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FISH AND WILDLIFE SERVICE
6578 Dogwood View Parkway, Suite A
Jackson, Mississippi 39213

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e-Memo

To: Paul Reynolds, Fire Management Officer, Sam D. Hamilton Noxubee NWR
From: Will McDearman, RCW Recovery Coordinator

Subject: Herbicide Risk Assessment for the RCW

Summary

This memorandum provides a herbicide ecological risk assessment for the effects of proposed herbicide treatments on the red-cockaded woodpecker (RCW) at Sam D. Hamilton Noxubee NWR (SDHN NWR). The analysis is provided as technical support for SDHN NWR during intraService section 7 consultation with the Mississippi Ecological Services Field Office. The proposed action is the application of 4 lbs/acre of glyphosate and, at other sites, a mix of 4 lbs/acre glyphosate and 1 lb/acre imazapyr. The purpose is to control non-native herbaceous plants, excessive young hardwoods, improve wildlife habitat, and increase RCW foraging habitat quantity and quality. The risk analysis is based on methods developed by Syracuse Environmental Research Associates for the U.S. Forest Service. RCWs are unlikely to be directly or indirectly exposed to herbicide due to the method of application using a downward spray boom from a ground sprayer. Highly conservative and unrealistic RCW dietary exposure scenarios to a diet of contaminated insects and fruits were assessed to more clearly document and evaluate toxicological risk. 24-hour acute and chronic dose exposures were calculated for a diet of 100% contaminated food items, with computation of associated hazard quotients (HQs) and hazard indices (HIs) based on reference NOAEL values. Based on the HQ and HI values for these unrealistic and conservative exposure scenarios, it is my opinion the proposed action is not likely to adversely affect the RCW.

Proposed Action

The proposed action at SDHN NWR is the controlled application of select herbicides to restore wildlife habitat. The objective is to reduce or eliminate noxious non-native plants and native vegetation at specific sites where, otherwise, the natural development of a native herbaceous plant ground cover and forest structure to benefit, for example, the endangered red-cockaded woodpecker (RCW) cannot be attained. Secondarily, the herbicide application will reduce small midstory hardwoods that are in excess of the desired midstory RCW condition specified by the recovery objective of good quality foraging habitat. The Refuge RCW management objective, in accord with the Service's 2003 RCW Recovery Plan, is to restore and provide suitable foraging habitat, while progressing toward a future objective of establishing good quality foraging habitat. Although the Recovery Plan provides specific criteria for this habitat, it is generally characterized by an open, fire-maintained pine dominated forest, without midstory encroachment of hardwoods, and a developed herbaceous plant ground layer.

Habitat for the current and future RCW population in many areas at SDHN NWR requires restoration management to reduce and eliminate excessive fire-intolerant understory hardwoods. Hardwood vegetation at certain sites has developed to larger stem sizes and heights that are not susceptible (e.g. mortality) to prescribed fire under controlled conditions without unacceptable fire risks due to historical site and management factors, including inadequate prescribed fire. Understory vegetation in this condition can only be effectively controlled and restored to the desired future condition by the application of mechanical methods and herbicides, after which prescribed fire can maintain habitat. Moreover, non-natives such as bicolor lespedeza have proliferated in a number of areas. The heavy cover of bicolor lespedeza eliminates the development of a native herbaceous plant layer that is an element of RCW good quality foraging habitat and other wildlife. Also, bicolor lespedeza is a rapid invader of additional habitat and is fire tolerant.

SDHN NWR proposes to apply glyphosate (Ranger Pro product formulation) at a rate of 4 lbs active ingredient per acre. At other select sites, a tank mix of glyphosate at the previously described rate with 32 ounces of imazapyr (Polaris AC formulation) at 1 lb active ingredient per acre will be applied. The proposed method of herbicide application is by a ground sprayer from booms less than 10 feet above the ground with downward directed foliar spray. This is not an aerial application.

Herbicide Risk Assessment

Although the proposed project will improve and restore habitat for the benefit of RCWs, the application of herbicides presents a potential toxicological risk to this species. “Risk” is the potential for adverse acute or chronic effects to the health of RCWs as a result of a toxic exposure to herbicide. A herbicide/pesticide risk assessment consists of 4 basic elements: hazard identification, dose exposure, response to exposure, and the risk characterization. For this project, the hazard is the application glyphosate and imazapyr in commercial product formulations within the proposed rates.

The frequency and amount of a particular chemical hazard for which RCWs may be exposed depends on the method of herbicide application and the potential route of exposure: ingestion (e.g. food, water, preening), dermal (e.g. skin absorption), and respiratory (e.g. inhalation). The proposed method of herbicide application is by a ground sprayer from booms less than 10 feet above the ground with downward directed foliar spray. This is not an aerial application.

RCWs forage primarily on arthropods and other invertebrates from the outer bark of live pine boles and branches in the crown (see RCW Recovery Plan for references). RCWs preferentially forage on the largest and older pines, typically ≥ 10” dbh, while avoiding or using smaller pines much less than their availability. A small portion of the RCW diet, no more than about 20 percent, occasionally may consist of plant fruits and seeds from species including wild cherry

(*Prunus serotina*), blueberry (*Vaccinium* sp.), poison ivy (*Rhus radicans*), and black gum (*Nyssa sylvatica*).

Given normal RCW foraging behavior and diet, RCWs are not likely to be directly exposed by the application of herbicides in this project. The bark of pine boles and branches subject to normal RCW foraging are above the ground layer targets of spray. Moreover, the foraging substrate on boles at or below the height of spray booms is highly unlikely to be indirectly sprayed because of the vertically directed, downward spray application. And in unusual instances of any RCWs foraging on fruits or insects at the ground level, they would flush from their position before the arrival of the slow moving tractor/dozer pulling the ground sprayer. Thus, RCWs are unlikely to be directly exposed by dermal or respiratory routes because of their normal foraging positions and flush or flight response.

Any seeds or fruits of native or other vegetation less than 10 feet in height would be sprayed. However, it is unlikely that potential RCW dietary plant seeds or fruits will be contaminated or become a significant source of dietary exposure. In addition to the minor component of plant seeds or fruits in the RCW diet, this is because the high density and cover of the selected hardwood and non-native vegetation for herbicide treatment has competitively excluded or significantly reduced the development of a native herbaceous plant stratum or with native woody plants with potential fruits in a RCW diet.

It possible that arthropods or other invertebrates originating on the forest floor may be exposed by direct spray or indirect contact with contaminated vegetation, and later move to the pine boles and limbs where they become potential RCW prey. The precise ecological relationship of the herbaceous ground cover, litter, and soil layer as a source for arthropods that move to pine trees is not well understood, but most of the arthropod biomass as potential RCW prey arrive by crawling from the forest soil and litter layer (Hanula and Franzreb 1998). The period of time such arthropods reside on the forest floor or the ground layer, where potentially exposed, relative to the period of movement to pine trees to become potential RCW prey is not known.

