Used in J/AM analysis (impacts to population)
	Endpoint 3	Second lowest= LC_{50}= **31.9 µg ai/L**; Midge	**LOAEC=6.3 µg/L**	LOAEC based 29% decrease in emergence at 6.3 µg/L.	Used in J/AM analysis for additional characterization and for calculating off-site risk for indirect effects to species that rely on aquatic invertebrates.

AM=adverse modification; J=jeopardy; LOAEC=lowest observed adverse effect concentration; NOAEC=no-observed adverse effect concentration; MA=may affect; MATC=maximum acceptable toxicant concentration—represents the geometric mean of the NOAEC and LOAEC; NLAA=not likely to adversely affect; PPHD=pollination, prey, habitat, or dispersal
[1] There are no listed non-vascular plants, so endpoints for direct effects are not necessary.

Based on the parameters defined above, if <5% overlap was associated with exceedance of Endpoint 2, EPA classified the magnitude of effect as low; EPA classified 5-10% overlap as a medium magnitude of effects; and if >10%, then EPA classified the magnitude of effect as high. Any exceedance of Endpoint 3 (regardless of the extent of overlap) was considered in the predictions of the likelihood of J/AM, for added characterization only. For example, an exceedance of Endpoint 3 would be used as additional support for predicting the likelihood of Jeopardy (*i.e.*, to strengthen the call based on the exceedance of the HC_{05}/MATC and Endpoint 3).

Species that did not screen out based on magnitude of effect or overlap and were classified as medium or high based on the extent of overlap were further reviewed for any effect modifiers before EPA predicted the likelihood of J-NJ/AM-NAM.

5.8 Methods for Using Effect Modifiers

In some cases, during the analysis for predicting the likelihood of jeopardy or adverse modification, EPA considered additional factors to determine if exposure is reasonably certain to occur at levels that could impact a species (*e.g*., species habitat, biology, number of dietary items, *etc.*). Species may be considered low magnitude of effect if life history and habitat characteristics allow the assessor to determine that a discernable effect is not reasonably expected to occur. Additionally, a species vulnerability (high, medium, low) as assigned by the Services (USFWS Draft Malathion Biological Opinion (2021)) can also be considered in the prediction of the likelihood of jeopardy. For this BE, the species with LAA determinations are terrestrial and aquatic invertebrates and the species that depend on invertebrates for PPHD. Therefore, the modifiers often were related to the species dietary or pollinator requirements. **Chapter 6** includes a discussion of each taxa group with the general risk modifiers applied.

5.9 Methods for Qualitative Species

EPA was not able to evaluate a subset of species through quantitative methods based on species traits (*e.g.*, habitat) limiting the ability to quantitatively model pesticide effects and exposure. Species were previously binned into qualitative categories for the Revised Methods (*e.g*., exposure pathway is incomplete, species is presumed extinct, range of the species and resulting overlap considered unreliable, exposure models are considered unreliable for assessed species). A detailed description of the qualitative assessment categories is provided in **APPENDIX C.** Specific species where EPA based effects determinations on a qualitative assessment are noted as such in **APPENDIX A** in the main summary table. Two worksheets in **APPENDIX A,** “Qual R” for the species and “Qual CH” for the critical habitats, list all species assessed using qualitative methods and include individual descriptions of the rationale applied on a species-by-species basis.

5.10 Critical Habitat Effects Determinations

EPA used the same overlap approach described in **Section 4** to predict whether overlap is sufficient to lead to a prediction of the likelihood for AM (*i.e.,* >5%) of CHs. For those CHs with medium or high overlap, EPA considered potential impacts to the CH. One key difference between the CH and species is that the Services define physical or biological features (PBFs) that are necessary for the CH to support the species for which it was designated. Based on the taxa-based RQs, EPA considered the following PBFs for dinotefuran:

1. Terrestrial habitat quality and function (for listed terrestrial invertebrates);
2. Aquatic habitat quality and function (for listed aquatic invertebrates);
3. Insect pollinators (for plants);
4. Terrestrial insect prey; and
5. Aquatic insect prey.

6 RESULTS OF EFFECTS DETERMINATIONS AND PREDICTIONS OF THE LIKELIHOOD OF J/AM

In this DRAFT BE, either a “No Effect” (NE), “Not Likely to Adversely Affect” (NLAA) or a “Likely to Adversely Affect” (LAA) determination is made for 1,715 listed species and 826 designated critical habitats and reflects the February 2022 updates for the species and CH location files. Detailed results of the quantitative and qualitative analysis are included in **APPENDIX A** and **APPENDIX C**, respectively. For further details, the individual species workbooks are organized as terrestrial and aquatic and contain all the data used for making the effects determinations and the preliminary JAM calls (**Attachments 3,4, and 5**). The critical habitat effects determinations and prediction of the likelihood AM workbook is contained in **Attachment 6**. For the species that were quantitatively assessed, the following sections provide further discussion by taxa.

Table 6-1. Summary of Dinotefuran Effects Determination and Predictions of the Likelihood of Jeopardy

Taxon	**No Effect**	**Not Likely to Adversely Affect**	**Likely to Adversely Affect**	**Preliminary Jeopardy**	**Totals**
Mammals	29	35	31	3	95
Birds	5	25	68	3	98
Amphibians	0	1	37	8	38
Reptiles	12	12	20	1	44
Fish	1	13	156	20	170
Plants	97	5	837	93	939
Aquatic Invertebrates	39	104	30	10	174
Terrestrial Invertebrates	57	21	79	13	157
Total	**240**	**216**	**1259**	**151**	**1715**
Percent of total	14%	13%	73%	**9%**	

Table 6-2. Summary of Dinotefuran Effects Determination for Critical Habitat and Predictions of the Likelihood of Adverse Modification

Taxon	No Effect	Not Likely to Adversely Affect	Likely to Adversely Affect	Preliminary Adverse Modification	Totals
Mammals	11	16	12	1	39
Birds	2	3	26	1	31
Amphibians	0	0	26	6	26
Reptiles	6	6	7	0	19
Fish	1	12	97	19	110
Plants	56	2	403	18	461
Aquatic Invertebrates	22	52	16	4	90
Terrestrial Invertebrates	13	0	37	10	50
Total	**111**	**91**	**624**	**59**	**826**
Percent of total	13%	11%	76%	**7%**	

Table 6-3. Summary of Quantitative Effects Determinations by Category

Reason for determination	No overlap	No toxicity	<1% overlap	Magnitude of Effect	
Determination	**NE**	**NE**	**NE**	**NLAA**	**LAA**
Number of species in category	11	212	0	109	1259
Number of critical habitats in category	20	67	0	51	624

LAA=Likely to Adversely Affect; NE=No Effect; NLAA=Not Likely to Adversely Affect;

Table 6-4. Summary of Qualitative Effects Determinations by Category

Qualitative Analysis						
Reason for determination	**Incomplete exposure pathway**	**Extinct**	**Unreliable overlap based on range analysis**		**Exposure models unreliable**	
Determination	**NE/NLAA**	**NLAA**	**NE/NLAA**	**LAA**	**NE/NLAA**	**LAA**
Number of species in category	49	17	9	0	50	0
Number of critical habitats	18	2	5	0	39	0
LAA=Likely to Adversely Affect; NE=No Effect; NLAA=Not Likely to Adversely Affect;						

6.1 Effects Determination and Predicted Likelihood of J/AM - Aquatic Taxa

As an organizational note, this section of the BE describes the species that were assessed in the quantitative assessment. Further details for the species and designated critical habitats that were qualitatively assessed are discussed in **APPENDIX C**. As discussed earlier, the focus for the aquatic taxa is based on the exceedances for aquatic invertebrates either as direct effects to listed aquatic invertebrates or to listed species that rely on aquatic or terrestrial invertebrates as prey.

6.1.1 Aquatic Invertebrate Taxa-Based Assessment Summary

Based on toxicity data, uses, and environmental exposure estimates, dinotefuran has the potential to affect aquatic invertebrates as a result of spray drift and/or runoff transport to aquatic habitats. At the LOC for non-listed species, there were concerns for both acute and chronic adverse effects based on the most sensitive endpoints. The listed species effects determination sections discusses higher-level species-specific refinements, the potential for population-level effects as well as indirect effects that result from the loss of prey.

6.1.2 Aquatic Invertebrate Listed Species Effects Determinations

6.1.2.1 Potential for Direct Effect

For aquatic invertebrates, specifically aquatic insects and crustaceans, EPA determined that there is a potential for direct effects. Endpoints used for determination of direct effects were reflective of acute and chronic exposures. As discussed in **Section 4** the acute LC_{50} of 9.8 µg a.i./L for the midge is representative of effects at the individual level for freshwater and estuarine marine aquatic invertebrates. The chronic MATC of 4.4 µg a.i./L (the geometric mean of the NOAEC and LOAEC), based on 29% decrease in emergence) is used for the chronic exposure endpoints for direct impacts to individuals.

Mollusks

Dinotefuran is practically non-toxic to the oyster with a non-definitive EC_{50} value of >141 mg a.i./L. Listed mollusks consist of a combination of bivalves (freshwater mussels), gastropods (mostly freshwater snails) and one cephalopod class (Chambered nautilus; *Nautilus pompilius-See Appendix C for Qualitative Analysis*). The majority of the freshwater mussels have an obligate relationship to certain species of fish in which mussel larvae (glochidia) attach to the fish gills during early development. The unionid mussels are sessile filter feeders, consuming plankton (bacteria, algae, zooplankton) and detritus. The freshwater snails are herbivores, consuming algae, bacteria and fungi from submerged surfaces. The listed aquatic snails are herbivores, and there were no effects identified for aquatic plants, so indirect effects to mollusks are not expected. Since there are no direct effects to fish, indirect effects to mollusks that rely on fish as a host are not expected. Therefore, based on the information above, EPA finds there are no direct effects to for the listed bivalves (freshwater mussels) and gastropods (mostly freshwater).

6.1.2.2 Potential for Indirect Effect (PPHD)

As indicated in the previous section, since mollusks are not likely to be impacted, indirect effects as it relates to species that depend upon only aquatic insect and crustation prey were considered.

Summary of Effect and Distance from Use Site

For evaluation of potential likelihood of individual and population-level effects, the calculated drift distances reflect consideration of the extent to which population-level impacts to listed aquatic insects are considered likely (*i.e*., 240m for individual/30m for population level). As described in **Section 5**, off-field distances were based on the most sensitive aquatic invertebrate toxicity endpoints.

6.1.3 Listed Aquatic Invertebrate Species with No Effect (NE) Determinations

EPA made NE determinations for species that inhabit areas where exposure is not reasonably expected to occur at levels that could cause effects. All of the aquatic invertebrate species had ≥ 1% overlap; therefore, overlap did not play a large role in the NE determinations at this step. For aquatic invertebrates with NE determinations, these determinations were based on no direct toxic effects or potential for indirect effects to prey items. This applies to the freshwater snails that are herbivores (i.e., diet is algae, bacteria and fungi from submerged surfaces).

6.1.4 Potential for Direct Effect to Fish and Aquatic-Phase Amphibians

EPA determined dinotefuran's direct effects on aquatic vertebrates by evaluating freshwater and estuarine/marine fish where freshwater fish serve as surrogates for aquatic-phase amphibians. As discussed in **Section 3**, dinotefuran is practically non-toxic on an acute basis to freshwater and estuarine/marine fish (96-hour LC_{50} > 99 mg a.i./L). Chronic toxicity testing on freshwater fish (Rainbow Trout) showed no treatment-related effects and NOAEC of 6.36 mg a.i./L (6,360 µg a.i./L). For the purposes of BE, the freshwater data are used to represent the potential toxicity to freshwater and estuarine marine fish.

The EECs generated for both the standard pond, rice paddy, and the edge-of-field runoff (see **Section 2** for EECs and **Appendix D** for the EEC and exposure-to-effect Ratio Workbook for Aquatic Species) were orders of magnitude below the available acute toxicity endpoints for fish (maximum 1-day mean water column pond EEC =39 µg a.i./L; rice paddy EEC=349 µg a.i./L; EoF EEC=483 µg a.i./L). Therefore, the currently registered and proposed uses of dinotefuran are not expected to cause direct effects to fish and aquatic-phase amphibians. Since direct effects to fish and aquatic-phase amphibians are not identified, there are no indirect effects to listed species that rely upon them.

Indirect Effects
Aquatic vertebrates that depend upon aquatic insects as a part of their diet, were further considered for potential indirect effects. Fish and aquatic-phase amphibians are known to consume a variety of aquatic organisms over the duration of their life cycle, including aquatic insects. As discussed in this assessment, no direct effects are indicated from the registered dinotefuran uses for mollusks or aquatic plants.

Based on the weight of evidence, fish and aquatic-phase amphibians are categorized as May Affect (MA) based on as a result of the loss of aquatic and terrestrial invertebrate prey.

6.1.5 Summary of Effect and Distance from Use Site

As discussed in **Section 4**, dinotefuran has the potential to affect aquatic insects at an individual and population level. For the potential effect to translate to an individual effect to fish and amphibians via a reduction in the food availability of aquatic insects, EPA believes that aquatic insects would need to experience population-level impacts. Therefore, indirect effects were only considered using the population-level endpoints and off-field distances that were established for aquatic insects. For evaluation of indirect effects, the calculated drift distances reflect consideration of the extent to which the potential for individual- and population-level impacts to listed species is considered likely. For aquatic vertebrate population-level effects, off-site effects were driven by runoff concerns within 0-30 m of the field and drift exposure within 0-30 m of the field.

6.1.6 Listed Fish and Amphibian Species with No Effect (NE) Determinations

The NE determinations for listed fish and aquatic-phase amphibians are based on no exceedance of the acute and chronic listed species LOCs and consider the potential for indirect effects as discussed above and following the methodology described in **Section 5**. Listed fish and amphibians rely on aquatic and or terrestrial invertebrates as a prey item, therefore, there are no NE determinations for these taxa.

6.1.7 May Affect (MA) Determination through NLAA/LAA-Aquatic Vertebrate and Invertebrates

Fish and Amphibians
For fish and amphibians, EPA made a MA determination due to the potential for indirect effects from the consumption of insect prey. Of the MA species, LAA determinations were driven by an assessment of the likelihood of indirect effects from the diet and exposure occurring based on different habitat characteristics. Species designated as LAA had both the potential for indirect effects from the consumption of insect prey and inhabit areas where exposure is expected to reasonably occur at levels that could cause effects.

Aquatic Invertebrates
For aquatic invertebrates that are insects or crustations, EPA based LAA determinations mostly on direct effects, (with some aquatic invertebrates that also depend on insects as prey). As discussed earlier, there are no direct effects to mussels due to the toxicity profile for dinotefuran. **Table 6-5** provides a summary of the number of aquatic species that met the LAA criteria and proceeded into the analysis for potential jeopardy.

Table 6-5. Summary of the Effects Determination for Aquatic Vertebrate and Invertebrate Species (LAA calls)

Taxon	Likely to Adversely Affect (# of species)
Amphibians (tabulating both aquatic- and terrestrial-phase)	37
Fish	156
Aquatic Invertebrates	30

6.1.8 LAA Aquatic Species to Examine for Potential Jeopardy

Introduction to Risk Modifiers

For those species identified as LAA, additional elements were considered to determine if there is the potential for population-level impacts (*i.e*., predicted likelihood of Jeopardy). In this analysis for dinotefuran, EPA predicted the likelihood of jeopardy by primarily relying upon overlap[36] and magnitude of effect.[37] EPA integrated concepts similar to USFWS "risk modifiers" into the determinations. For each species, EPA assigned a high, medium or low classification to both overlap and magnitude of effect. Similar to USFWS, if overlap was considered low (<5%), EPA predicted that there was not a likelihood of jeopardy (NJ). If overlap was medium (≥ 5 to ≤ 10 %) or high (> 10%) and magnitude of effect was considered low (based on both direct and indirect effects and relevant risk modifiers), EPA predicted NJ. If there were no risk modifiers that decreased the magnitude of effects or degree of overlap, EPA predicted that there could be a likelihood of jeopardy (J). If overlap was medium or high and magnitude of effect was medium or high, EPA predicted that there could be a likelihood of J. Although USFWS incorporated species vulnerability into the determinations, EPA did not consider this factor when predicting the likelihood of J, such that it was conservatively assumed to be vulnerable. Although, EPA and USFWS have a pilot for 27 vulnerable species[38] and those species are noted in this BE and flagged for extra consideration in the final call given the known vulnerability.