As an unrealistically conservative ecological risk and exposure scenario, the risk assessment data and models completed by the U.S. Forest Service for glyphosate (Syracuse Environmental Research Associates 2011, 2012) and imazapyr (Syracuse Environmental Research Associates 2011b, 2011c) were evaluated for a small bird (e.g. RCW) consuming 100 percent contaminated insect prey and plant fruits by glyphosate and imazapyr. The toxicological benchmark for evaluation was the hazard quotient (HQ) in relation to the estimated dose exposure and the NOAEL. The NOAEL is the no adverse effect level of glyphosate and imazapyr at which the dose from referenced studies was not associated with an adverse biological effect. For section 7 consultation purposes, the NOAEL is the dose exposure that is not likely to adversely affect when the HQ values are less than 1 (HQ < 1). HQs greater than one (HQ > 1) indicate a potential exposure greater than the reference acute and chronic dose at no adverse effects levels, requiring additional consideration and analysis.

Risk Model Scenario Methods

Dose exposures by the application of glyphosate and imazapyr and subsequent HQs to RCWs were evaluated by the ecological risk assessment methodologies developed by Syracuse Environmental Associates for the U.S. Forest Service. All computations were conducted on worksheets by Syracuse Environmental Associates ((http://www.fs.fed.us/foresthealth/pesticide/worksheets.shtml). Basic input for the unrealistic and highly conservative exposure scenario models consisted of the active ingredient application rate for the proposed action, at 4 lbs/acre glyphosate and 1 lb/acre imazapyr. Model scenarios represented those for a "small bird" adapted by adjusting the body weight to 0.048 kg for a typical RCW. The method and computations for ecological risk in all scenarios follow a basic procedure after entering the application rate for the following computations:

- Herbicide residue rates and concentration on insects and fruits,
- Daily dietary kilocalorie requirement for RCW, based on allometric equations for a small bird adjusted for RCW body weight,
- Caloric content (dry weight) of small insects and fruit,
- Dry weight of small insects and fruits consumed to meet daily caloric intake requirements,
- Herbicide concentration on fruit and insects immediately after application,
- Concentration of herbicide on insects and fruits based on half-life of herbicide and duration of time-weighted chronic exposure,
- Amount of herbicide ingested during 24-hour acute exposure, based on concentration on fruit and insects and amount consumed for daily caloric requirements, and
- Time-weighted amount of herbicide ingested from consumption of contaminated insects and fruit for duration of chronic dietary exposure.

Details of the exposure equations, calculations, and references are in the U.S. Forest Service Glyphosate Human Health and Ecological Risk Assessment (Syracuse Environmental Research Associates 2011), the Glyphosate Risk Assessment Worksheet Version 6.00.10 (Syracuse Environmental Associates 2012), Imazapyr Human Health and Ecological Risk Assessment (Syracuse Environmental Research Associates 2011b) and the associated Imazapyr Risk Assessment Worksheet Version 6.00.07 (Syracuse Environmental Associates 2011c) (http://www.fs.fed.us/foresthealth/pesticide/worksheets.shtml).

For each herbicide, exposure scenarios and ecological risk was evaluated for 24-hour acute exposure and chronic dietary exposure by consumption of fruit and insects. Four basic model scenarios and worksheets are provided by Syracuse Environmental Associates: glyphosate 24-hour acute exposure by consumption of small insects, glyphosate chronic exposure fruits, imazapyr 24-hour acute exposure fruit, imazapyr 24-acute insects, and imazapyr chronic dietary exposure fruit. The risk assessment worksheets also enable modifications that were used to create model scenarios for glyphosate 24-hour acute exposure fruit consumption, glyphosate chronic consumption insects, and imazapyr chronic consumption insects. For example, the basic spreadsheet scenario available for a small bird (RCW) with acute 24-hour exposure to glyphosate fundamentally provides default or automatic computations based on the data entry in root spreadsheets for the herbicide, herbicide application rate, and type of food source. Modification of the spreadsheet for other herbicides and food sources was made by entering the appropriate data values from root spreadsheets for appropriate variables. Likewise, the risk assessment spreadsheet computations for the default chronic exposure were modified for the respective herbicide and food source.

Spreadsheet modifications were made to model the 24-hour glyphosate acute exposure fruit, based on the 24-hour acute imazapyr insect methodology adjusted for the glyphosate herbicide concentration on fruit immediately after application, the dry weight caloric content of fruit, herbicide residue rates on fruit, and the amount of fruit consumed per day to meet daily dietary caloric requirements. The glyphosate scenario with chronic exposure to contaminated insects was modified from the imazapyr chronic scenario fruit by using the glyphosate concentration on insects immediately after application, glyphosate residue rates on small insects, the half-life and decay of glyphosate with the time-weighted amount of glyphosate on insects, caloric content of insects, and the amount of insects consumed per day to satisfy daily dietary caloric requirements. The imazapyr chronic consumption of insects was adapted from the glyphosate chronic dietary exposure to fruits by changing all applicable exposure equation values from glyphosate to imazapyr, in a manner as previously described .

Thus, each herbicide was assessed by 4 dose exposure model scenarios: 24-acute for insect consumption, 24 hour-acute for fruit consumption, chronic dietary exposure from insects, and chronic dietary exposure to fruits. The dose exposure for each scenario also consisted of a lower, central, and upper estimate.

The reference NOAELs for each herbicide and acute and chronic exposure scenario were derived from the reference values reported and recommended by Syracuse Environmental Associates. Each exposure scenario also included a lower, central, and upper estimate of the amount of herbicide consumed. All NOAEL values were the recommended references (Syracuse Environmental Research Associates 2011, 2011b), which the Forest Service adopted from EPA standards as derived from dietary glyphosate and imazapyr dietary exposure studies primarily with bobwhite quail and mallards.

HQs, as previously described, were computed for lower, central, and upper dose exposure estimates for each herbicide and scenario. However, the proposed action does not involve the application of imazapyr as a sole herbicide. Some sites will be treated with glyphosate only, for which the estimated exposures and HQs are reported. When imazapyr is applied, it is by a tank mix with glyphosate, although at the application rates previously described. A hazard index (HI) was computed for the combined exposure and risk of glyphosate and imazapyr. The HI is the sum of the HQs for glyphosate and imazapyr in the mix. The HI conservatively assumes that dietary exposure to glyphosate and imazapyr have similar toxic mechanisms and targets, which are additive. A HI less than 1 indicates an exposure with potential adverse consequences for additional analysis.

Results

Glyphosate

The estimated dose for dietary consumption of contaminated insects was greater than contaminated fruits for all acute and chronic exposures. For each glyphosate product formulation (less toxic and more toxic), the 24-hour acute exposure was always greater than the chronic exposure within each dietary type (e.g. insects and fruits). The lower and upper HQ estimates for all scenarios ranged from 0.005 (Scenario C, Table 1) to 1.014 (Scenario H, Table 1). The only HQ greater than 1 (HQ = 1.014) was for the upper estimate of the more toxic formulation with chronic exposure to contaminated fruit (Scenario H). By rank descending order, the greatest dose estimates were the upper estimate of the more toxic formulation with chronic exposure to fruit (1.013, Scenario H), the upper estimate for acute exposure to insects by the more toxic glyphosate formulation (0.891, Scenario B), and the chronic exposure to fruit from the less toxic product formulation (0.752, Scenario G). All other HQs were less than 0.400. None of the estimated central HQ values exceeded a value of 1, for either acute or chronic dietary exposure, which varied from 0.028 (Scenario F) to .175 (Scenario B).

Worksheet computations for the estimated acute and chronic dose exposures are tabulated in Tables 4 – 7.

Imazapyr

None of the estimated HQs were greater than 1 and, overall, were much less 1 and the HQs for glyphosate. The largest imazapyr HQ (0.0095, Scenario D, Table 2) was the upper estimate for chronic consumption of insects. Worksheet computations for each exposure scenario are in Tables 8 – 11.

Glyphosate and Imazapyr Mix

The only HI greater than 1, as for glyphosate when applied without imazapyr was by chronic consumption of contaminated small insects, with the more toxic glyphosate formulation in the mixture (HQ = 1.068, Scenario H, Table 3). Acute exposures by insect consumption and HIs were always greater for each scenario than respective chronic exposures. In contrast, HIs for chronic consumption of fruit were always greater than HIs for acute 24-hour exposure for each scenario. Because glyphosate exposure is the major dose and contributor to the HI, the relative trend in HI values resembled the same trend for glyphosate scenario HQs. By rank descending order, the greatest dose estimates were the upper estimate with the more toxic glyphosate formulation for chronic exposure to fruit (1.068, Scenario H), the upper estimate for acute exposure to insects with the more toxic glyphosate formulation in the mixture (0.939, Scenario B), and the chronic exposure to fruit with the less toxic glyphosate product formulation (0.806, Scenario G). All other HIs were less than 0.450. For all scenarios (Table 3), HIs varied from 0.002 (Scenario E, lower estimate) to the upper estimate (1.068) for Scenario H.

Discussion

The methods provided by Syracuse Environmental Research are the best available for estimating does exposure, HQs, and HIs for the proposed action. The risk assessments and worksheet computations by Syracuse Environmental Research are based on an extensive review of available toxicological studies combined with other data including herbicide residue rates, herbicide half-lives and decomposition rates, caloric requirements, and other values to estimate dose exposures relative to NOAELs. No other such assessment system is readily available for users, which was developed for the U.S. Forest Service and is available for public use.

The exposure scenarios evaluated for the proposed action are highly conservative and unrealistic because they require highly unusual and unlikely patterns of RCW foraging. Nevertheless, the exposure scenarios involving 100% of the diet by either contaminated insects or fruit were investigated to more clearly ascertain and document risks. HQs or HIs, for example, that greatly exceed a value of 1 would clearly indicate a need to further evaluate data parameters, assumptions, and more realistic risks of exposure.

As previously described, normal RCW diet does not consist of 100% fruit. And although small insects dominate RCW diet, normal RCW foraging for insects occurs on boles and branches of pines that will not be sprayed. A diet of 100% contaminated insects in these scenarios requires RCWs to forage on the ground, or primarily so, as an unexpected foraging behavior. Alternatively, all acute and chronic scenarios with contaminated insects from ground spray can be unrealistically assumed to move to trees where they become RCW prey. As an additional conservative measure, HIs were evaluated for the tank mix application of glyphosate and imazapyr assuming there was an additive toxicological interaction.

Of the 2 herbicides proposed for application, glyphosate was the greatest source of exposure, reflecting in part the greater application rate than imazapyr. The greatest 24-hour acute exposure and HQ (0.891) was the upper estimate by the glyphosate scenario B, insect consumption (Table 1). Similarly, the greatest acute HI (0.939) was for the upper estimate on application of glyphosate and imazapyr (Scenario B, Table 3), which approached a HI value of 1.0. However, these are highly exceptional scenarios that depend on RCWs foraging exlusively on contaminated insects from the ground for 24-hours immediately after herbicide application. Or alternatively, these scenarios depend on the unexpected movement of all potential insect prey from the ground within 24 hours of exposure to pine boles and branches where they are subject to RCW foraging.

The greatest chronic exposure was for the tank mix application of glyphosate and imazapyr, based on the upper estimate for dose and the HI (HI = 1.068, Scenario G, Table 3). Although this value exceeds a HQ of 1, it is also highly unlikely, as are all other estimated chronic dose exposures, HQs, and HIs. All chronic exposure scenarios require RCWs to feed entirely on contaminated insects or fruit, each day for a 90-day period of the model scenario. Thus, atypical RCW foraging behavior for chronic exposure scenarios extends for much more than a 24-hour period as simulated by acute exposure scenarios.

The 90-day chronic exposure period is the default duration for glyphosate and imazapyr chronic exposure computations and worksheets. The estimated chronic dose exposure is a time weighted estimate based on the number of days for chronic dietary consumption of contaminated fruits or seeds. The dose estimate is sensitive to the period of exposure and increases as the period decreases (Table 4). As the duration of exposure increases, the concentration of herbicide on fruit and insects decreases with decomposition, and the time weighted dose estimate for the period decreases. For example, the dose a RCW feeding entirely on 100% contaminated fruit every day for 10 days is 53.98 mg/kg bw/day with a HQ of 1.26 for the central exposure estimate (Table 4). The chronic time weighted dietary exposure for 90 days is 11.97 mg/kg bw/day and a central estimate HQ of 0.28 (Table 4). A shorter duration chronic exposure by this scenario (Table 4) is still unrealistic since it requires RCWs to feed entirely on contaminated fruit for multiple days.

A somewhat more realistic chronic exposure scenario is a diet of up to 20% contaminated fruit, with the remainder uncontaminated insects by foraging on pine boles and branches. By this scenario, a diet of up to 20% of contaminated fruit by chronic consumption for different periods of duration still produces the greatest dose estimate for the shorter duration (Table 5). However, the reduced consumption of contaminated fruit also lowers the dose exposure and HQs compared to a diet of 100% fruit, based on a NOAEL of 43 mg/kg bw/day for the more toxic glyphosate produce formulation. A RCW foraging on contaminated fruit for only a 10-day period, comprising 20% of the total diet, would have an estimated dose of 10.79 mg/kg bw/day of glyphosate with a central HQ estimate of 0.25 (Table 5). The time weighted dose estimate for a RCW feeding every day for 90 days in the same scenario is exposed with 2.39 mg/kg bw/day and a central HQ estimate of 0.06 (Table 5). The scenario is still unrealistic because it assumes that RCWs forage each day only in herbicide treated areas. The scope of the proposed action will not treat all potential foraging habitat in any RCW foraging partition. Furthermore, any fruit bearing shrubs or small diameter trees will be pushed over by the tractor pulling the sprayer, further reducing any potential fruit availability in treated sites.