For aquatic species, the focus is on direct effects to invertebrates or indirect impacts via prey reduction. The extent of spatial overlap between the species range and UDL, and various "effects modifiers" (*e.g.,* habitat preference/location, dietary composition) can influence the likelihood of exposure, thus, the focus is on modifiers or overlap and dietary preference.

6.1.9 Potential Risk Modifiers for Dinotefuran

Dinotefuran has a broad set of use patterns (*i.e*., agricultural and nonagricultural uses), thus, EPA utilized a weight-of-evidence approach. While modifiers were applied on a case-by -case basis, a species generally met the criteria for a refinement when one or more of the modifiers applied. For example, if a species had <5% overlap with agricultural uses and also had multiple non-insect diet items or met a habitat based refinement criteria (*e.g*., cave or mountain top) the two life history or exposure modifiers together formed a weight of evidence to refine the population-level prediction. **Table 6-6** provides and overview of the modifiers used.

Table 6-6. Modifiers For Consideration for Dinotefuran Predictions of the Likelihood of Jeopardy (J) and Adverse Modification (A/M)

Magnitude of Effect Modifiers for Consideration [Short description]	Overlap Modifiers for Consideration [Short description]
Species or CH found in montane/remote/coastal habitats/forest (interior dwelling focus given forestry uses are on label) [**Habitat-*e.g.*, remote**]	Species has <5% overlap with any Agricultural Uses. [**Low overlap lap with impact**] *Exclusions apply if habitat description includes descriptions such as:* -if developed land is mentioned in habitat and can be tied to a specific label use pattern -If species is in forest but may be likely to utilize managed forests.
Species consumes multiple dietary items for which indirect effects are not indicated. [**Diet**]	Species only has a High overlap with the "Other Crops UDL"-which is representing Sod -the overlap is modified considering the lower proportion of sod to the "other crops UDL overall. [**Sod-Refined overlap**]

[36] Referred to by USFWS as "usage"
[37] Referred to by USFWS as "risk"
[38] https://www.epa.gov/endangered-species/implementing-epas-workplan-protect-endangered-and-threatened-species-pesticides#species

Magnitude of Effect Modifiers for Consideration [Short description]	Overlap Modifiers for Consideration [Short description]
Species is highly mobile and has the ability forage in unaffected areas Species and/or invertebrate prey are mostly subterranean [**Foraging**]	Species is in Hawaii (HI), Puerto Rico or territories and the Census of Agriculture Overlap is <5% [**Refined overlap-HI CoA**]

CH=designated critical habitat; COA=Census of Agriculture; UDL=Use Data Layer

Predictions of the likelihood of jeopardy and justifications are found in the Summary Tables (**APPENDIX A**) and the Aquatic Workbook (**Attachment 3).** Any additional modifier information that was used is included in the "Additional Information Considered in the Prediction of Potential for Jeopardy" column adjacent to the Jeopardy prediction.

Table 6-7. Potential for Direct Effect to Aquatic Vertebrate and Invertebrate Species for Dinotefuran

Taxon	EPA Predictions of the Likelihood of Jeopardy (# of species)
Amphibians*	8
Fish	20
Aquatic Invertebrates	10

*Tabulating both aquatic and terrestrial phase

Jeopardy Discussion

For fish, the species that have predictions of a likelihood of Jeopardy based on a potential for prey impacts are listed in **Table 6-8**. Of the 20 species of fish for which EPA has predicted a likelihood of jeopardy, 11 are salmonids, 5 are darters, 2 are madtoms, 1 is a smelt and 1 is a sunfish. All of these fish have a reliance on insects as dietary items during some part of their life stage. Dinotefuran is an insecticide with noted incident reports to insects, thus, that is a line of evidence for the potential to impact these species through prey reduction. As reflected in **Table 6-8**, the species have overlaps with a variety of the dinotefuran uses and HUC regions. Amphibians are discussed in the Terrestrial Vertebrate section.

Table 6-8. Fish Predictions of the Likelihood of Jeopardy Species for Dinotefuran with Exposure and Overlap Details

Entity ID[39]	Common Name	HUC, BIN	Primary Agricultural Uses with Overlap (%) at 30 m
239	Slackwater darter	HUC 6 (Bin 2,3)- Exceedances for EoF	Cotton (7%) and Soybean (20%)
244	Bayou darter	HUC 3,8 (Bin 2,3)-Exceedances for EoF	Soybean (5%)
257	Niangua darter	HUC 7,10a,11a (Bin 2,3)-Exceedances for EoF	Soybean (7%)
3069	Trispot darter	HUC 3,5,6,8 (Bin 2,3,5)-Cotton Exceeds Pond and EoF; Soy exceedances for EoF	Soybean (9%), Sod (7%), and Cotton (6%)
313	Relict Darter	HUC 5,6,7,8 (Bin 2,3)-Exceedances for EoF	Soybean (60)
5288	Carolina madtom	HUC 8 (Bin 2,3,4)-Vegetables exceed Pond and EoF Soybean and cotton exceed EoF	Vegetables/Fruit (5%), Soybean (31%), Sod (19%), Cotton (13%)

[39] Entity ID is referring to the FWS Environmental Conservation Online System (ECOS) "ECOS Listed Species ID".

Entity ID[39]	Common Name	HUC, BIN	Primary Agricultural Uses with Overlap (%) at 30 m
7150	Chucky Madtom	HUC 6 (Bin 2,3)- Exceedances for EoF	Soybean (5)
305	Delta smelt	HUC 3,6 (Bin 2,3) -Rice exceedances; Vegetables exceedances pond and EoF; Grape exceedances EoF	Sod (11%), Grapes (4%), Vegetables /Fruit (5%). Rice is 3%.
7332	Spring pygmy sunfish	HUC 6 (Bin 2,5,6) Soybean EoF exceedances	Cotton (13%), Sod (2%), Soybean (34%)
NMFS Species			
2514	Chinook salmon	18 a,b; (All Bins) Rice exceedance; Pond exceedances for Vegetables/Fruit; Exceedances for EoF	Cotton (3%), Sod (21%), Orchards (30%), Rice (6%), Vegetables/Fruit (9%)
2528	Steelhead	17 a,b; (All Bins) Pond exceedances for Vegetables/Fruit; Exceedances for EoF	Sod (10%), Orchards (3%), Vegetables (7%)
2842	Steelhead	18 a,b; (All Bins) Pond exceedances for Vegetables/Fruit; Exceedances for EoF	Grapes (7%), Sod (11%), Orchards (4%), Vegetables/Fruit (5%)
3654	Steelhead	18 a; (All Bins) Exceedances for EoF	Grapes (6%), Sod (1%), Orchards (3.7%)
4112	Steelhead	17a; (All Bins) Pond exceedances for Vegetables/Fruit; Exceedances for EoF	Sod (21%), Orchards (7%), Vegetables/Fruit (9%)
4274	Steelhead	18 a,b; (All Bins) Rice exceedance; Pond exceedances for Vegetables/Fruit; Exceedances for EoF	Grapes (11%), Sod (20%), Orchards (26%), Rice (5%), Vegetables/Fruit (8%)
4300	Chinook salmon	17 a,b; (All Bins); Pond exceedances for Vegetables/Fruit; Exceedances for EoF	Sod (11%), Vegetables/Fruit (11%)
6966	Coho salmon	18 a; (All Bins); Exceedances for EoF	Grapes (4%), Orchards (2%)
7590	Chinook salmon	17 a,b; (All Bins); Pond exceedances for Vegetables/Fruit; Exceedances for EoF	Sod (6%), Orchards (2%), Vegetables /Fruit (3%)
7855	Chinook salmon	17 a,b; (All Bins) Pond exceedances for Vegetables/Fruit; Rice exceedance; Exceedances for EoF	Grapes (4%), Sod (25%), Orchards (26%), Rice (13%), Vegetables/Fruit (8%)
8241	Chinook salmon	17a; (All Bins) Pond exceedances for Vegetables/Fruit; Exceedances for EoF	Sod (13%), Orchards (4%), Vegetables /Fruit (5%)
HUC=Hydrologic Unit Code			

For aquatic invertebrates, there is a potential for direct effects (and for possible indirect effects to prey-depending on aquatic insects). As noted in **Table 6-9**, there are 10 aquatic invertebrates for which EPA has predicted a likelihood of jeopardy, 7 are shrimp, 1 is a beetle, 1 is an amphipod, and 1 is an isopod. Dinotefuran is an insecticide with noted incident reports to insects, thus, that is a line of evidence for the potential to impact these species. A similar feature of these species is that they are largely found in small aquatic waterbodies, for example vernal pools, subterranean pools, or impoundment pools. **Table 6-9** provides an overview of the potential uses with impact.

Table 6-9. Aquatic Invertebrates Predictions of the Likelihood of Jeopardy Species for Dinotefuran with Exposure and Overlap Details

Entity ID	Common Name	Primary Agricultural Uses with Overlap (%) at 30 m/Other Considerations
441	Hungerford's crawling water Beetle	<5 % with Agriculture. Considering Non-Ag. Use/Habitat as important populations of HCWB are found downstream from culverts, beaver and natural debris dams, and human-made impoundments. They are found in plunge pools created below these structures, as well as in riffles and other well-aerated sections of the stream.
476	Madison Cave isopod	Soybean (8%), Sod (6%). Vulnerable Species. Habitat: Karst highly sensitive to disturbance.
480	Alabama cave shrimp	Cotton (8%) and Soybean(24%)

Entity ID	Common Name	Primary Agricultural Uses with Overlap (%) at 30 m/Other Considerations
481	California freshwater shrimp	Grape (9%), Orchards (5%)
482	Kentucky cave shrimp	Soybean (21%)
484	Illinois cave amphipod	Soybean (54%)
490	Conservancy fairy shrimp	Grape (8%), Sod (14%), Orchard (17%), Rice (3%), Vegetables/Fruit (5%)
491	Longhorn fairy shrimp	Sod (14%), Orchards (9%), Vegetables/Fruit (7%)
493	Vernal pool fairy shrimp	Cotton (2%), Grapes (6%), Sod (14%), Orchards (15%), Rice (2%), Vegetables/Fruit (5%)
494	Vernal pool tadpole shrimp	Cotton (2%), Grapes (6%), Sod (13%), Orchards (17%), Rice (4%), Vegetables/Fruit (5%)

6.2 Terrestrial Invertebrate Listed Species Effects Determinations

6.2.1 Terrestrial Invertebrate Taxa-Based Risk Assessment Summary

EPA determined that the honey bee adult acute and chronic endpoints were the most protective and reliable for estimating risk to other terrestrial invertebrate orders with the data specific to dinotefuran. The selection of the honey bee toxicity endpoints for use in the effects determination at the individual level, is based on the surrogate species approach. As discussed in **Section 4**, however, EPA also relied on the broader dataset available for another active ingredient, with similar toxicity (imidacloprid) to gain a better understanding on the species sensitivity of other terrestrial invertebrate orders. Therefore, at the later stage for assessing the potential for population level effects, EPA assessment incorporated the HC_{25} from the species sensitivity distribution and this analysis is further described in the Jeopardy analysis sections of this BE.

6.2.2 Estimating Dietary EECs and RQs for Non-Apis Terrestrial Invertebrate Species

To use the honey bee data to evaluate effects on other terrestrial invertebrates, EPA compared the dietary concentration-based endpoints to potential exposures based on T-REX EECs for arthropods and potential dietary items. This is a specific approach for assessing listed terrestrial invertebrate species and differs from the use of BEE-Rex in terms of assessing effects to bees.

EFED conducted an exposure and effect assessment for terrestrial invertebrates following direct spray of dinotefuran to the treated field. Since terrestrial invertebrates may consume a wide variety of dietary items, this assessment considered the consumption of plant parts (*e.g.,* seeds, fruits, leaves), and arthropods. The adult acute dietary LC_{50} and the chronic NOAEC were compared to upper-bound Kenaga T-REX EECs for tall grass and broadleaf plants to represent dietary exposures to terrestrial invertebrates at the individual level. Specifically tall grass and broadleaf plant foraging groups are presented as they are considered the most protective of other invertebrates including those that consume arthropods and fruits/pods and seeds without being overly conservative. EPA estimated exposure with T-REX (**Table 6-10**). For adults, the best available toxicity data for terrestrial invertebrates is represented by the honey bee data described **in Section 4.**

For dietary risks to terrestrial invertebrates, the EECs for all dietary items exceed dietary toxicity endpoints across all food items. The upper-bound and mean Kenaga-based EECs exceed both the acute LC_{50} and the chronic NOAEC and LOAEC values by several orders of magnitude. Therefore, EPA concluded that dinotefuran affects terrestrial invertebrates at all application rates for all food items evaluated.

Table 6-10. Summary of Dietary (mg a.i./kg-diet) Exposure-to-Effect Ratios for Terrestrial Invertebrates using Upper-Bound Exposure (calculated Ratio is for the highest EEC-Broadleaf plants).

Use Pattern	Broad-leaf Plants	Adult acute oral LD_{50}=0.0076 µg ai/bee	Adult Chronic NOAEL=0.0015 µg ai/bee	Adult Chronic LOAEL=0.0035 µg ai/bee
		[LC_{50}= 0.026 mg ai/kg diet]	[NOEAD=0.064 mg ai/kg diet]	[LOAEC=0.16 mg ai/kg diet]
CONUS_Cotton-aerial	18	696	283	113
CONUS_Vegetables and Ground Fruit-aerial	24	935	380	152
CONUS_Other Orchards-aerial	24	935	380	152
CONUS_Soybeans-aerial	14	519	211	84
CONUS_Rice-aerial	18	680	276	111
CONUS_Grapes-aerial	24	935	380	152
CONUS_Christmas Trees-ground	73	2804	1139	456
CONUS_Other Crops-ground	68	2596	1055	422
CONUS_Open Spaced Developed-ground	73	2804	1139	456
CONUS_Developed-ground	73	2804	1139	456
NL48_Developed-ground	73	2804	1139	456
NL48_Open Spaced Developed-ground	73	2804	1139	456
CONUS_Field Nurseries-ground	68	2596	1055	422
NL48_Nurseries_ground	68	2596	1055	422
NL48_Managed Forests-ground	73	2804	1139	456
CONUS_Forest Trees-ground	73	2804	1139	456

CONUS=contiguous United States; LC_{50}=lethal concentration to 50% of the organisms tested; LD_{50}=lethal dose to 50% of the organisms tested; NL48=Hawaii, Alaska and U.S. Territories; NOAEC=no-observed adverse effect concentration; NOAEL=no-observed adverse effect level.

Table 6-11. Summary of Dietary (mg a.i./kg-diet) Exposure-to-Effect Ratios for Dinotefuran for Terrestrial Invertebrates using Mean Exposure (calculated Ratio is for the highest EEC-Broadleaf plants).

Use Pattern	Broad-leaf Plants	Adult acute oral LD_{50}=0.0076µ g ai/bee [0.026 mg ai/kg diet]	Adult Chronic NOAEC=0.0015 µg ai/bee [0.064 mg ai/kg diet]	Adult Chronic LOAEC=0.0035 µg ai/bee [0.16 mg ai/kg diet]
CONUS_Cotton-aerial	6	232	94	38
CONUS_Vegetables and Ground Fruit-aerial	8	312	127	51
CONUS_Other Orchards-aerial	8	312	127	51
CONUS_Soybeans-aerial	5	173	70	28
CONUS_Rice-aerial	6	227	92	37
CONUS_Grapes-aerial	8	312	127	51
CONUS_Christmas Trees-ground	24	935	380	152
CONUS_Other Crops-ground	23	865	352	141
CONUS_Open Spaced Developed-ground	24	935	380	152
CONUS_Developed-ground	24	935	380	152
NL48_Developed-ground	24	935	380	152
NL48_Open Spaced Developed-ground	24	935	380	152
CONUS_Field Nurseries-ground	23	865	352	141
NL48_Nurseries_ground	23	865	352	141
NL48_Managed Forests-ground	24	935	380	152
CONUS_Forest Trees-ground	24	935	380	152

CONUS=contiguous United States; LC_{50}=lethal concentration to 50% of the organisms tested; LD_{50}=lethal dose to 50% of the organisms tested; NL48=Hawaii, Alaska and U.S. Territories; NOAEC=no-observed adverse effect concentration; NOAEL=no-observed adverse effect level.