Overall, the estimated HQs and HIs from acute and chronic exposures are sufficiently conservative and unrealistic to conclude the proposed action is not likely to adversely affect the RCW. The net effect of the treatments will improve RCW foraging habitat quality and quantity. Provisions should be included to prohibit the operation of mechanical spray equipment within active clusters during the breeding season to avoid potential RCW harassment.

References

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Table 1. Glyphosate hazard quotients (HQ) by unrealistically conservative model scenarios of RCW 100% dietary exposure to contaminated insects and fruit, for acute and subchronic exposure, and less toxic and more toxic glyphosate product formulations.

Model Scenario	NOAEL mg/kg bw	Exposure mg/kg bw/day	HQ
A. Less toxic formulation, 24-hour acute exposure, insects			
Central	1500	94.4	0.063
Lower	1500	9.4	0.006
Upper	1500	481.2	0.321
B. More toxic formulation, 24-hour acute exposure, insects			
Central	540	94.4	0.175
Lower	540	9.4	0.017
Upper	540	481.2	0.891
C. Less toxic formulation, 24-hour acute exposure, fruit			
Central	1500	57.4	0.038
Lower	1500	7.9	0.005
Upper	1500	209.0	0.139
D. More toxic formulation, 24-hour acute exposure, fruit			
Central	540	57.4	0.106
Lower	540	7.9	0.015
Upper	540	209.0	0.387
E. Less toxic formulation, subchronic exposure, insects			
Central	1500	15.1	0.010
Lower	1500	1.51	0.001
Upper	1500	77.0	0.051
F. More toxic formulation, subchronic exposure, insects			
Central	540	15.1	0.028
Lower	540	1.51	0.003
Upper	540	77.0	0.143
G. Less toxic formulation, subchronic exposure, fruit			
Central	58	12.0	0.207
Lower	58	1.6	0.028
Upper	58	43.6	0.752
H. More toxic formulation, subchronic exposure, fruit			
Central	43	12.0	0.279
Lower	43	1.6	0.037
Upper	43	43.6	1.014

Table 2. Imazapyr hazard quotients (HQ) by unrealistically conservative model scenarios of RCW 100% dietary exposure to contaminated fruit and insects, for acute and subchronic exposure.

Model Scenario	NOAEL mg/kg bw	Exposure mg/kg bw/day	HQ
A. 24-acute dietary exposure, 100% fruit consumption			
Central	2510	18.71	7.5×10^{-3}
Lower	2510	2.57	1.0×10^{-3}
Upper	2510	68.15	2.7×10^{-2}
B. 24-hour acute dietary exposure, 100% insects			
Central	2510	23.59	9.3×10^{-3}
Lower	2510	2.36	9.4×10^{-4}
Upper	2510	120.3	4.8×10^{-2}
C. Chronic dietary exposure, 100% fruit			
Central	610	7.9	1.3×10^{-2}
Lower	610	0.61	1.0×10^{-3}
Upper	610	32.93	5.4×10^{-2}
D. Chronic dietary exposure, 100% insects			
Central	610	9.82	1.6×10^{-2}
Lower	610	0.56	9.2×10^{-4}
Upper	610	58.14	9.5×10^{-2}

Table 3. Hazard index (HI) as an additive value of the glyphosate and imazapyr HQs, applied in a tank mix for 4 lb/acre of glyphosate and 1 lb/acre of imazapyr.

Model Scenario	Glyphosate HQ	Imazapyr HQ	HI
A. 24-hour acute exposure, insects, with less toxic glyphosate formulation in mix			
Central	0.063	0.009	0.072
Lower	0.006	0.001	0.007
Upper	0.321	0.048	0.369
B. 24-hour acute exposure, insects, with more toxic glyphosate formulation in mix			
Central	0.175	0.009	0.184
Lower	0.017	0.001	0.018
Upper	0.891	0.048	0.939
C. 24-hour acute exposure, fruit, with less toxic glyphosate formulation in mix			
Central	0.038	0.013	0.051
Lower	0.005	0.001	0.006
Upper	0.139	0.054	0.193
D. 24-hour acute exposure, fruit, with more toxic glyphosate formulation in mix			
Central	0.106	0.013	0.119
Lower	0.015	0.001	0.016
Upper	0.387	0.054	0.441
E. Chronic exposure, insects, with less toxic glyphosate formulation in mix			
Central	0.010	0.016	0.026
Lower	0.001	0.001	0.002
Upper	0.051	0.095	0.146
F. Chronic exposure, insects, with more toxic glyphosate formulation in mix			
Central	0.028	0.016	0.044
Lower	0.003	0.001	0.004
Upper	0.143	0.095	0.238
G. Chronic exposure, fruit, with less toxic glyphosate formulation in mix			
Central	0.207	0.013	0.220
Lower	0.028	0.001	0.029
Upper	0.752	0.054	0.806
H. Chronic exposure, fruit, with more toxic glyphosate formulation in mix			
Central	0.279	0.013	0.292
Lower	0.037	0.001	0.038
Upper	1.014	0.054	1.068

Table 4. Glyphosate concentration on fruit at end of time period, based on herbicide decomposition/decay rates, and chronic dietary exposure dose estimates based on time weighted dose. HQ based on a NOAEL of 43 mg/kg bw/day for the more toxic glyphosate product formulation, computed for the central dose estimate.

Time (Days)	Herbicide Concentration on Fruit at End of Time Period (mg/kg fruit)	Time Weighted Dose Estimate (mg/kg bw/day)			HQ Central Estimate
		Central	Lower	Upper	
10	14.00	53.98	7.40	196.65	1.26
20	7.00	40.49	5.45	147.49	0.94
40	1.75	25.31	3.47	92.18	0.59
60	0.44	17.71	2.43	64.52	0.41
80	0.11	13.44	1.84	48.97	0.31
90	0.05	11.97	1.64	43.61	0.28

Table 5. Glyphosate concentration on fruit at end of time period, based on a chronic diet of 20% contaminated fruit daily with herbicide decomposition/decay rates. Chronic dietary exposure dose estimates based on a time weighted dose for RCW foraging only for the duration of each time period. HQ based on a NOAEL of 43 mg/kg bw/day for the more toxic glyphosate product formulation, and computed for the central dose. Dose exposures adjusted by calculating 20% of the amount of food consumed per day (kg wet wt/day) from a diet of 100% contaminated fruit (glyphosate worksheet F12d).

Time (Days)	Herbicide Concentration on Fruit at End of Time Period (mg/kg fruit)	Time Weighted Dose Estimate (mg/kg bw/day)			HQ Central Estimate
		Central	Lower	Upper	
10	14.00	10.79	1.48	39.3	0.25
20	7.00	8.10	1.11	29.50	0.19
40	1.75	5.06	0.69	18.44	0.12
60	0.44	3.54	0.49	12.90	0.08
80	0.11	2.69	0.37	9.79	0.06
90	0.05	2.39	0.33	8.72	0.06

Table 6. Glyphosate RCW 24-acute dietary exposure worksheet, upon application of 4 lbs active ingredient/acre, with 100% diet of contaminated small insects. Derived from glyphosate exposure worksheet F09c and other associated computation sheets by Syracuse Environmental Research Associates (2012).

Consumption of Small Insects by a RCW, Acute exposure.				
Short Title	Small Insects			FdKcalV6
Receptor	RCW			
Duration	Acute			Scenario parameter
Material consumed	Small Insects			
Parameter/Assumption	**Code / Range**	**Equation/ Value**	**Units**	**Reference/Designation**
Commodity				
Concentration on consumed commodity	**Conc**			
	Central	**180**	mg/kg food wet weight	='B05b'!Acute_C
	Lower	**60**		='B05b'!Acute_L
	Upper	**540**		='B05b'!Acute_U
Receptor				
Body weight	**BW**	**0.048**	kg	Default
Allometric coefficients for caloric requirement per day in kilocalories and BW in grams				
	alpha	**3.12**		U.S. EPA/ORD 1993
	beta	**0.605**		U.S. EPA/ORD 1993
Caloric requirement per day	**KR**	= alpha x (BW x 1kg/1000g)beta		
		32.45678829	kcal/day	Eq
Caloric content of commodity (dry weight)	**KCD**	**4.3**	kcal/gdw [Note 1]	U.S. EPA/ORD 1993
Food consumed per day (dry weight)	**AmntDry**	***= KR ÷ KCD***		
		7.548090299	gdry/day	Eq
Water content of food item as a proportion	**PropWater**	**0.7**	gwater/gfood	Chapman 1998
Dry weight content of food item as a proportion	**PropDry**	***= 1-PropWater***		
		0.3	gdry/gfood	Eq
Variability in caloric requirements not accounted for by allometric equation	**Error**			
	Central	1	Note 2	
	Lower	0.3		
	Upper	1.7		
Amount of food consumed per day, wet weight	**AmntFood**	***= Error x (AmntDry ÷ PropDry) ÷ (1000g/kg)***		
	Central	*0.025160301*	kgfood/day	Eq
	Lower	*0.00754809*		Eq
	Upper	*0.042772512*		Eq
Estimate				
Dose	**Dose**	***= AmntFood × Conc / BW***		
	Central	*94.35112874*	mg/kg bw/day	Eq
	Lower	*9.435112874*		Eq
	Upper	*481.1907566*		Eq

Table 7. Glyphosate RCW 24-acute dietary exposure worksheet, upon application of 4 lbs active ingredient/acre, with 100% diet of contaminated fruit. Derived from glyphosate exposure worksheet F09c and other associated computation sheets by Syracuse Environmental Research Associates (2012).

Consumption of Fruit by a RCW, Acute exposure.				
Short Title	Acute fruit			FdKcal/ 6
Receptor	RCW			
Duration	Acute			Scenario parameter
Material consumed	Fruit			
Parameter/Assumption	**Code / Range**	**Equation/ Value**	**Units**	**Reference/Designation**
Commodity				
Concentration on consumed commodity	**Conc**			
	Central	**28**	mg/kg food wet weight	='B05a'!C28
	Lower	**12.8**		='B05a'!C29
	Upper	**60**		='B05a'!C30
Receptor				
Body weight	**BW**	**0.048**	kg	Default
Allometric coefficients for caloric requirement per day in kilocalories and BW in grams				
	alpha	**3.12**		U.S. EPA/ORD 1993
	beta	**0.605**		U.S. EPA/ORD 1993
Caloric requirement per day	**KR**	= alpha x (BW x 1kg/1000g)beta		
		32.4568	kcal/day	Eq
Caloric content of commodity (dry weight)	**KCD**	**1.1**	kcal/gdw [Note 1]	U.S. EPA/ORD 1993
Food consumed per day (dry weight)	**AmntDry**	***= KR ÷ KCD***		
		29.5062	gdry/day	Eq
Water content of food item as a proportion	**PropWater**	**0.7**	gwater/gfood	Chapman 1998
Dry weight content of food item as a proportion	**PropDry**	***= 1-PropWater***		
		0.3	gdry/gfood	Eq
Variability in caloric requirements not accounted for by allometric equation	**Error**			
	Central	1	Note 2	
	Lower	0.3		
	Upper	1.7		
Amount of food consumed per day, wet weight	**AmntFood**	***= Error x (AmntDry ÷ PropDry) ÷ (1000g/kg)***		
	Central	*0.09835*	kgfood/day	Eq
	Lower	*0.02951*		Eq
	Upper	*0.1672*		Eq
Estimate				
Dose	**Dose**	***= AmntFood × Conc / BW***		
	Central	*57.3731*	mg/kg bw/day	Eq
	Lower	*7.86831*		Eq
	Upper	*209.002*		Eq

Table 8. Glyphosate RCW chronic dietary exposure worksheet, upon application of 4 lbs active ingredient/acre, with 100% diet of contaminated fruit. Derived from glyphosate exposure worksheet F12d and other associated computation sheets by Syracuse Environmental Research Associates (2012).

Consumption of Fruit by a RCW, chronic exposure.				
Short Title	Fruit			FdKcalV6
Receptor	RCW			
Duration	Chronic			Scenario parameter
Material consumed	Fruit			
Parameter/Assumption	**Code / Range**	**Equation/ Value**	**Units**	**Reference/Designation**
Commodity				
Concentration on consumed commodity	**Conc**			
	Central	**4.479618196**	mg/kg food wet weight	='B05a'!Chronic_C
	Lower	**2.047825461**		='B05a'!Chronic_L
	Upper	**9.599181848**		='B05a'!Chronic_U
Receptor				
Body weight	**BW**	**0.048**	kg	Default
Allometric coefficients for caloric requirement per day in kilocalories and BW in grams				
	alpha	**3.12**		U.S. EPA/ORD 1993
	beta	**0.605**		U.S. EPA/ORD 1993
Caloric requirement per day	**KR**	= alpha x (BW x 1kg/1000g)beta		
		32.45678829	kcal/day	Eq
Caloric content of commodity (dry weight)	**KCD**	**1.1**	kcal/gdw [Note 1]	U.S. EPA/ORD 1993
Food consumed per day (dry weight)	**AmntDry**	***= KR ÷ KCD***		
		29.50617117	gdry/day	Eq
Water content of food item as a proportion	**PropWater**	**0.77**	gwater/gfood	U.S. EPA/ORD 1993
Dry weight content of food item as a proportion	**PropDry**	***= 1-PropWater***		
		0.23	gdry/gfood	Eq
Variability in caloric requirements not accounted for by allometric equation	**Error**			
	Central	1	Note 2	
	Lower	0.3		
	Upper	1.7		
Amount of food consumed per day, wet weight	**AmntFood**	***= Error x (AmntDry ÷ PropDry) ÷ (1000g/kg)***		
	Central	*0.128287701*	kgfood/day	Eq
	Lower	*0.03848631*		Eq
	Upper	*0.218089091*		Eq
Estimate				
Dose	**Dose**	***= AmntFood × Conc / BW***		
	Central	*11.9724983*	mg/kg bw/day	Eq
	Lower	*1.641942624*		Eq
	Upper	*43.61410095*		Eq

Table 9. Glyphosate RCW chronic dietary exposure worksheet, upon application of 4 lbs active ingredient/acre, with 100% diet of contaminated insects. Derived from glyphosate exposure worksheet F12d and other associated computation sheets by Syracuse Environmental Research Associates (2012).