6.2.3 Drift Distances for Other Non-*Apis* Invertebrates (Dietary)

Terrestrial invertebrates may also be located in habitats adjacent to the treated fields and may be exposed to dinotefuran from the direct consumption of dietary items that receive drift or via plant uptake from runoff exposure. EPA relied on the most sensitive honey bee effects data for the evaluation of impact to other terrestrial invertebrate species (*e.g*., beetles, butterflies, *etc*.). As described above, the adult acute toxicity honey bee endpoint (LC_{50}=0.026 mg a.i./kg-diet) and chronic toxicity endpoint (NOAEC=0.064 mg a.i./kg-diet) were the most sensitive effects endpoint for dietary exposure at the individual level. For assessing risk at the individual level, EPA compared to upper-bound Kenaga T-REX EECs for tall grass and broadleaf plants to represent dietary exposures to terrestrial invertebrates at the individual level. Specifically tall grass and broadleaf plant foraging groups are presented as they are considered the most protective of other invertebrates including those that consume arthropods and fruits/pods and seeds without being overly conservative.

For population and community impacts, the HC_{25} from the SSD (see further discussion in **Section 4**) was used as the primary endpoint for assessing population-level effects. These endpoints were compared to the EECs based on mean Kenaga values to determine if population-level effects were likely. The offsite distances are provided in **Table 6-12** and Table **6-13** are based on the upper-bound and mean Kenaga EECs. The mean EECs are used to represent population-level events because exceedances of the mean are more likely representative of exposures to multiple individuals (representing a population).

Drift distances for invertebrates at the individual and population levels are summarized in **Table 6-12** and **Table 6-13.** Using the acute oral endpoint, both ground and aerial applications have risk out to the bounds for AgDRIFT® using the upper-bound and mean EECs. The droplet size was not specified on the label so the default settings were used.

Table 6-12. Distance to Individual Effects for Terrestrial Invertebrates (Dietary) with Upper-Bound Estimated Environmental Concentrations (EECs) for Dinotefuran.

Use	Maximum labeled rates (lb a.i./A)	Application Method	Upper-Bound EEC mg ai/kg Broad-leaf Plants	Individual Effects Endpoint (lowest LC_{50}=0.026 mg ai/kg diet)	Exposure to Toxicity Ratio	LOC for Indiv. Effects	Fraction of Applied (LOC/RQ)	Distance to individual effects (feet)
Cotton	0.134	Aerial	18	0.026	695	0.05	0.000072	>2600
Vegetables/Fruit	0.18	Aerial	24	0.026	934	0.05	0.000054	>2600
Other Orchards	0.18	Aerial	24	0.026	934	0.05	0.000054	>2600
Soybeans	0.1	Aerial	14	0.026	519	0.05	0.000096	>2600
Rice	0.131	Aerial	18	0.026	679	0.05	0.000074	>2600
Grapes	0.18	Aerial	24	0.026	934	0.05	0.000054	>2600
Other Crops (Sod)	0.5	Ground-High Boom	73	0.026	2801	0.05	0.000018	>1000
Christmas Trees	0.54	Ground-High Boom	68	0.026	2593	0.05	0.000019	>1000
Open Spaced Developed	0.54	Ground-High Boom	73	0.026	2801	0.05	0.000018	>1000
Developed	0.54	Ground-High Boom	73	0.026	2801	0.05	0.000018	>1000
Nurseries	0.5	Ground-High Boom	68	0.026	2593	0.05	0.000019	>1000
Forest Trees	0.54	Ground-High Boom	73	0.026	2801	0.05	0.000018	>1000

LC_{50}=lethal concentration to 50% of the organisms tested: LOC=level of concern; RQ=risk quotient (exposure to effect ratio)
*Aerial =default droplet size of "Fine To Medium" and Ground ="Very Fine to Fine" Distribution

Table 6-13. Distance to Population-Level Effects Endpoint for Terrestrial Invertebrates (Dietary) with Mean Kenaga Estimated Environmental Concentrations (EEC)s for Dinotefuran

Use	Maximum labeled rates (lb a.i./A)	Application Method	Mean EEC Broad-leaf Plants	Population Endpoint (HC25=0.78 mg ai/kg-diet)	Exposure to Toxicity Ratio	LOC for Population Effects	Fraction of Applied (LOC/RQ)	Distance to effects (Feet)	Distance to effects (Meter)
Cotton	0.134	Aerial	6	0.78	8	1	0.1294	75	23
Vegetables / Fruit	0.18	Aerial	8	0.78	10	1	0.0963	101	31
Other Orchards	0.18	Aerial	8	0.78	10	1	0.0963	101	31
Soybeans	0.1	Aerial	5	0.78	6	1	0.1733	49	15
Rice	0.131	Aerial	6	0.78	8	1	0.1323	72	22
Grapes	0.18	Aerial	8	0.78	10	1	0.0963	101	31
Other Crops (Sod)	0.5	Ground-High	24	0.78	31	1	0.0321	78	24
Christmas Trees	0.54	Ground-High	23	0.78	29	1	0.0347	72	22
Open Spaced Developed	0.54	Ground-High	24	0.78	31	1	0.0321	78	24
Developed	0.54	Ground-High	24	0.78	31	1	0.0321	78	24
Nurseries	0.5	Ground-High	23	0.78	29	1	0.0347	72	22
Forest Trees	0.54	Ground-High	24	0.78	31	1	0.0321	78	24

LC_{50}=lethal concentration to 50% of the organisms tested: LOC=level of concern; RQ=risk quotient (exposure to effect ratio)
*Aerial =default droplet size of "Fine To Medium" and Ground ="Very Fine to Fine" Distribution

6.2.4 Drift Distances for Other Non-*Apis* Invertebrates (Contact)

Terrestrial invertebrates may be exposed to dinotefuran via the interception of spray droplets on the treated field or off-field via spray drift or via contact with residues on various surfaces such as foliage. Estimates of contact exposure of listed terrestrial invertebrates are based on the available acute (48-hr) contact-based toxicity studies with the honey bee. Contact drift distances were then estimated using the AgDRIFT® model under the assumption that drift deposition on foliage is equivalent to the deposition on an invertebrate. Using the acute contact LD_{50} of 0.024 µg ai/bee [converted to 0.19 µg a.i./g-bw = mg a.i./kg-bw using the bodyweight (0.128 g) of the honey bee (test organism)], the exposure-to-effect ratio of the Arthropod EEC/acute toxicity endpoint is up to 267 for the maximum single rate of dinotefuran. With the higher ratios from the dietary exposure noted in Sect 6.2.3, the assessment using the dietary-based endpoint (being 10X more sensitive) is protective of contact exposure to dinotefuran.

Table 6-14. Terrestrial Invertebrates Summary of Contact (LD_{50} of 0.024 µg ai/bee) Exposure-to-Effect Ratios for Dinotefuran based on Upper-Bound Estimated Exposure Concentrations (EECs).

Use Pattern Arthropods)	Application Method	Upper-bound Arthropod EEC (mg/kg)	Individual Effects Endpoint Acute Adult Contact LC_{50}=0.19 mg a.i./kg-bw)*	Upper-bound Exposure to Toxicity Ratio	Mean Arthropod EEC(mg/kg)	Mean Exposure to Toxicity Ratio
Cotton-aerial	Aerial	12.6	0.19	66.3	8.7	45.8
Vegetables and Ground Fruit-aerial	Aerial	16.9	0.19	89.1	11.7	61.6
Other Orchards-aerial	Aerial	16.9	0.19	89.1	11.7	61.6
Soybeans-aerial	Aerial	9.4	0.19	49.5	6.5	34.2
Rice-aerial	Aerial	12.3	0.19	64.8	8.5	44.8
Grapes-aerial	Aerial	16.9	0.19	89.1	11.7	61.6
Xmas Trees-ground	Ground	50.8	0.19	267.2	35.1	184.7
Other Crops-ground	Ground	47.0	0.19	247.4	32.5	171.1
Open Spaced Developed-ground	Ground	50.8	0.19	267.2	35.1	184.7
Developed-ground	Ground	50.8	0.19	267.2	35.1	184.7
Field Nurseries-ground	Ground	47.0	0.19	247.4	32.5	171.1
Forest Trees-ground	Ground	50.8	0.19	267.2	35.1	184.7

LC_{50}=lethal concentration to 50% of the organisms tested: LOC=level of concern; RQ=risk quotient (exposure to effect ratio)
Acute Adult Contact converted from LD_{50}= 0.024 µg a.i/bee (dose is divided by bodyweight (0.128 g) of honey bee)

6.2.5 Listed Terrestrial Invertebrate Species with No Effect (NE) Determinations

EPA made NE determinations for species that inhabit areas where exposure is not reasonably expected to occur at levels that could cause effects. All of the terrestrial invertebrate species had ≥ 1% overlap (1 exception); therefore, overlap did not play a large role in the NE determinations at this step.

EPA based NE determinations on the following:

- no direct or indirect effects to snails (see detailed section below); or,
- where there is no overlap with UDLs and the off-field areas identified (<1% overlap at 792 m).

Terrestrial Snails

No data are available with which to quantify the toxicity of dinotefuran to terrestrial snails. However, as summarized in **Section 4**, aquatic mollusks (snails and mussels) have very low sensitivity to dinotefuran. In the absence of terrestrial snail effects data, this effects determination relies on the toxicity findings for aquatic mollusks as a surrogate for terrestrial snails. Notably, the relevant exposure routes of aquatic and terrestrial snails differ. Aquatic snails would be exposed primarily via respiration and contact whereas terrestrial snails would be exposed primarily through their diet or from direct/residual contact. However, the presence of their shell would likely substantially reduce their exposure through direct contact. These differences in exposure introduce some uncertainty into the use of aquatic mollusks as a surrogate for the toxicity of dinotefuran to terrestrial snails. However, this same approach of using aquatic mollusks as a surrogate for terrestrial snails was adopted recently by the USFWS in their final malathion BiOp (USFWS, 2022). The majority of listed terrestrial snails are considered herbivorous and/or consume dead invertebrate prey. Since no direct effects to aquatic or terrestrial plants are indicated for the registered uses of dinotefuran (as discussed in sections to follow), EPA expects indirect effects to listed snails are not reasonably expected to occur. Therefore, based on the weight of evidence indicating that there are no direct or indirect effects, EPA designated terrestrial snails as NE.

The listed terrestrial invertebrates with an NE classification and justifications for the individual species determinations can be found in **APPENDIX A.**

6.2.6 Listed Terrestrial Invertebrate Species with May Affect (MA) Determinations

For terrestrial invertebrates there is the potential for direct and indirect effects, thus, for any species with ≥1% overlap with a UDL + 792m, EPA made a MA determination because of the potential for direct effects. In addition to direct effects, EPA made MA determinations for any terrestrial invertebrate species consuming other invertebrate prey. Exposure and toxicity data suggest that there may be population-level effects to terrestrial invertebrates and aquatic insects in off-field areas through the reduction of prey for those species which consume other terrestrial invertebrates.

6.2.7 May Affect (MA) Determination through NLAA/LAA for Listed Terrestrial Invertebrates

EPA made a MA determination due to the potential for direct and indirect effects. Of the MA species, LAA determinations were driven by an assessment of the likelihood of effects from the diet and also indirect exposure occurring based on different habitat characteristics.

Since there are direct effects identified for listed terrestrial invertebrates, the LAA determinations were driven by the likelihood of direct effects and also included any potential indirect effects via reductions in insect prey (aquatic or terrestrial invertebrate). **Table 6-15** provides a summary of the number of terrestrial vertebrate species that met the LAA criteria and proceeded into the analysis for potential jeopardy.

Table 6-15. Summary of the Effects Determination for Terrestrial Invertebrate Species (LAA calls) for Dinotefuran

Taxon	Likely to Adversely Affect (LAA) (# of species)
Terrestrial Invertebrates	79

6.2.8 LAA Species to Examine for Potential Jeopardy

For those species identified as LAA, EPA considered additional modifiers to determine if there is the potential for population-level impacts (*i.e*., a likelihood of Jeopardy). At this stage, the extent of spatial overlap between the species range and UDL, and various "effects modifiers" (*e.g.,* habitat preference/location, dietary composition) that can influence the likelihood of exposure. For this BE, the focus is on direct effects to invertebrates and indirect impacts to other taxa via prey/pollination impacts. Dinotefuran has a broad set of use patterns (*i.e*., agricultural and non-agricultural uses), thus, EPA employed a weight-of-evidence approach. A species with two modifiers usually met the criteria for predicting a low likelihood of Jeopardy. For example, if a species had <5% with agricultural uses and the habitat description indicated a lower likelihood of exposure (i.e., overlap), noting there are forestry uses, the two life history or exposure modifiers together formed a weight of evidence to rule out a population-level prediction. Other considerations that may strengthen the weight of evidence towards predicting a likelihood of Jeopardy is if the species is identified as a vulnerable species.

6.2.9 Potential Terrestrial Risk Modifiers

Modifiers are discussed in further detail in Section 6.1.9 (See *Potential Effect Modifiers*; **Table 6-6**). For terrestrial invertebrates, EPA considers the major overlaps and the likely exposure. For instance, the agricultural UDLs have a higher likelihood of broad and uniform use, thus the overlap with impact is one potential modifier. Although careful review of the species habitat description is employed, for example because dinotefuran has some non-agricultural uses (*e.g*., forestry), focus was more in terms of if the species forest habitat of the species is described as managed or if it is a interior species that would be less likely to encounter an exposure. Other examples are if the species only inhabits caves or islands. Foraging likelihood is another modifier that applies to terrestrial invertebrates in some cases (*e.g*., if the species or insect prey is fossorial/subterranean).

The predictions of the likelihood of jeopardy are summarized in **APPENDIX A** and detailed justifications are found in the Terrestrial Workbook (**Attachment 4).** Any additional modifier information that was used is included in the "Additional Information Considered in the Prediction of Potential for Jeopardy and Modifiers Used" columns adjacent to the Jeopardy prediction.

Table 6-16. Number of EPA Predictions of the Likelihood of Jeopardy for Terrestrial Vertebrate Species from Registered Uses of Dinotefuran.

Taxon	EPA Preliminary Jeopardy Prediction (# of species)
Terrestrial Invertebrates	13

Jeopardy Discussion

There were 13 species of terrestrial invertebrate for which EPA has predicted a likelihood of Jeopardy. The majority have a high overlap with agricultural uses and are expected to be impacted by direct effects from dinotefuran uses. **Table 6-17** provides a list of the species for which EPA has predicted a likelihood of jeopardy along with the agricultural uses with >5% overlap at 30 meters and a brief description of the diet as an indicator of the most relevant exposure. Within this list there are butterflies, beetles, bees, and a moth. These species are all likely to be impacted by direct effects and that is relatable to the dinotefuran target pest (i.e., insects). There also are incident reports documenting the effects to invertebrate non-target species.

Table 6-17. Terrestrial Invertebrates-Predictions of the Likelihood of Jeopardy Species

Entity ID	Common Name	
421	Langes metalmark butterfly	Grapes (9%), Sod (14%), Orchards (5%); Diet: Adult Nectivores; First and second instar larvae start to feed immediately on the succulent leaves.(FWS)
424	Mitchells satyr Butterfly	Soybean (31%), Sod (6%); Diet: Adult Unknown, does not visit flowers. Larvae almost certainly feed on Carex.(FWS)
433	Kern primrose sphinx moth	Sod (13%), Vegetables and Fruit (8%); Adult Kern primrose sphinx moths feed on nectar; Larvae-feed exclusively on the vegetation of evening primrose (FWS)
435	Delta green ground beetle	Sod (35%), Grapes (8%), Vegetables and Fruit (8%); Diet-predator (Contact exposure)

Entity ID	Common Name	
436	Valley elderberry longhorn beetle	Grapes (12%), Sod (25%), Orchards (34%), Rice (7%), Vegetables and Fruit (10%); Diet: herbivorous specialist that feeds almost exclusively on blue elderberry (Sambucus cerulea) throughout all stages of its life (FWS)
450	Fenders blue butterfly	Sod (31%), Orchards (9%), Vegetables and Fruit (11%); Adult Nectarivore; Larvae Herbivore (FWS)
457	Ohlone tiger beetle	<5% with Agriculture. Habitat suggests interaction with crops. Tiger beetles often feed on insect species that are considered injurious to man and crops, and are regarded as beneficial (FWS). Diet-predator (Contact exposure)
3412	Dakota Skipper	Soybean (8%); Diet: Adult Nectarivore, Larvae feed on several native grass species (FWS)
4910	Salt Creek Tiger beetle	Soybean (51%); Diet-predator (Contact exposure)
8503	Caseys June Beetle	<5% with Agriculture. Habitat suggests Non-Agriculture exposure. Occupied habitats such as unprotected vacant lots and wash areas are often characterized by an intermediate level of disturbance, and may include a relatively high cover of nonnative plant species. The species is also present within a gated community (FWS). Diet: Larval food plants not well known.
420	Karner blue butterfly	Soybean (24%), Vegetables and Fruit (5%) Adult Nectarivore, Larvae Herbivore (FWS) Wild lupine is the only known larval food plant (FWS)
10383	Rusty patched bumble bee	Soybean (18%); Diet: Adult female collects nectar and pollen from flowers to support the production of her eggs (FWS)
10147	Poweshiek skipperling	Soybean (69%); Diet: The preferred larval food plant for some populations of Poweshiek skipperling is prairie dropseed (FWS)

6.3 Bird, Reptile, and Terrestrial-Phase Amphibian Listed Species Effects Determination

6.3.1 Potential for Direct Effect

Based on the screening-level assessment there are no direct effects to listed birds, reptiles and terrestrial-phase amphibians from the foliar uses of dinotefuran. **Appendix B** provides an analysis of effects from the non-foliar uses (*i.e*., tree injection, soil spray, and granular) and there are no effects anticipated via these methods. Within this (non-foliar) analysis, EPA also considered the potential for secondary exposure to animals that may glean insects from the tree injection uses and there are no direct effects anticipated from secondary exposure to contaminated insect prey. Registered uses are also not expected to lead to indirect effects to listed species that depend upon birds, reptiles or terrestrial-phase amphibians.

6.3.2 Potential for Indirect Effect (PPHD)

Birds that depend upon terrestrial and aquatic invertebrates as part of their diet were further considered for potential indirect effects. There is potential for indirect effects through reductions in impacted prey items (PPHD) including terrestrial invertebrates and aquatic insects.

6.3.3 Summary of Effect and Distance from Use Site

Dinotefuran has the potential to affect aquatic insects at an individual and population level. EPA assumed that, for an effect to occur to an individual listed bird, amphibian, or reptile from loss of diet, the diet items, terrestrial invertebrates, and aquatic insects, in this case, would require a population-level reduction. Therefore, the same distances that were used for calculating drift distances for population-level effects to terrestrial invertebrates were applied to the determination of potential effects to individual and population-level indirect effects to birds, amphibians and reptiles.

6.3.4 Listed Terrestrial Vertebrate Species with No Effect (NE) Determinations

EPA based the NE determinations on no exceedance of the acute and chronic listed species LOCs and considered the potential for indirect effects discussed above and followed the methodology described in **Section 5.** The NE determinations for listed birds, reptiles and terrestrial-phase amphibians are based on species that inhabit areas where exposure is not reasonably expected to occur and took into consideration habitat, overlap and diet. EPA made NE determinations for birds, reptiles and terrestrial-phase amphibians for species that:

- do not consume invertebrates (*e.g.,* carnivorous and piscivorous birds); or,
- if no overlap with UDLs and the off-field areas identified (<1% overlap at 792 m).

The listed birds and reptiles and terrestrial-phase amphibians with an NE classification and justifications for the individual species determinations can be found in **APPENDIX A .**

6.3.5 Listed Terrestrial Vertebrate Species with May Affect (MA) Determinations

For those birds, reptiles and terrestrial-phase amphibians which consume insect prey and had ≥1% overlap with a UDL + 792m, EPA made a MA determination because indirect effects may occur.

6.3.6 May Affect (MA) Determination through NLAA/LAA for Terrestrial Vertebrate Species

EPA made a MA determination due to the potential for indirect effects from the consumption of insect prey. Of the MA species, LAA determinations were driven by an assessment of the likelihood of indirect effects from the diet and exposure occurring based on different habitat characteristics.

Species designated as LAA had both the potential for indirect effects from the consumption of insect prey and inhabit areas where exposure is reasonably expected to occur at levels that could cause effects.

Since there are no direct effects identified for listed birds, reptiles and terrestrial-phase amphibians, the LAA determinations were driven by the likelihood of indirect effects via reductions in insect prey (aquatic or terrestrial invertebrate). **Table 6-18** provides a summary of the number of terrestrial vertebrate species that met the LAA criteria (for PPHD effects) and proceeded into the analysis for potential jeopardy.

Table 6-18. Summary of the Effects Determination for Terrestrial Vertebrate and Invertebrate Species (LAA calls)

Taxon	Likely to Adversely Affect (LAA) (# of species)
Mammals	31
Birds	68
Reptiles	20
Amphibians*	37

(*Note: tabulating both aquatic and terrestrial-phase)

6.3.7 LAA Species to Examine for Potential Jeopardy

For those species identified as LAA, EPA considered additional modifiers to determine if there is the potential for population-level impacts (i.e., predictions of likelihood of Jeopardy). The extent of spatial overlap between the species range and UDL, and various "effects modifiers" (*e.g.,* habitat preference/location, dietary composition) that can influence the likelihood of exposure. For terrestrial vertebrate species, the focus is on indirect impacts via prey reduction.

6.3.8 Potential Terrestrial Effect Modifiers

Modifiers are discussed in further detail in Section 6.1.9 (See *Potential Effect Modifiers*; **Table 6-6**). For terrestrial vertebrates, EPA considers the major overlaps and the likelihood of exposure. For instance, the agricultural UDLs have a higher likelihood of broad and uniform use, thus the overlap with impact is one potential modifier. Although careful review of the species habitat description is employed, for example because dinotefuran has some non-agricultural uses (*e.g.*, forestry), focus was more in terms of if the species forest habitat is described as managed or if it is a interior species that would be less likely to encounter an exposure. Other examples are if the species only inhabits caves or islands. Diet is another consideration (*e.g.*, if the species has multiple dietary items for which indirect effects are not indicated when considering all life stages). Finally, foraging likelihood is another modifier that may apply to terrestrial vertebrates in some cases. For example, if the species is primarily expected to be foraging for insect prey that are fossorial (subterranean) or if the species is highly mobile (case-by-case basis).

EPA predictions for the likelihood of jeopardy are summarized in **APPENDIX A** and detailed justifications are found in the Weight of Evidence Sheets of **Attachment 4.** Any additional modifier information that was used is included in the "Additional Information Considered in the Prediction of Potential for Jeopardy and Modifiers Used" columns adjacent to the Jeopardy prediction.

The predictions of the likelihood of jeopardy and their justifications are found in the Summary Tables and Weight of Evidence Sheets of **Appendix A.** Any additional modifier information that EPA used is included in the "Additional Information Considered in the Prediction of Potential for Jeopardy" column adjacent to the Jeopardy prediction.

Table 6-19. Number of EPA Predictions of the Likelihood of Jeopardy for Terrestrial Vertebrate Species from Registered Uses of Dinotefuran.

Taxon	Preliminary EPA Jeopardy Prediction (# of species)
Mammals	3
Birds	3
Reptiles	1
Amphibians*	8

*Note: tabulating both aquatic and terrestrial phase

Predictions of the Likelihood of Jeopardy Discussion for Terrestrial Vertebrates

All of the predictions of the likelihood of jeopardy for terrestrial vertebrates are based on a potential impact to the species prey items (aquatic or terrestrial invertebrates). Of the terrestrial vertebrates for which EPA is predicting a likelihood of jeopardy, there are 3 birds, 3 mammals, 1 turtle, and 6 amphibians (the California tiger salamander has three distinct populations). All of these species have a reliance on insects as dietary items during a part or all of their life stage. Dinotefuran is an insecticide with noted incident reports to insects, thus, that is a line of evidence for the potential to impact these species through prey reduction. **Table 6-20** provides a summary of the details.

Table 6-20. Terrestrial Vertebrate Species Predictions of the Likelihood of Jeopardy with Exposure and Overlap Details

Entity ID	Common name	Overlap with Uses with Impact at 30 m/Other considerations
58	Buena Vista Lake ornate Shrew	>5% overlap with Agriculture. Vulnerable Species.
21	Gray bat	>5% overlap with Agriculture. Foraging area consideration uncertain. Foraging is generally parallel to streams, over the water at heights of 2 to 3M or in forests. Consideration of the forestry uses.
10043	Northern Long-Eared Bat	>5% overlap with Agriculture. Foraging area consideration uncertain. Capture flying insects and also glean prey from plants or the forest floor. Foraging occurs within forests, along forest edges, over forest clearings, and occasionally over pond.
83	Attwater's greater prairie-chicken	>5 % overlap with Agriculture. Vulnerable species. Juvenile dependency on insect prey.
123	Least Bells vireo	>5% with Agriculture. Juvenile dependency on insect prey. The least Bell's vireo is an obligate riparian species during the breeding season.
4296	Streaked Horned lark	>5% with Agriculture. Juvenile dependency on insect prey. Broad range of habitats, including native prairies, coastal dunes, fallow and active agricultural fields, wetland mudflats, sparsely-vegetated edges of grass fields, recently planted Christmas tree farms with extensive bare ground, pastures, rights of way, airports, and dredge deposition sites.
182	Bog turtle	Agriculture uses >5%. Greater than three diet items, but diet generally is dominated by insects. Bog turtles usually occur in small, discrete populations, generally occupying open-canopy, herbaceous sedge meadows and fens bordered by wooded area.
Amphibians (Terrestrial and Aquatic Phase)		
188	Santa Cruz long-toed salamander	Several Agricultural uses >5%. Feed on mosquito larvae, worms, and larval amphibians that are distributed in the ponds they inhabit. Juvenile and adult are opportunistic invertivores, feeding on isopods, beetles, slugs, and earthworms distributed on the soil surface.
190	Houston toad	Sod use at 8% (may be refined), however, 3% overlap with rice is a concern given the high EECs and low mobility of species. Habitat is sandy soils, wooded areas (pine, mixed deciduous) with some grassy areas, costal prairie, pastures.
202	Wyoming Toad	Vulnerable species. <5% with Agriculture. Invertivore following metamorphosis. Metamorphosed toads eat various small terrestrial arthropods. The most common insects Wyoming toads eat are ants.
203, 4773, 8395	California tiger Salamander	Several Agricultural uses >5%. Given high EECs, rice use is a concern. Terrestrial foraging pattern may reduce exposure but aquatic prey reduction is concern during breeding.
195	Puerto Rican crested toad	4.6% UDL overlap for All Agriculture (Puerto Rico); Both UDL and COA ~5%. Limited additional diet info. Likely Conservative- may be revised if additional life history data are available.
2932	Neuse River waterdog	Several Agricultural uses >5%. Juvenile diet may be impacted-may be revised for additional data.

COA=Census of Agriculture; EECs=estimated environmental concentrations; UDL=Use Data Layer

6.4 Terrestrial and Aquatic Plant Listed Species Effects Determination

6.4.1 Potential Direct Effects

Based on the screening-level assessment, there are no direct effects to plants. Since there were no direct effects to terrestrial, wetland, or aquatic plants identified, there are no potential indirect effects to any species that may rely upon plants in these habitats.

6.4.2 Potential for Indirect Effects

Plants that depend upon terrestrial invertebrates for pollination or seed dispersal mechanisms were further considered for potential indirect effects. Some insects do disperse seeds (*e.g.,* harvester ants); however, information on the role of insects and other terrestrial invertebrates in seed dispersal of listed plants appears limited. To the extent that available information identifies terrestrial invertebrates as significant contributors to seed dispersal, EPA considered this in the assessment of indirect effects on listed plants.

Based on the USFWS 2021 Malathion BiOp, listed terrestrial plants are categorized according to 11 assessment groups (**Table 6-21**); species-specific assignments to USFWS plant groups are provided in the Plant Workbook (**Attachment 5**). These groups reflect commonalities in taxonomy (*e.g.,* monocots, dicots, ferns, conifers) and reproductive strategy (*e.g.,* self-fertilization, asexual reproduction, biotic pollination vectors).

Table 6-21. Plant Assessment Groups Used for Effect Determinations and Predictions of the Likelihood of Jeopardy for Listed Terrestrial Plants.

Plant Group #	Group	Reproductive Strategy[1]	# Listed Species
1	Lichens	Asexual reproduction	2
2	Ferns and Allies	Sexual and asexual reproduction, wind dispersal of spores	38
3	Conifers & Cycads	Wind dispersal of pollen, 1 species rely on mammals for seed dispersal	4
4	Monocots,	Abiotic Pollination vectors, abiotic + biotic dispersal mechanisms	41
5	Monocots	Out-crossers with Biotic Pollination vectors	9
6	Monocots	Biotic Pollination vectors; asexual reproduction or self-fertilization	20
7	Monocots	Biotic Pollination vectors; other reproductive mechanisms unknown	19
8	Dicots	Abiotic Pollination vectors	12
9	Dicots	Out-crossers with Biotic Pollination vectors	244
10	Dicots	Biotic Pollination vectors; asexual reproduction or self-fertilization	114
11	Dicots	Biotic Pollination vectors, other reproductive mechanisms unknown	431
NA	Dicots	Pollination mechanism unknown (2 species), presumed by USFWS to be extinct (1 species) and insect pollination (1 species)	4

[1]Source: Final Malathion Biological Opinion (USFWS, 2021)

6.4.3 Summary of Effect and Distance from Use Site

Dinotefuran has the potential to effect terrestrial invertebrates at an individual and population level. EPA assumed that for an effect to occur to an individual listed plant, it would require a population-level reduction of terrestrial invertebrate pollinators or dispersers. Therefore, the same distances (30 m) that were used for calculating drift distances for population-level effects to terrestrial invertebrates (see **Section 6.3**) were applied to the determination of potential effects to individual and population-level indirect effects to plants.

6.4.4 Listed Plant Species with No Effect (NE) Determinations

EPA based NE determinations on the potential for indirect effects discussed above and followed the methodology described in **Section 5**. EPA based NE determinations for listed plants on species that inhabit areas where exposure is not reasonably expected to occur and took into consideration habitat, overlap and invertebrate pollination and dispersal mechanisms. Additionally, all listed plant species in assessment groups 1-4 and 8 depend solely on abiotic and non-invertebrate biotic mechanisms of pollination and/or asexual reproduction (*e.g.,* vegetative propagation).

Therefore, the potential for indirect effects on listed terrestrial plants via interference with biotic-mediated pollination mechanisms is not indicated and a NE determination is made.

EPA made NE determinations for plants for species:

- that do not rely on invertebrates for pollination or dispersal (*i.e.,* plant groups 1-4 and 8); or,
- where there is a <1% overlap with UDLs inclusive of off-field areas (<1% overlap at 792 m).

The listed plants with a NE classification and justifications for the individual species determinations can be found in the Plants worksheet in **Attachment 5** and in **Appendix A.**

6.4.5 Listed Plant Species with May Effect (MA) Determinations

For those plants which rely on terrestrial invertebrates for pollination and/or dispersal and had $\geq$1% overlap with at least one UDL, EPA mad a MA determination because indirect effects may occur. Listed plants in assessment groups 5, 6 and 7 are all monocots that employ biotic pollination mechanisms alone (*e.g.,* birds, mammals, insects), or in combination with other abiotic pollination methods. Similarly, listed plants in groups 9-11 are dicots that use biotic means of pollination. Notably, listed plants in groups 7 and 11 do not have information to define the specific mechanism of biotic-mediated pollination. For plants in groups 7 and 11, EPA assumed pollination to be primarily driven by terrestrial invertebrates.

6.4.6 May Affect (MA) Determination through NLAA/LAA for Listed Plants

For all the plants that did not get screened out in the previous step (all groups other than plant groups 1-4 and 8), and have overlap >1% at 792 m, EPA made a MA determination due to the potential for indirect effects from pollinator impacts. Of the MA species, LAA determinations were driven by an assessment of the likelihood of indirect impacts to pollination or dispersal.

Table 6-22 provides a summary of the number of terrestrial plant species that met the LAA criteria (for PPHD effects) and proceeded into the analysis for potential jeopardy.

Table 6-22. Summary of the Effects Determination for Terrestrial Plant Species (LAA calls)

Taxon	Likely to Adversely Affect (LAA) (# of species)
Plants	837

6.4.7 LAA Plant Species to Examine for Potential Jeopardy

For those species identified as LAA, additional elements were considered to determine if there is the potential for population-level impacts (*i.e*., predictions of the likelihood of Jeopardy). These elements consisted of the extent of spatial overlap between the species range and UDL and various "effects modifiers" that can influence the likelihood of exposure.