Consumption of contaminated insects by a RCW, chronic exposure.				
Short Title	Chronic insects			FdKcalV6
Receptor	RCW			
Duration	Chronic			Scenario parameter
Material consumed	Insects			
Parameter/Assumption	**Code / Range**	**Equation/ Value**	**Units**	**Reference/Designation**
Commodity				
Concentration on consumed commodity	**Conc**			
	Central	**28.8**	mg/kg food wet weight	='B05b'! C49
	Lower	**9.6**		='B05b'! C50
	Upper	**86.4**		='B05b'! C51
Receptor				
Body weight	**BW**	**0.048**	kg	Default
Allometric coefficients for caloric requirement per day in kilocalories and BW in grams				
	alpha	**3.12**		U.S. EPA/ORD 1993
	beta	**0.605**		U.S. EPA/ORD 1993
Caloric requirement per day	**KR**	= alpha x (BW x 1kg/1000g)beta		
		32.4568	kcal/day	Eq
Caloric content of commodity (dry weight)	**KCD**	**4.3**	kcal/gdw [Note 1]	U.S. EPA/ORD 1993
Food consumed per day (dry weight)	**AmntDry**	***= KR ÷ KCD***		
		7.54809	gdry/day	Eq
Water content of food item as a proportion	**PropWater**	**0.7**	gwater/gfood	U.S. EPA/ORD 1993
Dry weight content of food item as a	**PropDry**	***= 1-PropWater***		
		0.3	gdry/gfood	Eq
Variability in caloric requirements not accounted for by allometric equation	**Error**			
	Central	1	Note 2	
	Lower	0.3		
	Upper	1.7		
Amount of food consumed per day, wet weight	**AmntFood**	***= Error x (AmntDry ÷ PropDry) ÷ (1000g/kg)***		
	Central	*0.02516*	kgfood/day	Eq
	Lower	*0.00755*		Eq
	Upper	*0.04277*		Eq
Estimate				
Dose	**Dose**	***= AmntFood × Conc / BW***		
	Central	*15.0962*	mg/kg bw/day	Eq
	Lower	*1.50962*		Eq
	Upper	*76.9905*		Eq

Table 10. Imazapyr RCW 24-acute dietary exposure worksheet, upon application of 1 lb active ingredient/acre, with 100% diet of fruit. Derived from imazapyr exposure worksheet F04d and other associated computation sheets by Syracuse Environmental Research Associates (2011c).

Consumption of Fruit by a RCW, acute exposure.				
Short Title	Fruit			FdKcalV6
Receptor	RCW			
Duration	Acute			Scenario parameter
Material consumed	Fruit			
Parameter/Assumption	**Code / Range**	**Equation/ Value**	**Units**	**Reference/Designation**
Commodity				
Concentration on consumed commodity	**Conc**			
	Central	**7**	mg/kg food wet weight	='B05a'!Acute_C
	Lower	**3.2**		='B05a'!Acute_L
	Upper	**15**		='B05a'!Acute_U
Receptor				
Body weight	**BW**	**0.048**	kg	Default
Allometric coefficients for caloric requirement per day in kilocalories and BW in grams				
	alpha	**3.12**		U.S. EPA/ORD 1993
	beta	**0.605**		U.S. EPA/ORD 1993
Caloric requirement per day	**KR**	= alpha x (BW x 1kg/1000g)beta		
		32.45678829	kcal/day	Eq
Caloric content of commodity (dry weight)	**KCD**	1.1	kcal/gdw [Note 1]	WkMk Documentation
Food consumed per day (dry weight)	**AmntDry**	***= KR ÷ KCD***		
		29.50617117	gdry/day	Eq
Water content of vegetation as a proportion	**PropWater**	0.77	gwater/gfood	WkMk Documentation
Dry weight content of vegetation as a proportion	**PropDry**	***= 1-PropWater***		
		0.23	gdry/gfood	Eq
Variability in caloric requirements not accounted for by allometric equation	**Error**			
	Central	1	Note 2	
	Lower	0.3		
	Upper	1.7		
Amount of food consumed per day, wet weight	**AmntFood**	***= (AmntDry ÷ PropDry) ÷ (1000g/kg)***		
	Central	*0.128287701*	kgfood/day	Eq
	Lower	*0.03848631*		Eq
	Upper	*0.218089091*		Eq
Estimate				
Dose	**Dose**	***= AmntFood × Conc / BW***		
	Central	*18.70862302*	mg/kg bw/day	Eq
	Lower	*2.565754015*		Eq
	Upper	*68.15284101*		Eq

Table 11. Imazapyr RCW 24-acute dietary exposure worksheet, upon application of 1 lb active ingredient/acre, with 100% diet of insects. Derived from imazapyr exposure worksheet F07c and other associated computation sheets by Syracuse Environmental Research Associates (2011c).

Consumption of Small Insects by a RCW, acute exposure.				
Short Title	Small Insects			FdKcalV6
Receptor	RCW			
Duration	Acute			Scenario parameter
Material consumed	Small Insects			
Parameter/Assumption	**Code / Range**	**Equation/ Value**	**Units**	**Reference/Designation**
Commodity				
Concentration on consumed commodity	**Conc**			
	Central	**45**	mg/kg food wet weight	='B05b'!Acute_C
	Lower	**15**		='B05b'!Acute_L
	Upper	**135**		='B05b'!Acute_U
Receptor				
Body weight	**BW**	**0.048**	kg	Default
Allometric coefficients for caloric requirement per day in kilocalories and BW in grams				
	alpha	**3.12**		U.S. EPA/ORD 1993
	beta	**0.605**		U.S. EPA/ORD 1993
Caloric requirement per day	**KR**	= alpha x (BW x 1kg/1000g)beta		
		32.45679	kcal/day	Eq
Caloric content of commodity (dry weight)	**KCD**	4.3	kcal/gdw [Note 1]	WkMk Documentation
Food consumed per day (dry weight)	**AmntDry**	***= KR ÷ KCD***		
		7.54809	gdry/day	Eq
Water content of vegetation as a proportion	**PropWater**	0.7	gwater/gfood	WkMk Documentation
Dry weight content of vegetation as a	**PropDry**	***= 1-PropWater***		
		0.3	gdry/gfood	Eq
Variability in caloric requirements not accounted for by allometric equation	**Error**			
	Central	1	Note 2	
	Lower	0.3		
	Upper	1.7		
Amount of food consumed per day, wet weight	**AmntFood**	***= (AmntDry ÷ PropDry) ÷ (1000g/kg)***		
	Central	*0.02516*	kgfood/day	Eq
	Lower	*0.007548*		Eq
	Upper	*0.042773*		Eq
Estimate				
Dose	**Dose**	***= AmntFood × Conc / BW***		
	Central	*23.58778*	mg/kg bw/day	Eq
	Lower	*2.358778*		Eq
	Upper	*120.2977*		Eq

Table 12. Imazapyr RCW chronic dietary exposure worksheet, upon application of 1 lb active ingredient/acre, with 100% diet of fruit. Derived from imazapyr exposure worksheet F10d and other associated computation sheets by Syracuse Environmental Research Associates (2011c).