For the dinotefuran uses, the LAA plant species are driven by an assessment of the likelihood of indirect effects from the loss of terrestrial invertebrates for pollination and/or dispersal and exposure occurring based on different habitat characteristics. Species designated as LAA had both the potential for indirect effects from the loss of terrestrial invertebrates for pollination and/or dispersal and inhabit areas where exposure is expected to reasonably occur at levels that could cause effects. Dinotefuran has a broad set of use patterns (*i.e*., agricultural and non-ag uses), thus, EPA utilized a weight-of-evidence approach. A species with two modifiers usually met the criteria for a reduction in likelihood of Jeopardy. For example, if a species had <5% overlap with agricultural uses and, did not have an obligate relationship to terrestrial invertebrates, the two life history or exposure modifiers may together provide sufficient weight of evidence to rule out a population-level prediction. Other considerations that may strengthen the weight of evidence towards a prediction of the likelihood of Jeopardy is if the species is identified as a vulnerable species.

Potential Risk Modifiers
Risk modifiers considered by EPA include:

- Species with a low overlap with the UDLs with higher certainty of exposure were not predicted as a likelihood of jeopardy (*e.g*.,<5% overlap with any single with agricultural use).;
- Species inhabits areas where exposure is likely to be overestimated (*e.g.,* island and coastal habitats; or,
- Species has a non-obligate relationship to terrestrial invertebrates.

The predictions of a likelihood of jeopardy and their justifications are found in the Summary Tables (**APPENDIX A**) and the Plant Workbook (**Attachment 5**). Any additional modifier information that EPA utilized is included in the "Additional Information Considered in the Prediction of Potential for Jeopardy" column adjacent to the Jeopardy prediction. **Table 6-23** provides the number of listed plants with a predicted likelihood of Jeopardy.

Table 6-23. Number of EPA Predicted Likelihood of Jeopardy for Terrestrial Plant Species from Registered Uses of Dinotefuran.

Taxon	Predicted Likelihood of Jeopardy (# of species)
Plants	93

Of the plants for which EPA has predicted a likelihood of jeopardy, 3 have obligate relationships with terrestrial invertebrates and the remaining listed plant species have non-obligate relationships with terrestrial invertebrates. The Jeopardy determinations are based on the potential for effects to terrestrial invertebrates (i.e., insects) for which these plants rely on for pollination. Dinotefuran is an insecticide and incidents have been reported for terrestrial invertebrates. **Table 6-24** provides the specific species EPA has identified as a predicted a likelihood of jeopardy.

Table 6-24. Terrestrial Plants-Preliminary Jeopardy Species

Species with Reliance on Terrestrial Invertebrate for Pollination and >5% Overlap with Agriculture, or is a noted vulnerable species (VS shown in bold). [Entity ID/Common name]									
508	Clara Hunts milk-vetch	620	Northern wild monkshood	804	**Wireweed**	994	Alabama canebrake pitcher-plant	1082	Bakersfield cactus
513	Star cactus	624	South Texas ambrosia	828	Nelsons checker-mallow	996	American chaffseed	1123	San Joaquin wooly-threads
528	purple amole	636	Meads milkweed	835	Shorts goldenrod	1014	**Wide-leaf warea**	1150	**Leedys roseroot**
530	Suisun thistle	637	Four-petal pawpaw	836	Gentian pinkroot	1017	Tennessee yellow-eyed grass	1171	Yadons piperia
531	La Graciosa thistle	647	Sonoma sunshine	852	Cooleys meadowrue	1022	Springville clarkia	1229	Deltoid spurge
532	Vine Hill clarkia*	651	Texas poppy-mallow	891	Decurrent false aster	1023	Pennells birds-beak	1233	Willamette daisy
534	Soft birds-beak	655	Small-anthered bittercress	899	golden paintbrush	1024	Longspurred mint*	1234	**Florida ziziphus**
540	Yellow larkspur	666	Sonoma spineflower	903	Monterey spineflower	1042	Relict trillium	1235	**Avon Park harebells**
546	Lompoc yerba santa	675	**Short-leaved rosemary**	924	Smooth coneflower	1043	Crenulate lead-plant	1710	Fleshy-fruit gladecress
568	Spring Creek bladderpod	679	**Palmate-bracted birds beak**	930	Clay-Loving wild buckwheat	1044	Smalls milkpea*	1881	Whorled Sunflower
570	Pitkin Marsh lily	695	**Scrub mint**	935	Minnesota dwarf trout lily	1045	Texas prairie dawn-flower	2810	Slickspot peppergrass
573	Nipomo Mesa lupine	696	Lakelas mint	945	Schweinitzs sunflower	1048	Alabama leather flower	4420	Florida brickell-bush
578	Few-flowered navarretia	702	Black lace cactus	960	Pondberry	1055	Kern mallow	4565	White Bluffs bladderpod
579	Many-flowered navarretia	712	Contra Costa wallflower	967	Rough-leaved loosestrife	1059	Lakeside daisy	5273	Florida prairie-clover
585	Lake County stonecrop	739	Slender rush-pea	969	Michigan monkey-flower	1074	Munzs onion	7167	Kentucky glade cress
593	Calistoga allocarya	750	Lyrate bladderpod	976	Canbys dropwort	1077	Texas ayenia	7206	Carters small-flowered flax
599	Hartwegs golden sunburst	754	Sebastopol meadowfoam	984	Eastern prairie fringed orchid	1078	California jewelflower	10076	Vandenberg monkeyflower
600	San Joaquin adobe sunburst	763	Walkers manioc	989	Tiny polygala	1080	Western prairie fringed Orchid	*Obligate relationship with terrestrial invertebrate BOLD Indicates Vulnerable Species	
610	Kecks Checker-mallow	784	Antioch Dunes evening-primrose	992	Michauxs sumac	1081	Butte County meadowfoam		

6.5 Critical Habitat

There were 10 terrestrial invertebrates and 4 aquatic invertebrates for which spray drift or runoff to the critical habitat may have direct or indirect effects to the species by reducing diet or water quality. There are 18 plant species that may be impacted by indirect effects to pollinators. The remaining habitats are for 19 fish, 6 amphibians and 1 bird and 1 mammal and these are based on potential impacts to prey availability.

Table 6-25. Number of EPA Predicted Likelihood of Adverse Modification to Critical Habitat for Terrestrial and aquatic invertebrates

LAA	Preliminary Adverse Modification
624	59

7 Conclusions

Dinotefuran is a systemic, neonicotinoid insecticide which affects insects via ingestion or direct contact routes of exposure. It is in the N-nitroguanidine group of neonicotinoids (IRAC subclass 4a) along with clothianidin, imidacloprid, and thiamethoxam. Since dinotefuran is taken up by plants (*i.e.*, is systemic and distributed throughout the plant), target pests include chewing and sucking pests such as aphids, whiteflies, thrips, leafhoppers, scales, and leaf miners. Dinotefuran may be applied to a wide array agricultural crops via a variety of methods including aerial and ground foliar sprays, soil treatment, granular, chemigation, and as a tree trunk injection. In addition to the agricultural uses, there are a wide variety of non-agricultural uses, including Christmas trees, forestry, shelterbelts, turf, and ornamental applications.

In this BE, EPA made LAA determinations for listed invertebrate (aquatic and terrestrial) species that may be directly affected, listed animals that rely upon aquatic and terrestrial insects (non-mollusks) for prey; or listed plants that rely upon insects for pollination or dispersal. Similar to the species, for critical habitat, EPA considered factors related to habitat/water quality for terrestrial and aquatic invertebrates and also elements to support the insect prey and pollination requirements of the species the critical habitat supports.

EPA further evaluated the LAA species and designated CH and made predictions about the potential likelihood of future jeopardy (J) to any listed species or adverse modification of any designated CH from the use of dinotefuran. Of the species with LAA determinations, EPA predicted a potential likelihood of future jeopardy for 151 listed species. EPA also predicted a potential likelihood of future adverse modification of 59 designated CHs. EPA identified these predictions primarily for listed aquatic and terrestrial invertebrates or listed species that are highly dependent on terrestrial or aquatic insects for prey or pollination and also have a high to medium UDL overlap when extended by 30 meters. In this BE, EPA used a tiered approach to apply refinement as the analysis proceeded from LAA to J/AM.

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List of Acronyms

ACR	Acute-to-Chronic Ratio
BE	Biological Evaluation
BEAD	Biological and Economic Analysis Division
Bee-REX	Bee Residue EXposure model
BiOp	Biological Opinion
CDL	Cropland Data Layer
CH	Critical Habitat
CoA	Census of Agriculture
DT_{50}	Dissipation time required for the concentration to decline to half of the initial value
EC_{25}	Concentration leading to 25% effect
EC_{50}	Concentration leading to 50% effect
EEC	Estimated Environmental Concentration
EFED	Environmental Fate and Effects Division
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FGDC	Federal Geospatial Data Committee
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GIS	Geographic Information System
HED	Health Effects Division
HUC	Hydrologic Unit Code
IC_{25}	Concentration leading to 25% inhibition
IDS	Incident Data System
LAA	Likely to Adversely Affect
LC_{50}	Concentration leading to 50% mortality
LD_{50}	Dose leading to 50% mortality
LOAEC	Lowest Observed Adverse Effect Concentration
LOAEL	Lowest Observed Adverse Effect Level
LOC	Level of Concern
MA	May Affect
MATC	Maximum Acceptable Toxic Concentration
MRID	Master Record Identification
NC	Not Calculated
NE	No Effect
NLAA	Not Likely to Adversely Affect
NMFS	National Marine Fisheries Service
NOAEC	No Observed Adverse Effect Concentration
NOAEL	No Observed Adverse Effect Level
NOEC	No Observed Effect Concentration
NOEL	No Observed Effect Level
NWIS	National Water Information System
PBF	Physical or Biological Features
PPHD	Prey, Pollination, Habitat and/or Dispersal
PWC	Pesticide in Water Calculator
RQ	Risk Quotient
TGAI	Technical Grade Active Ingredient

T-REX	Terrestrial Residue EXposure model
UDL	Use Data Layer
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VVWM	Variable Volume Water Body Model
WQP	Water Quality Portal

Appendix A. Master Effects Determination & J/AM Workbooks

Summary results for the species determinations and overlap analysis results are contained in the attached **APPENDIX A** Excel workbook. The "Summary and ReadMe" page contains a summary of the results and an explanation of the additional sheets in the workbook. Detailed weight of evidence details are located in the Grouped Workbooks (Aquatic Taxa-**ATTACHMENT 3**; Terrestrial Animals **ATTACHMENT 4**; and Plants (**ATTACHMENT 5**).

As described in the assessment, species are screened at successive steps to make determinations. The logic applied and the analysis are summarized in the "Summary and ReadMe" worksheet of the **Appendix A** workbook, and also described below.

"NE - No overlap" – Determination made if species/CH has no overlap with any of the use sites with appropriate buffers applied. The appropriate buffer based on runoff and drift are determined in the tool based on relevant endpoints and EECs to the species. For dinotefuran, the maximum buffer applied to any use site was 792 m (810 in MAGtool, 792 in Terrestrial Plant and Aquatic Workbooks).

"NE - No toxicity" – Determination made for the species/CH, if no toxicity is anticipated based on maximum possible exposure values and conservative endpoints (e.g., NOAEC values). The tool automatically determines all species relationships, including PPHD and obligate relationships, to consider all taxa endpoints that are relative to the species. If none of these relationships predict EEC exceedances of the endpoints, an NE determination is made based on no toxicity.

"NE - <1% overlap" – Determination made if species/CH has <1% overlap when rounded to one significant digit (i.e., <0.44% overlap) with any of the use sites with appropriate buffers applied. The appropriate buffer based on runoff and drift are determined in the tool based on relevant endpoints and EECs to the species. For dinotefuran, the maximum buffer applied to any use site was 792 m (810 m in MAGtool).

"NE or NLAA - Qualitative species" – Species/CH where a quantitative analysis is not deemed appropriate for various reasons, or for which range/CH spatial information is not available, are assessed qualitatively. These species/CH are flagged in the tool to not be analyzed and are assessed separately. The sheets **"Qual Species R"** and **"Qual Species CH"** in the **Appendix A** workbook describe these individual species determinations in more detail. Further description of qualitative species considerations is also provided in **APPENDIX C**.

"NLAA - < 1 individual impacted/ Effects discountable" - Determination made if species has less than 1 individual predicted to be impacted based on specific species parameters including likelihood of being on use site (On/Off field).

"NLAA/LAA/J/NJ/AM/NAM - Weight of evidence analysis" – Determinations based on tool output, which considers all species relationships, including through PPHD and obligate relationships. Endpoints used in this part of the analysis are less conservative than the NE determinations, using MATC or LOAEC values instead of the NOAEC, and are described in the assessment.

Appendix B. Other Uses (Tree Injection, Soil Spray and Granular)

The foliar, soil spray, granular, and tree injection uses were recently assessed in the 2017 DRA and there are no new endpoints to consider. An abridged analysis is provided in this Appendix and the inputs are provided in **Table B.1**. For assessing the soil spray exposures (to bare soil) to birds, reptiles, and terrestrial phase amphibians, the EECS are based on the residues of the arthropod diet item are used (**Table B.2**).

For the tree injection, data from a study with cherry trees (MRID 50714706) measured residues in leaves 6-days after fall application via trunk injection according to current label directions; and residues in pollen and nectar were measured the following spring. The study was conducted on cherry trees (*Prunus spp.*), which is not currently a registered use site for dinotefuran (but is a typical test species for injection studies). In this study, Dinotefuran 20 SG was applied at a nominal rate of 2 g of product per inch of trunk diameter at breast height prior to leaf drop which is consistent with the maximum labelled rate. Measured residues in leaves ranged from to 68-148 ppm (mean maximum over the three study sites and 4 intervals), which is similar to the range of short grass residues calculated in T-REX (**Table B.2**). Trends in dinotefuran and total dinotefuran residue concentrations in leaves were similar between the three sites, with concentrations peaking in the fall following application, and then declining over time during the flowering period the following spring. DT50 values of dinotefuran ranged from 36.2 to 79.3 days following trunk injection, calculated following the maximum mean detection. The data from this study suggest that birds and mammals that feed on the leaves (surrogates for fruit and seeds) of trees treated with dinotefuran via trunk injection may be exposed to residues that are similar residues from foliar spray applications. While there is uncertainty noted with only having data from a single type of tree, the data do provide an understanding of the injection residues and how they relate to the foliar and soil applications of dinotefuran. For the purposes of this risk assessment, EECs from foliar spray applications are considered within the range from trunk injection applications and serve as a proxy for estimating exposure. There is uncertainty noted, with this assumption and the actual tree injection could result in higher EECs.

For foliar spray applications (and trunk injection using foliar as proxy), acute dose-based RQs for upper-bound exposures range from <0.01 to 0.42, exceeding the listed species LOC (0.1) for small and medium herbivores and omnivores, and small insectivores. If the mean exposure values were used, the RQs would only slightly exceed the listed species LOC for small birds feeding on short grass and leaves, from tree injection (0.15), and arthropods (0.11) for the highest application rate. The avian acute oral study had an LD_{50} of 334 mg a.i.kg bw and probit slope of, 6.9. When using the mean EECS, there are slight ES LOC exceedances for small herbivores (RQ=0.15) and small insectivores (RQ= 0.1). Other considerations, are that these EECS are based on the assumption of 100% feeding on a contaminated diet. Therefore, the focus of the assessment is on the indirect impacts to birds via prey reductions as the primary analysis in the BE (note: while the foliar direct dietary exposure is also assessed in the main analysis, it is secondary to the prey impacts).

Table B.1. Inputs for TREX Model for Dinotefuran Spray Applications

Crop-Use Pattern	Application method	Application type	Application units	Single application rate	Number of applications	Application Interval
Cotton-aerial	aerial	foliar spray	lb a.i./A	0.134	2	7
Vegetables and Ground Fruit-aerial	aerial	foliar spray	lb a.i./A	0.18	2	7
Other Orchards-aerial	aerial	foliar spray	lb a.i./A	0.18	2	7
Soybeans-aerial	aerial	foliar spray	lb a.i./A	0.1	2	7
Rice-aerial	aerial	foliar spray	lb a.i./A	0.131	2	7
Grapes-aerial	aerial	foliar spray	lb a.i./A	0.18	2	7
Christmas Trees-ground	ground	foliar spray	lb a.i./A	0.54	1	NA
Sod -ground	ground	foliar spray	lb a.i./A	0.5	1	NA
Developed ground	ground	foliar spray	lb a.i./A	0.54	1	NA
Nurseries-ground	ground	foliar spray	lb a.i./A	0.5	1	NA

Table B.2. Dose-based EECs (mg/kg-bw) as food residues for birds, reptiles, and terrestrial-phase amphibians from labeled uses of dinotefuran spray formulations (T-REX v. 1.5.2)

	Herbivores and Omnivores												Insectivores		
Animal Size →	Small				Med				Large				Small	Med	Large
Dietary Items → / Use(s) ↓	Short Grass	Tall Grass	Broad-leaf Plants	Fruits, pods, seeds, *etc.*	Short Grass	Tall Grass	Broadleaf Plants	Fruits, pods, seeds, *etc.*	Short Grass	Tall Grass	Broadleaf Plants	Fruits, pods, seeds, *etc.*	Arthropods		
Cotton-aerial	68.5	31.4	38.5	4.3	39.1	17.9	22.0	2.4	17.5	8.0	9.8	1.1	26.8	15.3	6.9
Vegetables and Ground Fruit-aerial	92.0	42.2	51.8	5.8	52.5	24.1	29.5	3.3	23.5	10.8	13.2	1.5	36.0	20.6	9.2
Other Orchards-aerial	92.0	42.2	51.8	5.8	52.5	24.1	29.5	3.3	23.5	10.8	13.2	1.5	36.0	20.6	9.2
Soybeans-aerial	51.1	23.4	28.8	3.2	29.2	13.4	16.4	1.8	13.1	6.0	7.3	0.8	20.0	11.4	5.1
Rice-aerial	67.0	30.7	37.7	4.2	38.2	17.5	21.5	2.4	17.1	7.8	9.6	1.1	26.2	15.0	6.7
Grapes-aerial	92.0	42.2	51.8	5.8	52.5	24.1	29.5	3.3	23.5	10.8	13.2	1.5	36.0	20.6	9.2
Xmas Trees/Forest trees-ground	147.6	67.7	83.0	9.2	84.2	38.6	47.3	5.3	37.7	17.3	21.2	2.4	57.8	33.0	14.8
Sod -ground	136.7	62.6	76.9	8.5	77.9	35.7	43.8	4.9	34.9	16.0	19.6	2.2	53.5	30.5	13.7
Developed-ground	147.6	67.7	83.0	9.2	84.2	38.6	47.3	5.3	37.7	17.3	21.2	2.4	57.8	33.0	14.8
Nurseries-ground	136.67	62.64	76.88	8.54	77.93	35.72	43.84	4.87	34.89	15.99	19.63	2.18	53.53	30.52	13.67

Table B.3. Acute Dose-based RQ values for Birds, Reptiles, and Terrestrial-Phase Amphibians from Labeled Uses of Dinotefuran (upper bound)

	Herbivores and Omnivores												Insectivores		
Animal Size →	Small				Med				Large				Small	Med	Large
Dietary Items → / Use(s) ↓	Short Grass	Tall Grass	Broad-leaf Plants	Fruits, pods, seeds, *etc.*	Short Grass	Tall Grass	Broadleaf Plants	Fruits, pods, seeds, *etc.*	Short Grass	Tall Grass	Broadleaf Plants	Fruits, pods, seeds, *etc.*	Arthropods		
Cotton-aerial	0.19	0.09	0.11	0.01	0.09	0.04	0.05	<0.01	0.03	0.01	0.02	<0.01	0.08	0.03	0.01
Vegetables and Ground Fruit-aerial	0.26	0.12	0.15	0.02	0.12	0.05	0.07	<0.01	0.04	0.02	0.02	<0.01	0.10	0.05	0.01
Other Orchards-aerial	0.26	0.12	0.15	0.02	0.12	0.05	0.07	<0.01	0.04	0.02	0.02	<0.01	0.10	0.05	0.01
Soybeans-aerial	0.14	0.07	0.08	<0.01	0.06	0.03	0.04	<0.01	0.02	<0.01	0.01	<0.01	0.06	0.03	<0.01
Rice-aerial	0.19	0.09	0.11	0.01	0.08	0.04	0.05	<0.01	0.03	0.01	0.02	<0.01	0.07	0.03	0.01
Grapes-aerial	0.26	0.12	0.15	0.02	0.12	0.05	0.07	<0.01	0.04	0.02	0.02	<0.01	0.10	0.05	0.01
Sod-ground	0.39	0.18	0.22	0.02	0.17	0.08	0.10	0.01	0.05	0.03	0.03	<0.01	0.15	0.07	0.02
Developed-ground	0.42	0.19	0.23	0.03	0.19	0.09	0.10	0.01	0.06	0.03	0.03	<0.01	0.16	0.07	0.02
Nurseries-ground	0.39	0.18	0.22	0.02	0.17	0.08	0.10	0.01	0.05	0.03	0.03	<0.01	0.15	0.07	0.02
Forest Trees-ground	0.42	0.19	0.23	0.03	0.19	0.09	0.10	0.01	0.06	0.03	0.03	<0.01	0.16	0.07	0.02

Table B.4 Acute Dose-based RQ values for Birds, Reptiles, and Terrestrial-Phase Amphibians from Labeled Uses of Dinotefuran (Mean Kenaga)

Primary Feeding Strategy →	Herbivores and Omnivores												Insectivores		
Animal Size →	Small				Med				Large				Small	Med	Large
Dietary Items → / Use(s) ↓	Short Grass	Tall Grass	Broad-leaf Plants	Fruits, pods,	Short Grass	Tall Grass	Broadleaf Plants	Fruits, pods,	Short Grass	Tall Grass	Broadleaf Plants	Fruits, pods,	Arthropods		
Cotton-aerial	0.07	0.03	0.04	<0.01	0.03	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.02	<0.01
Vegetables and Ground Fruit-aerial	0.09	0.04	0.05	<0.01	0.04	0.02	0.02	<0.01	0.01	<0.01	<0.01	<0.01	0.07	0.03	<0.01
Other Orchards-aerial	0.09	0.04	0.05	<0.01	0.04	0.02	0.02	<0.01	0.01	<0.01	<0.01	<0.01	0.07	0.03	<0.01
Soybeans-aerial	0.05	0.02	0.03	<0.01	0.02	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	0.02	<0.01
Rice-aerial	0.07	0.03	0.04	<0.01	0.03	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	0.02	<0.01
Grapes-aerial	0.09	0.04	0.05	<0.01	0.04	0.02	0.02	<0.01	0.01	<0.01	<0.01	<0.01	0.07	0.03	<0.01
Xmas Trees-ground	0.15	0.06	0.08	0.01	0.07	0.03	0.03	<0.01	0.02	<0.01	0.01	<0.01	0.11	0.05	0.02
Sod-ground	0.14	0.06	0.07	0.01	0.06	0.03	0.03	<0.01	0.02	<0.01	0.01	<0.01	0.10	0.05	0.01
Developed-ground	0.15	0.06	0.08	0.01	0.07	0.03	0.03	<0.01	0.02	<0.01	0.01	<0.01	0.11	0.05	0.02
Nurseries-ground	0.14	0.06	0.07	0.01	0.06	0.03	0.03	<0.01	0.02	<0.01	0.01	<0.01	0.10	0.05	0.01
Forest Trees-ground	0.15	0.06	0.08	0.01	0.07	0.03	0.03	<0.01	0.02	<0.01	0.01	<0.01	0.11	0.05	0.02

Secondary Exposure and Indirect Exposure Discussion.
Some species also obtain insect prey via gleaning the insects from leaves. For example, the Northern long-eared bat (*Myotis septentrionalis*), is commonly referred to as a gleaning bat because it often catches insects that are at rest on leaves or twigs, in addition to catching insects that are flying (Lee and McCracken 2004). Many insectivorous birds will also glean insect prey from the bark and leaves.

Tree injections of dinotefuran are targeting the pest larvae that feed on the inner bark of trees; therefore, not likely accessed by bat or bird; however, non-target insect larvae that may be feeding on plant tissues (e.g., leaves, sap) could serve as prey. This type of exposure is called secondary exposure in which the bat may be exposed to the residues via consumption of prey (e.g., caterpillars) that have ingested plant tissues that have taken up the active ingredient. The assumption used in this BE is that the residues in the invertebrates consuming the leaves would be no higher than the leaf residues, thus, the secondary exposure pathway is not likely to be of concern for direct impacts. An additional consideration is that dinotefuran has a low K_{OW} (0.28) and is not likely to accumulate in prey via bioaccumulation through the trophic web.

The earlier comparison, with the tree injection residues and the foliar EECS for birds also suggests a low risk to mammals considering the low toxicity (mammal LD_{50} of 2000 mg/kg-bw). Therefore, the overall risk to bats and birds from gleaning invertebrate prey from injected trees is not likely to result in direct effects from secondary foraging.

Indirect Effects
Another important consideration is the potential for indirect effects to the overall prey base for tree gleaning birds and mammals. With respect to indirect effects via prey reduction it is helpful to understand the number of trees that may be treated in the species area and the availability of alternative forage. For example, impacts may be offset by bats foraging on larvae that had not consumed a toxic dose and by the assumption that other sources of flying insects/invertebrate prey would also be available as prey. EFED also assumes that the number of treated trees is limited by the time and cost to treat individual trees. In this case there is a potential for indirect effects to prey but the likelihood for impacts is low considering all factors.

Granular: The T-REX model (version 1.5.2) was also used to estimate the terrestrial exposures associated with granular applications of dinotefuran using the LD_{50}/ft^2 method and there were no listed species LOC exceedances for birds or mammals. (USEPA, 2017)

Appendix C. Qualitative Species

This appendix contains general discussions of species that were assessed using a qualitative analysis. Two tabs in **APPENDIX A,** "Qual R" for the species and "Qual CH" for the critical habitats, list all species assessed using qualitative methods and descriptions of the rationale applied on a by species basis.

SPECIES EXPOSURE PATHWAY CONSIDERED INCOMPLETE

For dinotefuran, three types of species characteristics led to a conclusion that the exposure pathway is incomplete: species that only occur on uninhabited islands, species that predominantly occur in the open ocean and terrestrial species that only occur in caves. Additional explanation of why the exposure pathway is incomplete for these three types of species habitats is provided below.

Species whose ranges only occur on uninhabited islands are not expected to be exposed to dinotefuran because dinotefuran is not reasonably expected to be applied in areas not inhabited by humans. The majority of dinotefuran use is on agricultural uses, which would not be expected to occur on uninhabited islands.

Exposures to species that predominantly occur in the open ocean (*e.g.,* whales) or rely on ocean species (*e.g.,* seabirds) are reasonably expected to be discountable. This is because dinotefuran is not applied directly to the ocean, and sources of dinotefuran via runoff and spray drift that reach the open ocean are diluted, and dinotefuran does not bioaccumulate.

Dinotefuran is not registered for applications within caves. Exposures to terrestrial organisms living within caves are expected to be discountable. The major transport routes of dinotefuran from treatment sites to non-target areas include spray drift and runoff. Since caves are enclosed, spray drift transport is not reasonably expected to result in exposures to cave dwelling organisms. Runoff transport and mobility of dinotefuran may lead to dinotefuran reaching groundwater that is associated with caves. Therefore, for aquatic species that inhabit caves (e.g., Barton Springs salamander), exposures and associated risks are assessed in the quantitative risk analysis.

For listed terrestrial species that are obligate to caves (e.g., spiders), exposure from water is expected to be discountable. The atmosphere of the inner cave (where these obligate cave species live) is saturated with water vapor. Species have adapted to this hydrating environment by increasing their permeability such that they "become freshwater animals living in an aerial environment" (Howarth 1987). This means that species get the majority of their water needs met by the atmosphere and from consumption of their prey. For terrestrial obligate cave species, water sources are limited to the condensation in the cave and on cave walls resulting from groundwater sources or from detritus/guano. Dinotefuran is classified as non-volatile from dry non-adsorbing surfaces and water. As a result, dinotefuran is not expected to be presented in water vapor or condensation water that may occur in caves.

Another possible route of exposure is from leaf litter, animal droppings, and carcasses that may fall or be washed into cave systems. While there is evidence in the literature indicating that animal feces (*e.g*., guano) and carcasses contaminated with pesticides have been found in cave systems (*e.g*., Land, *et al.* 2019; Eidels, *et al*. 2012; Eidels, *et al.* 2007; Land 2001; MacFarland 1998; and Sandel 1999), dinotefuran residues in these studies were not analyzed as they focused on other pesticides (*e.g.*, organochlorines, organophosphates, carbamates). Based on the physical properties of dinotefuran, residues may not be expected because it is rapidly metabolized and excreted from the body. Therefore, exposures to species that rely on food items that are derived from exterior sources are expected to be discountable.

EXPOSURE MODELS CONSIDERED UNRELIABLE FOR ASSESSED SPECIES

At this time, the current exposure models used in this assessment do not estimate exposures for all types of pesticide applications, all habitat types, or for all potential exposure routes relevant to listed species. Therefore, there may be uncertainty in the exposure values being used for a particular species based on what potential uses its range or critical habitat may overlap with, what type of habitat the species is found in, or what the main potential exposure route(s) might be. For species and critical habitats that have not been determined to be NE or NLAA based on the above analyses, consideration is given to how well the conceptual model of the relevant exposure model(s) matches up with the specific species being assessed. 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.

The qualitative analysis considered whether exposures to dinotefuran are reasonably certain to occur given the habitat of the listed species (e.g., ocean, beach, and/or freshwater habitats) and, if exposures are expected to occur, are impacts to an individual likely. The analysis also considered the potential for effects to the prey, pollination, habitat and/or dispersal (PPHD) of the species and whether those effects would rise to the level of impacting an individual of a listed species.

AQUATIC SPECIES

This discussion focuses primarily upon species that have marine and estuarine habitats. Effects to marine mammals (e.g., pinnipeds, mustelids, polar bear, manatee), sea birds, and sea turtles are considered for both aquatic and terrestrial exposures. Effects to fish and corals are considered for aquatic exposures only. Since dinotefuran is not considered bioaccumulative and is not expected to accumulate in the tissue of prey, EPA expects exposure from eating contaminated fish would be very low. In the marine environment, exposure of these species to conventional pesticides is not reasonably expected to reach the estuarine/marine environments at concentrations high enough to impact an individual of a species because of dilution. Additionally, tidal reversal in freshwater streams and vertical stratification of the freshwater inflow due to differences in salinity and temperature can enhance the mixing process at the freshwater/marine interface and disperse potential pesticide concentrations that may occur in freshwater streams and rivers that discharge into marine environments, limiting the potential for a pesticide to reach individuals of the listed species.

Marine mammals, sea birds, and sea turtles may also spend a portion of their life-cycle (*i.e.,* breeding and basking) on shore, so the potential for exposure in the terrestrial environment is also considered. Potential exposure routes include inhalation and dermal interception of spray droplets on the day of application. Since these species do not forage while on land, dietary exposure while in terrestrial habitats is not expected. Based on the points below, exposure at concentrations high enough to impact an individual are not reasonably expected to occur for these species.

- In a quantitative assessment, the overlap analysis assumes that all individuals of the species are in the terrestrial portion of their range, which represents a relatively small fraction of the entire range of the species. This artificially inflates the overlap numbers resulting in low confidence in the potential for exposure.
- While in the terrestrial environment, exposure of these species would be limited to spray drift from use sites adjacent to nesting or basking sites. The potential for exposure in the terrestrial

environment is limited because on the day of application, dinotefuran would have to be transported by wind blowing from the application site toward the beach with little opportunity for interception of spray droplets.

- The duration of potential exposures would be limited as these species spend a relatively short amount of time on the shore for basking and/or breeding purposes. For example, sea turtles spend the vast majority of their lives in aquatic habitats but use beaches to lay eggs, other species such as seals may bask on the shore.
- In addition, several of the species only occur in aquatic and terrestrial areas that are in Alaska. These species include the bearded seal, the Pacific walrus, the ringed seal, and the polar bear. Although, there are some potential pesticide use sites found in Southcentral Alaska, they are likely limited and/or largely removed from coastal areas. A limited amount of land is used for growing grains and fruits and vegetables, based on USDA's Census of Agriculture data for Alaska (2012). Most of these crops are grown in the interior of the state (e.g., near Fairbanks). Although, there are some potential agricultural use sites found in Southcentral Alaska (e.g., forage crops), they are limited and largely removed from coastal areas. Therefore, pesticide exposure to these species is not reasonably expected to occur.