Consumption of Fruit by a RCW, chronic exposure.				
Short Title	Fruit Chronic			FdKcalV6
Receptor	RCW			
Duration	Chronic			Scenario parameter
Material consumed	Fruit			
Parameter/Assumption	**Code / Range**	**Equation/ Value**	**Units**	**Reference/Designation**
Commodity				
Concentration on consumed commodity	**Conc**			
	Central	**2.9455**	mg/kg food wet weight	='B05a'!Chronic_C
	Lower	**0.7574**		='B05a'!Chronic_L
	Upper	**7.2485**		='B05a'!Chronic_U
Receptor				
Body weight	**BW**	**0.048**	kg	Default
Allometric coefficients for caloric requirement per day in kilocalories and BW in grams				
	alpha	**3.12**		U.S. EPA/ORD 1993
	beta	**0.605**		U.S. EPA/ORD 1993
Caloric requirement per day	**KR**	= alpha x (BW x 1kg/1000g)beta		
		32.457	kcal/day	Eq
Caloric content of commodity (dry weight)	**KCD**	1.1	kcal/gdw [Note 1]	WkMk Documentation
Food consumed per day (dry weight)	**AmntDry**	***= KR ÷ KCD***		
		29.506	gdry/day	Eq
Water content of vegetation as a proportion	**PropWater**	0.77	gwater/gfood	WkMk Documentation
Dry weight content of vegetation as a ...	**PropDry**	***= 1-PropWater***		
		0.23	gdry/gfood	Eq
Variability in caloric requirements not accounted for by allometric equation	**Error**			
	Central	1	Note 2	
	Lower	0.3		
	Upper	1.7		
Amount of food consumed per day, wet weight	**AmntFood**	***= (AmntDry ÷ PropDry) ÷ (1000g/kg)***		
	Central	*0.1283*	kgfood/day	Eq
	Lower	*0.0385*		Eq
	Upper	*0.2181*		Eq
Estimate				
Dose	**Dose**	***= AmntFood × Conc / BW***		
	Central	*7.8723*	mg/kg bw/day	Eq
	Lower	*0.6073*		Eq
	Upper	*32.934*		Eq

Table 13. Imazapyr RCW chronic dietary exposure worksheet, upon application of 1 lb active ingredient/acre, with 100% contaminated diet of insects. Derived from imazapyr exposure worksheet F10d, B05d, and other associated computation sheets by Syracuse Environmental Research Associates (2011c).

Consumption of insects by a RCW, chronic exposure.				
Short Title	Insects chronic imazapyr			FdKcalV6
Receptor	RCW			
Duration	Chronic			Scenario parameter
Material consumed	Insects			
Parameter/Assumption	**Code / Range**	**Equation/ Value**	**Units**	**Reference/Designation**
Commodity				
Concentration on consumed commodity	**Conc**			
	Central	**18.74**	mg/kg food wet weight	='B05b'! C50
	Lower	**3.55**		='B05b'! C51
	Upper	**65.24**		='B05b'! C52
Receptor				
Body weight	**BW**	**0.048**	kg	Default
Allometric coefficients for caloric requirement per day in kilocalories and BW in grams				
	alpha	**3.12**		U.S. EPA/ORD 1993
	beta	**0.605**		U.S. EPA/ORD 1993
Caloric requirement per day	**KR**	= alpha x (BW x 1kg/1000g)beta		
		32.4568	kcal/day	Eq
Caloric content of commodity (dry weight)	**KCD**	4.3	kcal/gdw [Note 1]	WkMk Documentation
Food consumed per day (dry weight)	**AmntDry**	***= KR ÷ KCD***		
		7.54809	gdry/day	Eq
Water content of vegetation as a proportion	**PropWater**	0.7	gwater/gfood	WkMk Documentation
Dry weight content of vegetation as a	**PropDry**	***= 1-PropWater***		
		0.3	gdry/gfood	Eq
Variability in caloric requirements not accounted for by allometric equation	**Error**			
	Central	1	Note 2	
	Lower	0.3		
	Upper	1.7		
Amount of food consumed per day, wet weight	**AmntFood**	***= (AmntDry ÷ PropDry) ÷ (1000g/kg)***		
	Central	*0.02516*	kgfood/day	Eq
	Lower	*0.00755*		Eq
	Upper	*0.04277*		Eq
Estimate				
Dose	**Dose**	***= AmntFood × Conc / BW***		
	Central	*9.823*	mg/kg bw/day	Eq
	Lower	*0.55824*		Eq
	Upper	*58.135*		Eq

Table 14. Estimated concentration of glyphosate on contaminated fruit, from glyphosate worksheet B05a.