Effects to the PPHD of marine mammals, fish, sea birds, sea turtles, and corals are also considered. The listed species considered rely on more than one dietary item, most of which are entirely marine. In estuarine/marine environments, exposures to conventional pesticides are not reasonably expected to decrease prey populations.

Two species were given additional consideration for this exposure pathway and are discussed below. These species are the Western manatee and the killer whale.

The Western manatee forages in freshwater, as well as marine environments and requires freshwater on a regular basis. There is a great deal of uncertainty in estimating potential dinotefuran exposures in marine environments that support the Western manatee, but it is possible to use estimated environmental concentrations (EECs) for the large flowing bins (3 and 4) to estimate exposures in freshwater. Dinotefuran has no direct effects to mammals or plants. Therefore, EPA made a NLAA determination for the Western manatee.

The killer whale (*Orcinus orca*, Southern resident DPS), is found in the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound, and has an obligate relationship with Pacific salmon (which are anadromous), including several species (Chinook, Chum, and Coho) that are themselves considered threatened or endangered.

Dinotefuran exposures are reasonably expected to be reduced due to dilution and the fate characteristics (i.e., not expected to bioaccumulate); therefore, exposures to killer whales are not expected. The obligate relationship of salmon with the killer whale is unique as species of salmon are also listed and are assessed in this BE, which allows for a more detailed analysis of the obligate species. an NLAA determination is made for the killer whale (Southern resident DPS).

In addition, the beluga whale occurs in waters of the United States and terrestrial areas that are in Alaska. Although there are some potential pesticide use sites found in Southcentral Alaska, they are likely limited and/or largely removed from coastal areas. A limited amount of land is used for growing grains and fruits and vegetables, based on USDA's Census of Agriculture data for Alaska (2012). Most of these crops are grown in the interior of the state (e.g., near Fairbanks). Although, there are some potential agricultural use sites found in Southcentral Alaska (e.g., forage crops), they are limited and largely removed from coastal areas. Therefore, pesticide exposure to the critical habitat of this species is not reasonably expected to occur.

TERRESTRIAL SPECIES

There is one species of terrestrial animal, the wood bison, that has extensive portions of its range located outside of the United States (i.e., in Canada). In a quantitative assessment, the overlap analysis assumes that all individuals of the species are in the portion of their range located in the United States, which represents a relatively small fraction of the entire range of the species. Since this artificially inflates the overlap numbers, which would result in low confidence in the potential for exposure, the overlap analysis was not run for these species and they are assessed qualitatively. For the wood bison, the population in the United States consists of a nonessential experimental population (NEP) established in 2015 in Western Alaska. This population is highly managed and tracked extensively. In addition, while there are some potential pesticide use sites found in Southcentral Alaska, they are likely limited and/or largely removed from areas utilized by the wood bison. A limited amount of land is used for growing grains and fruits and vegetables (USDA's Census of Agriculture data for Alaska (2012)). Most of these crops are grown in the interior of the state (e.g., near Fairbanks). Although, there are some potential agricultural use sites found in Southcentral Alaska (e.g., forage crops), they are limited. Therefore, pesticide exposure to the wood bison is not reasonably expected to occur and a NLAA determination is made.

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Appendix D. Aquatic Modeling EECs and Risk Quotients for Aquatic Invertebrates

The attached excel sheet (**Appendix D. Aquatic Modeling EECs and Risk Quotients for Aquatic Invertebrates_1-19-23**) provides the acute and chronic EECs and RQs for aquatic invertebrates based on water column and pore water concentrations for the standard farm pond and edge of field modeling. The first tab in the worksheet contains aquatic modeling EECs. The second tab contains standard farm pond acute RQs. In this worksheet, Blue shading represents LOC exceedances for listed species (LOC=0.05). The second tab contains the standard farm pond chronic RQs. In this worksheet, Blue shading represents LOC exceedances on a chronic basis (LOC=1.0) for listed and non-listed species.

Appendix E. Pesticide in Water Calculator (PWC) Files

This appendix is saved as separate files named ATTACHMENT 7a through 7e and contains the batch input and output files used in the aquatic exposure and residential analysis for dinotefuran.

Appendix F. Edge-of-Field Calculator

This appendix is saved as separate files named ATTACHMENT 8a through 8d and contains the Edge of Field calculator along with input and output associated with generating edge of field EECs for dinotefuran.

Appendix G : Qualitative considerations of confidence and uncertainty in overlap estimates for non-agricultural or non-crop UDLs

Managed forests

The labeled tree plantation are spatially represented using the managed forest Use Data Layers (UDLs). When considering theses managed forest use sites, dinotefuran is applied via spray to Christmas tree, poplars and cottonwoods plantations. For all other tree uses, dinotefuran is applied as a trunk drench or injection. These application methods have low geographic cohesiveness, low uniformity in geographic placement, making them similar to spot treatments. For trunk drench and injection, it was assumed that exposure is so limited that it is unlikely to contribute to jeopardy and therefore would not require mitigation. Therefore, for the managed forest use sites, only spray applications to Christmas tree, cottonwoods and poplars plantations were considered relevant at the population level.

In the contiguous United States (CONUS), Christmas trees is a unique UDL that is mostly independent from the Managed Forest UDL, thus, overlap with this use site was assessed separately without geospatial uncertainty evaluation. This is the only labeled conifer tree plantation. However, the CONUS Managed Forest UDL represents all forest tree plantations and forested area managed for timber extraction. Cottonwood and poplar plantations are captured in these forestry practices; however, this is an overestimate because it also represents other tree plantations and managed trees for timber extraction. When considering the land cover classes found within the Managed Forest UDL across different regions across the United States, tree plantations made up between 2 and 53% of Managed Forest UDL (USGS 2012). In some regions, identification of deciduous tree plantations like cottonwood and poplar, and evergreen or pine tree plantation is possible. In the southeast region where 53% of the Managed Forest UDL represented tree plantations, only 4% of the identified tree plantations were deciduous (USGS 2011). The 2017 Census of Agriculture reports acreage for short rotation wood crops by state. Short rotation woody crops are defined as trees that grow from seed to a mature tree in 10 years or less and would include mostly deciduous trees like cottonwood and poplar plantations (USDA 2017). When considering the same regions as identified in the UDL, the reported acreage for short rotation woody crops represents less than 1% of the total Managed Forest UDL area and less than 1% to 3% of the area identified as tree plantation. The 3% estimate based on available information from the Census of Agriculture, is similar to percent cropped area (PCA) for deciduous trees identified using the U.S. Geological Survey (USGS) Gap Analysis Program (GAP) land cover information. The Short Rotation Wood Crop description from the Census of Agriculture would capture deciduous tree plantations (**Table G-1**). In regions with available spatial data on deciduous verses evergreen or pine plantations the Managed Forest UDL includes mostly evergreen, or pine plantation compared to deciduous. Christmas Tree plantations, assessed using a separate UDL, is the only registered conifer plantation making these evergreen or pine plantation a non-registered use area. Deciduous tree plantation only represents 5% or less of the total Managed Forest UDL. The Census of Agriculture also reports Short Rotation Wood Crops, with a description that aligns with deciduous tree plantations. When considering the area reported from the Census of Agriculture the deciduous tree plantations would also make up <5% of the total Managed Forest UDL. Usage information on these tree plantations is unknown resulting in an assumption of 100% usage. Given Managed Forest UDL overestimates, the area associated with the registered deciduous tree planation, and the lack of usage information, it is assumed that at the population level, overlap for this use is unlikely to contribute to jeopardy given the limited geographic use and usage footprint and would not require mitigation.

In Hawaii, tree plantations are also included in the Managed Forest UDL. Additional consideration of the land cover classes found within the Managed Forest UDL indicates tree plantations represent 5% of the Hawaii Managed Forest UDL (USGS 2012). The Census of Agriculture reports less than 100 acres of Christmas Trees in Hawaii, which represent <1% of the Managed Forest UDL in Hawaii (USDA 2017). This overestimate from the Managed Forest UDL of the cottonwood and poplar tree plantation was qualitatively considered if overlap with the managed forest UDL was >5%.

Table G-1. Percent of the Managed Forest Use Data Layer (UDL) represented by Tree Plantations

Region	Percent of Managed Forest UDL		Percent of Area (PCA) Identified as Tree Plantation			
	Area Identified as Tree Plantation (LandFire)	Short Rotation Woody Crop (CoA)	Deciduous Tree Plantation (GAP)	Evergreen or Pine Plantation (GAP)	Unknown Plantation Type (GAP)	Short Rotation Wood Crop (CoA)
North Central	12%	<1%	--	--	100%	<1%
North East	18%	<1%	0%	83%	17%	<1%
North West	--	<1%	--	--	--	<1%
South Central	2%	<1%	5%	0%	95%	3%
South East	53%	<1%	4%	78%	18%	<1%
South West	--	<1%	--	--	--	<1%
Hawaii	5%	--	--	--	--	--

North Central: IL, IN, IA, KS, MI, MN, MO, MT, NE, ND, OH, SD, WI, WY
North East: AR, GA, IN, IA, KS, KY, ME, MD, MA, MI, MO, NH, NJ, NY, NC, OH, PA, RI, SC, TN, VT, VA, WV, WI
North West: CA, CO, ID, MT, NE, ND, OR, SD, UT, WA, WY
South Central: CO, IL, IA, KS, MO, NE, NM, OK, SD, TX, WY
South East: AL, AR, FL, GA, IL, KY, LA, MS, MO, OK, SC, TN, TX
South West: AZ, CA, CO, ID, NM, OR, TX, UT, WY
--: Unknown or Data are not available in the Geographic Information System (GIS) source data

Field nurseries

The Field Nurseries UDL is a combination of two other non-agricultural UDLs including Nurseries and Other Orchards. The Nurseries UDL identifies locations occupied by retail nurseries, garden supply stores, retail greenhouse, retail shade houses or retail horticultural. Orchard trees initially grown in these nursery locations may be transplanted to orchards or tree plantations following a pesticide application. In order to capture applications occurring in the nursery prior to transplant, or separately in both locations, these two UDLs were combined into the Field Nurseries UDL. While the geographic extent of the represents where dinotefuran could be applied, it is not expected that every acre would be treated. Additionally, not all application types for this UDL are expected to lead to exposure. In general, given the lack of usage information of dinotefuran in the U.S. for the field nurseries uses, it is assumed that at the population level, overlap for this use is unlikely to contribute to jeopardy given the limited geographic usage footprint, unless the species is known to occur in these habitats.

Developed and open space developed

There are a number of labels uses that are geographically represented using the developed and open spaced developed UDLs. In general, the developed UDL represents non-agricultural areas with a mixture of some constructed materials and vegetation that has >20% impervious and the open space developed represents <20% impervious surface. Given the number of label uses that align with the land cover found in these UDLs, these geographic extents are considered representative of locations where dinotefuran could be applied. Available usage data for these uses is minimal therefore 100% usage was assumed. While the geographic extent of the represents where dinotefuran could be applied, it is not expected that every acre would be treated. In general, given the lack of usage information of dinotefuran in the U.S. for the developed and open spaced developed uses, it is assumed that at the population level, overlap for this use is unlikely to contribute to jeopardy given the limited geographic usage footprint, unless the species is known to occur in these habitats.

Other crops (sod farms)

The sod farm label use is mapped using the Other Crops UDL, however, this UDL includes areas in addition to sod farms such as clover, wildflowers and idle cropland. As a result, the geographic extent of the Other Crops UDL overestimates the area of sod farms, and therefore overestimates where dinotefuran can be applied for this use pattern. It is not possible to refine the locations of sod farm based solely on available GIS data, while maintaining the accuracy thresholds outlined.

Nationally, nearly 340,000 acres of sod were harvested in 2017 based on the Census of Agriculture; top producing states were Florida and Texas, each representing about 20% of the national acreage harvested (USDA NASS 2017). Alabama (6%), Oklahoma (6%), and Georgia (5%) represent the next highest producing states. Various additional states represent less than 5% of national sod production each in terms of acres harvested (USEPA 2022). Nationally, the Other Crops UDL estimated ~73,402,000 acres, at this scale sod farms make up <1% of the total area found in the Other Crops UDL (**Table G-2**).

Table G-2. Percent of the Other Crops Use Data Layer (UDL) represented by sod farms

Region*	Area from CoA (Acres)	Area from UDL	Counties with Sod Farm Production (CoA)	Reported Acres from CoA to Estimated Acres in the UDL PCA (Percent cropped area)
National	340,000	73,402,000	589	<1%
North Central	46,000	2,9172,200	80	<1%
Northeast	119,200	13,239,460	252	1%
Northwest	34,500	32,933,310	71	<1%
South Central	104,000	32,683,380	54	<1%
Southeast	239,000	33,556,670	125	1%
Southwest	85,500	24,204,530	2	<1%
Hawaii	175	142,210	4	<1%
Alaska	>5	71,050	1	<1%

North Central: IL, IN, IA, KS, MI, MN, MO, MT, NE, ND, OH, SD, WI, WY
Northeast: AR, CT, DE, GA, IN, IA, KY, ME, MD, MA, MI, MO, NH, NJ, NY, NC, OH, PA, RI, SC, TN, VT, VA, WV, WI
Northwest: CA, CO, ID, MT, NE, ND, OR, SD, UT, WA, WY
South Central: CO, IL, IA, KS, MO, NE, NM, OK, SD, TX, WY
Southeast: AL, AR, FL, GA, IL, KS, KY, LA, MS, MO, OK, SC, TN, TX
Southwest: AZ, CA, CO, ID, NM, OR, TX, UT, WY

When considering the percent cropped area (PCA) of sod farms (based on the reported harvest area in the Census of Agriculture) within the Other Crops UDL (based on the estimated acres of all crops with the UDL), regionally sod farms represent at least 1 percent of the total area in the Other Crops UDL on the east coast. At a state level, Rhode Island, Florida, and Tennessee have the highest PCA of sod farms within the Other Crop UDL with 20%, 6% and 6% respectively. Both datasets indicate the east coast as the most likely area where listed species could come in contact with sod farms.

Given Other Crops UDL overestimates the area associated with the registered sod farm use and the lack of usage information it is assumed that at the population level, overlap for this use is unlikely to contribute to jeopardy and would not require mitigation.

Appendix H. Scenario Development

Agricultural Uses

Crop Subgroup 20C COTTON

Foliar

Application Number	Application Timing; Type	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1-2[a]	Foliar; Broadcast	Wettest Month[b]	7	Aerial, Ground	0.134	Cotton
TOTAL					0.268	

a. Up to 3 applications are allowed; however, two applications at the maximum single rate equate to the maximum annual rate. Therefore, only two applications were modeled.

b. Wettest month with the crop on the field for at least 20 days

Batch input file corresponding file names: dino_cotton_foliar_air

Crop Group 1 POTATO

Foliar

Application Number	Application Timing; Type	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1-3	Foliar; Broadcast	Wettest Month[a]	14	Aerial, Ground	0.068	Vegetable commodity
TOTAL					0.198	

a. Wettest month with the crop on the field for at least 20 days

Batch input file corresponding file names: dino_potato_foliar_air, dino_potato_foliar_ground

Soil

Application Number	Application Timing; Type	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1	At-plant or foliar; Soil broadcast	7 days pre-emergence[a] Wettest Month[b]	NA	Ground	0.338	Vegetable commodity
TOTAL					0.338	

a. 7 days pre-emergence used for at-plant initial application date

b. Wettest month with the crop on the field for at least 20 days

Not applicable (NA)

Batch input file corresponding file names: dino_potato_soil_ground, dino_potato_at-plant_ground

NOTE: foliar and soil applications cannot be combined for potatoes.

Crop Groups 3-5, 8, 9 VEGETABLES

The scenarios listed below generally represent use sites including all vegetable (1c tuberous and corm, 3-07A and B onions, brassica, cucurbits, fruiting, leafy).

<u>Foliar</u>

Application Number	Application Timing; Type	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1-2	Foliar; Broadcast	Wettest Month[a]	7	Aerial, Ground	0.18	Vegetable fresh or processing market; Vegetable commodity
TOTAL					0.36	

[a.] Wettest month with the crop on the field for at least 20 days

Batch input file corresponding file names: dino_vegetables_foliar_air, dino_vegetables_foliar_ground

<u>Soil</u>

<table>
<tr><th>Application Number</th><th>Application Timing; Type</th><th>Date</th><th>Minimum Treatment Interval (days)</th><th>Method</th><th>Application Rate (lb a.i./A)</th><th>Scenario</th></tr>
<tr><td>1</td><td>Pre-plant; Soil broadcast</td><td rowspan="2">7 days pre-emergence[a]</td><td rowspan="2">7</td><td rowspan="2">Aerial, Ground</td><td>0.34</td><td rowspan="2">Vegetable fresh or processing market; Vegetable commodity</td></tr>
<tr><td>2</td><td>Foliar; Soil broadcast</td><td>0.20</td></tr>
<tr><td>TOTAL</td><td></td><td></td><td></td><td></td><td>0.54</td><td></td></tr>
</table>

[a.] Application date selected is days before emergence date in PRZM scenario.
Example use represented includes brassica head and steam, leafy, and fruiting vegetables.

Batch input file corresponding file names: dino_vegetables_pre-plant_air, dino_vegetables_pre-plant_ground
NOTE: foliar and soil applications cannot be combined for vegetables.

Crop Groups 13-07 GRAPES, BERRIES

The scenarios listed below represent all grape (table and wine), small fruit vine climbing, and low growing berry subgroup of dinotefuran.

Foliar

Application Number	Application Timing; Type	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1-2[a]	Foliar; Broadcast	Wettest Month[b]	14	Aerial, Ground	0.18[c]	Small fruit trellised
TOTAL					0.36	

a. Up to 3 applications are allowed; however, two applications at the maximum single rate equate to the maximum annual rate. Therefore, only two applications were modeled.
b. Wettest month with the crop on the field for at least 20 days
c. Single application rates for grapes are 0.132 lb a.i./A and are conservatively grouped with other low growing berries with higher application rates

Batch input file corresponding file names: dino_berries_foliar_ground, dino_berries_foliar_air

Soil

Application Number	Application Timing; Type	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1	Foliar; Soil broadcast	Wettest Month[a]	NA	Ground	0.34	Small fruit trellised
TOTAL					0.34	

a. Wettest month with the crop on the field for at least 20 days

Batch input file corresponding file names: dino_berries_soil_ground

Combined

Application Number	Application Timing; Type	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1	Foliar; Soil broadcast	Wettest Month[a]	14	Ground	0.33	Small fruit trellised
2	Foliar; Broadcast				0.264	
TOTAL					0.529	

a. Wettest month with the crop on the field for at least 20 days

Batch input file corresponding file names: dino_berries_foliar_combo

Crop Groups 12 and 14 ORCHARD

The scenarios listed below represent all orchard dinotefuran uses (stone fruit, tree fruit, etc.).

Foliar

Application Number	Application Timing; Type	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1-2	Foliar; Broadcast	Wettest Month[a]	7	Aerial, Ground	0.18[b]	Orchard deciduous
TOTAL					0.36	

a. Wettest month with the crop on the field for at least 20 days

b. The highest single application rate is 0.20; however, the yearly maximum rate is 0.36 lb a.i./A. Splitting the applications into two equal applications of 0.18 lb a.i./A is not expected to alter the risk assessment conclusions.

Batch input file corresponding file names: dino_orchard_foliar_air, dino_orchard_foliar_ground

Soil

Application Number	Application Timing; Type	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1	Foliar; Soil Broadcast	Wettest Month[a]	NA	Aerial, Ground	0.54	Orchard deciduous
TOTAL					0.54	

a. Wettest month with the crop on the field for at least 20 days

Not applicable (NA)

This scenario represents tree nuts. Other orchard crops permit soil applications at a lower rate.

Batch input file corresponding file names: dino_orchard_soil_ground

NOTE: foliar and soil applications may be combined for some use sites; however, the annual application is not greater than 0.54 lb a.i./A. As such, the scenarios above are expected to bracket the potential exposure.

Soybean

Soil and Foliar

Application Number	Application Timing; Type[a]	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
2	Soil or Foliar; Broadcast	7 days pre-emergence[b] Wettest Month[c]	7	Aerial, Ground	0.1	Soybeans
TOTAL					0.2	

a. Application requires mandatory 150 ft aerial and 25 ft ground buffers, resulting in calculated drift values of 0.039 and 0.027 respectively

b. 7 days pre-emergence used for soil initial application date

c. Wettest month with the crop on the field for at least 20 days

Batch input file corresponding file names: dino_soybean_ground, dino_soybean_air, dino_soybean_pre-emergence_ground, dino_soybean_pre-emergence_air

CHRISTMAS TREES OR FORESTRY

The scenarios listed below represent Christmas trees, forest plantings, other tree farms, shelterbelt plantings, etc.

Foliar

Application Number	Application Timing; Type	Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1[a]	Foliar; Broadcast	Wettest Month[b]	NA	ground	0.54	Christmas Trees
TOTAL					0.54	

a. More applications are allowed a lower application rates; however, 1 application at the highest single and annual application is modeled.
b. Wettest month with the crop on the field for at least 20 days

Batch input file corresponding file names: dino_xmas_foliar_ground

ORNAMENTALS

Foliar

Application Number[a]	Application Timing; Type	Date[b]	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1	Foliar; Broadcast	3/1 (CA)[a] 3/1 (TN)[a]	7	Ground	0.50	TNnurserySTD_V2 (W13882) CAnurserySTD_V2 (W23188)
TOTAL					0.50	

a. More applications are allowed a lower application rates; however, 1 application at the highest single and annual application is modeled.

Residential Uses

TURF

Soil

Application Number	Application Timing; Type	Initial Date	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1	Foliar; Broadcast	1/1 (CA)[a]	NA	Aerial, Ground	0.54	CATurfRLF CAImperviousRLF
TOTAL					0.54	

a. Wettest month with the crop on the field for at least 20 days

Batch input file corresponding file names: Dino_Residential_Turf

ORNAMENTALS

Foliar

Application Number[a]	Application Timing; Type	Date[b]	Minimum Treatment Interval (days)	Method	Application Rate (lb a.i./A)	Scenario
1	Foliar; Broadcast	1/1 (CA)	NA	Ground	0.50	CArightofwayRLF_V2 CAImperviousRLF
TOTAL					0.50	

a. More applications are allowed a lower application rates; however, 1 application at the highest single and annual application is modeled.

b. Wettest month with the crop on the field for at least 20 days

Batch input file corresponding file names: Dino_Residential_Ornamental

The EPA residential conceptual model for turf is based on a previous assessment on pyrethroids (USEPA, 2016) which assumes a house on a fenced quarter acre lot with a driveway leading to the street. Different parts of the lot are modeled using impervious, residential, or right-of-way PWC scenarios. The results of each scenario are weighted according to the ratio expected for a given use profile. The lot is 10,816 ft^2 (104 ft x 104 ft), with a 1000 ft^2 (31.6 ft x 31.6 ft) house, 1200 ft^2 garden, 375 ft^2 (25 ft x 15 ft) driveway, and 1000 ft^2 other untreated areas (patio, garbage cans, etc.). Subtracting these features from the lot results in 7,241 ft^2 that is assumed to be treated turf and modeled with the residential PWC scenario. Additionally, 2 ft of overapplication is assumed at the turf application rate onto the length of the driveway (25 ft) on each side and modeled as 100 ft^2 of the lot using the impervious PWC scenario (**Figure H-1**). It is assumed that no overspray to the street occurs due to the fence line. In total, this results in the residential turf scenario covering 66.9% of the lot and impervious scenario covering 0.9% of the lot. The remaining 32.2% of the lot are untreated and there are no right-of-way exposure pathways (e.g., fence over pervious surfaces).

An estimate of the number of residential lots in a 10 ha watershed has been previously evaluated for California Red Legged Frog (CRLF) and other endangered species assessments (i.e., Appendix G of USEPA 2009a). The assumption previously made was 58 lots arranged in 10 lot blocks, resulting in an additional adjustment factor of 0.587.

Based on this, the residential turf scenario is assumed to cover 66.9% of the lot and impervious scenario covers 0.9%.

Patios, garbage cans, porches, shrubs, firewood piles, and ornamentals account for 1,000 ft^2 of treated area or 9.18% of the quarter acre lot. Therefore, the residential ornamental scenario is assumed to cover 9.18% of the residential lot (**Table H-1)**.

For a conservative estimate, turf and ornamental use were modeled as if they were used at their maximum annual rates within the same residential lot. These EECs were modeled separately and combined for a single EEC estimate. This was done with a residential post processing tool which adds the

30-year time series and multiplies the time series outputs by the fraction of use on the residential lot as mentioned above.

The resulting EEC from these combined uses are further multiplied by 0.587 to account for the fraction of residential lots in a watershed.

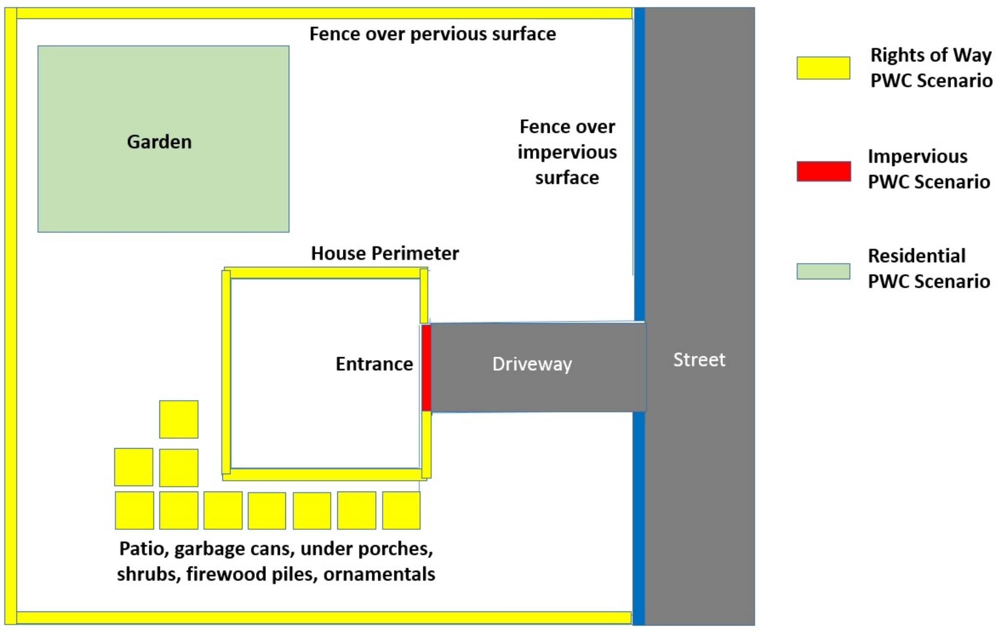


Figure H-1. **Residential conceptual model of pesticide applications**

Table H-1. Standard Percent Assumptions

PWC Scenario	Use Pattern	Percentage of 1 lot Treated
Residential	Garden/Ornamentals	11
Rights-of-Way	house perimeter	17
Rights-of-Way	along fences over pervious surfaces	5.58
Rights-of-Way	patios, garbage cans, under porches, shrubbery, firewood piles, ornamental vegetation	9.18
Impervious	Along point of entry over impervious surfaces (1inch)	0.0115

Appendix I. Imidacloprid Terrestrial Invertebrate Species Sensitivity Distribution

As noted in the Effects Characterization section, the dinotefuran dataset was too sparse to calculate a Species Sensitivity Distribution (SSD) for terrestrial invertebrates. The SSD from imidacloprid is serving as a proxy for population and community level effects by providing an endpoint for the HC_{25}.

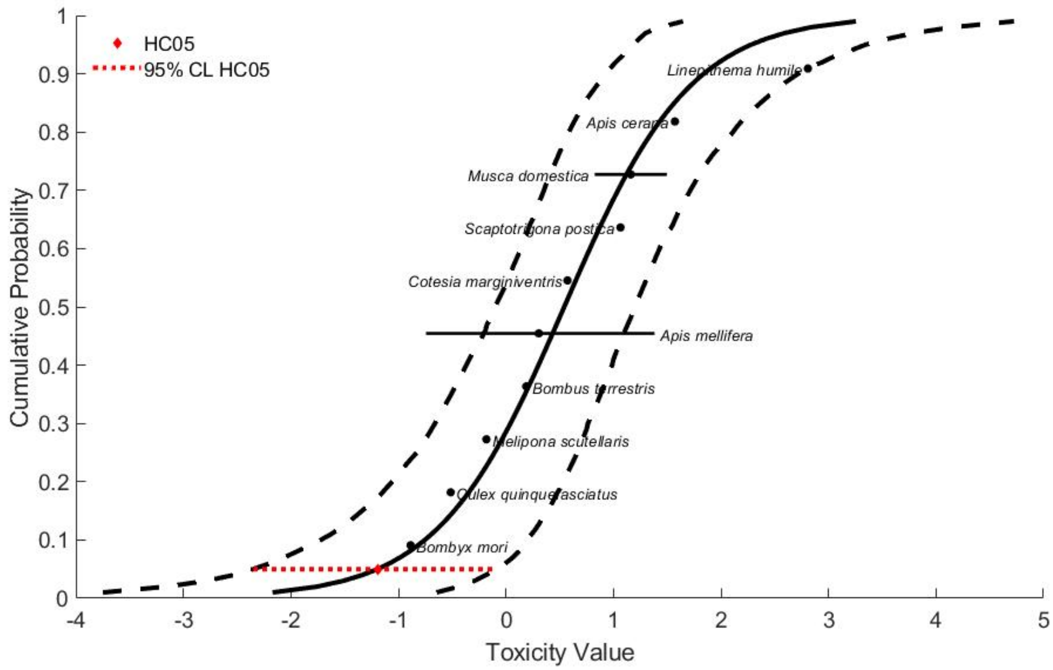
The following SSD section is from the imidacloprid Biological Evaluation (USEPA, 2023).
The available data for acute mortality to terrestrial invertebrates resulting from dietary exposure expressed as mg a.i./kg-food is provided in the SSD shown in **Figure I-1,** below. A total of 10 insect species are represented in this SSD and are distributed among 3 Orders (7 Hymenoptera, 2 Diptera and 1 Lepidoptera). No suitable mortality data for acute dietary exposure of non-insect species were identified. For the acute dietary SSD, six distributions were tested using the ML fitting method. The logistic distribution was selected to represent HC_{05} through HC_{95} values for terrestrial invertebrate endpoints from dietary exposure. **Table I-1** provides a summary of the results.

The threshold for terrestrial invertebrates is 0.064 mg a.i./kg-food based on the HC_{05} from the SSD which is about 2X below the most sensitive LC50 of 0.13 mg a.i./kg-food for the silkworm, *Bombyx mori* (Sun *et al.*, 2012; E162856). The least sensitive LC_{50} of 643 mg a.i./kg-food belongs to the Argentine ant, *Linepithema humile* (Rust *et al.,* 2004) which is about 5000X less acutely sensitive than *B. mori*. The 2^{nd} most sensitive species identified was the southern house mosquito, *Culex quinquefasciatus*, with an acute LC_{50} of 0.31 mg a.i./kg-food (Shah *et al.,* 2016; E175414). A total of 9 definitive LC_{50} values were identified for the European honey bee, *Apis mellifera*, from 8 studies. The geometric mean LC_{50} for *A. mellifera* is 2.02 mg a.i./kg-food, but the range in LC_{50} values varies from 0.18 to 24 mg a.i./kg-bw; this maximum approaches the HC_{80} from the SSD and the minimum value approaches the HC_{05}. The 100-fold variation in LC_{50} values observed for *A. mellifera* suggests that intraspecies variability in sensitivity may contribute substantially to observed differences in LC_{50} values among species.

Table I-1. Summary of imidacloprid acute mortality endpoints for dietary exposure of terrestrial invertebrates to imidacloprid.

Statistic	SSD Endpoint (mg a.i./kg-food)
HC_{05} (95% CI)	0.064 (0.0045-0.81)
HC_{50} (95% CI)	3.48 (0.79-15.8)
Slope[1]	1.8

CI = confidence interval
[1] Geometric mean of slopes from the tests nearest the HC_{05}



FigureI-1. Species sensitivity distribution of imidacloprid acute dietary toxicity values for terrestrial invertebrates. Selected model was logistic, fit using maximum likelihood, selected based on the lowest AIC, confidence interval around the HC_{05} and visual inspection of model fit. Black points are single estimates, horizontal lines are range of endpoints.

Literature Cited

Rust *et al.,* 2004. Rust, M.; Reirson, D.; Klotz, J. (2004) Delayed Toxicity as a Critical Factor in the Efficacy of Aqueous Baits for Controlling Argentine Ants (Hymenoptera: Formicidae). Journal of Economic Entomology 97(3): 1017-1024.