Concentration of Glyphosate in Contaminated Fruit				
Short Title	Concentration in food item			FoodConcV6
Material consumed		Fruit		Scenario parameter
Parameter/Assumption	**Code / Range**	**Equation/ Value**	**Units**	**Reference/Designation**
Application Information				
Application Rate (lbs/acre)	**ApRt**	**4**	lb/acre	Worksheet A01
Number of applications	**n**	**1**	unitless	Worksheet A01
Interval between applications	**intv**	**1**	days	Worksheet A01
Special Adjustments (See Note 1)				
Metabolite Adjustment Factor : (See risk assessment if this has a value other than 1.)	**MetFact**			
	Central	1	unitless	Default
	Lower	1		Default
	Upper	1		Default
Toxic Equivalency Factor for formulation: (See risk assessment if this has a value other than 1.)	**TEF**			
	Central	**1**	Unitless	Worksheet A01
	Lower	**1**		Worksheet A01
	Upper	**1**		Worksheet A01
Acute Concentrations				
Residue Rates	**rr**			
	Central	**7**	mg/kg food per lb/acre	Worksheet A01
	Lower	**3.2**		Worksheet A01
	Upper	**15**		Worksheet A01
Drift	**Drift**			
	Central	**1**	proportion	Worksheet A01
	Lower	**1**		Worksheet A01
	Upper	**1**		Worksheet A01
Concentration on commodity immediately after first application.	**C_0**	***ApR × rr × Drift × MetFact × TEF***		
	Central	*28*		Eq
	Lower	*12.8*		Eq
	Upper	*60*		Eq
Half-life on commodity	**Halflife**			
	Central	**10**	Days	Section 3.2.3.6
	Lower	**10**		Section 3.2.3.6
	Upper	**10**		Section 3.2.3.6
Decay Coefficient	**k**	***Ln(2)/Halflife***		
	Central	*0.0693*	$Days^{-1}$	Eq
	Upper	*0.0693*	Note 2	Eq
	Lower	*0.0693*	Note 2	Eq
Proportion remaining at end of each application interval	**p**	***exp(-k × intv)***		
	Central	*0.933*	proportion	Eq
	Lower	*0.933*		Eq
	Upper	*0.933*		Eq
Concentration on commodity immediately after last application.	**C_n**	$C_n = C_0 \times (1-p^n) \div (1-p)$		
	Central	*28*	mg/kg food item	Eq
	Lower	*12.8*		Eq
	Upper	*60*		Eq
Longer-term Concentrations				
Duration for time-weighted average exposure	**T**	**90**	Days	Worksheet A01
Time-weighted average concentration on commodity over time, T, after the last application.	**$Conc_{TWA}$**	$C_n \times (1-e^{-kT}) \div (k\,T)$		
	Central	*4.4796*	mg/kg food item	Eq
	Lower	*2.0478*		Eq
	Upper	*9.5992*		Eq
Maximum Time-weighted average concentration on commodity over time, T.	**$Conc_{TWA}$**	***See Documentation***		
	Central	*4.4796*	mg/kg food item	Eq
	Lower	*2.0478*		Eq
	Upper	*9.5992*		Eq

Table 15. Concentration of glyphosate on small insects, from glyphosate worksheet B05b.

Concentration of Glyphosate on Contaminated Small Insects				
Short Title		Concentration in food item		FoodConcV6
Material consumed		Small Insects		Scenario parameter
Parameter/Assumption	**Code / Range**	**Equation/ Value**	**Units**	**Reference/Designation**
Application Information				
Application Rate (lbs/acre)	**ApRt**	**4**	lb/acre	Worksheet A01
Number of applications	**n**	**1**	unitless	Worksheet A01
Interval between applications	**intv**	**1**	days	Worksheet A01
Special Adjustments (See Note 1)				
Metabolite Adjustment Factor : (See risk assessment if this has a value other than 1.)	**MetFact**			
	Central	1	unitless	Default
	Lower	1		Default
	Upper	1		Default
Toxic Equivalency Factor for formulation: (See risk assessment if this has a value other than 1.)	**TEF**			
	Central	**1**	Unitless	Worksheet A01
	Lower	**1**		Worksheet A01
	Upper	**1**		Worksheet A01
Acute Concentrations				
Residue Rates	**rr**			
	Central	**45**	mg/kg food per lb/acre	Worksheet A01
	Lower	**15**		Worksheet A01
	Upper	**135**		Worksheet A01
Drift	**Drift**			
	Central	**1**	proportion	Worksheet A01
	Lower	**1**		Worksheet A01
	Upper	**1**		Worksheet A01
Concentration on commodity immediately after first application.	**C_0**	***ApR × rr × Drift × MetFact × TEF***		
	Central	*180*		Eq
	Lower	*60*		Eq
	Upper	*540*		Eq
Half-life on commodity	**Halflife**			
	Central	**10**	Days	Section 3.2.3.6
	Lower	**10**		Section 3.2.3.6
	Upper	**10**		Section 3.2.3.6
Decay Coefficient	**k**	***Ln(2)/Halflife***		
	Central	*0.06931*	$Days^{-1}$	Eq
	Upper	*0.06931*	Note 2	Eq
	Lower	*0.06931*	Note 2	Eq
Proportion remaining at end of each application interval	**p**	***exp(-k × intv)***		
	Central	*0.93303*	proportion	Eq
	Lower	*0.93303*		Eq
	Upper	*0.93303*		Eq
Concentration on commodity immediately after last application.	**C_n**	$C_n = C_0 \times (1- p^n) \div (1- p)$		
	Central	*180*	mg/kg food item	Eq
	Lower	*60*		Eq
	Upper	*540*		Eq
Longer-term Concentrations				
Duration for time-weighted average exposure	**T**	**90**	Days	Worksheet A01
Time-weighted average concentration on commodity over time, T, after the last application.	**$Conc_{TWA}$**	$C_n \times (1-e^{-kT}) \div (k\ T)$		
	Central	*28.7975*	mg/kg food item	Eq
	Lower	*9.59918*		Eq
	Upper	*86.3926*		Eq
Maximum Time-weighted average concentration on commodity over time, T.	**$Conc_{TWA}$**	***See Documentation***		
	Central	*28.7975*	mg/kg food item	Eq
	Lower	*9.59918*		Eq
	Upper	*86.3926*		Eq

Table 16. Imazapyr concentration in contaminated fruit, from imazapyr worksheet B05a.

Concentration of Imazapyr in Contaminated Fruit				
Short Title		Concentration in food item		FoodConcV6
Material consumed		Fruit		Scenario parameter
Parameter/Assumption	**Code / Range**	**Equation / Value**	**Units**	**Reference/Designation**
Application Information				
Application Rate (lbs/acre)	**ApRt**	**1**	lb/acre	Worksheet A01
Number of applications	**n**	**1**	unitless	Worksheet A01
Interval between applications	**intv**	**1**	days	Worksheet A01
Special Adjustments (See Note 1)				
Metabolite Adjustment Factor : (See risk assessment if this has a value other than 1.)	**MetFact**			
	Central	1	unitless	Default
	Lower	1		Default
	Upper	1		Default
Toxic Equivalency Factor for formulation: (See risk assessment if this has a value other than 1.)	**TEF**			
	Central	**1**	Unitless	Worksheet A01
	Lower	**1**		Worksheet A01
	Upper	**1**		Worksheet A01
Acute Concentrations				
Residue Rates	**rr**			
	Central	**7**	mg/kg food per lb/acre	Worksheet A01
	Lower	**3.2**		Worksheet A01
	Upper	**15**		Worksheet A01
Drift	**Drift**			
	Central	**1**	proportion	Worksheet A01
	Lower	**1**		Worksheet A01
	Upper	**1**		Worksheet A01
Concentration on commodity immediately after first application.	**C_0**	***ApR × rr × Drift × MetFact × TEF***		
	Central	*7*		Eq
	Lower	*3.2*		Eq
	Upper	*15*		Eq
Half-life on commodity	**Halflife**			
	Central	**30**	Days	Section 3.2.3.6
	Lower	**15**		Section 3.2.3.6
	Upper	**37**		Section 3.2.3.6
Decay Coefficient	**k**	***Ln(2)/Halflife***		
	Central	*0.0231*	$Days^{-1}$	Eq
	Upper	*0.0462*	Note 2	Eq
	Lower	*0.0187*	Note 2	Eq
Proportion remaining at end of each application interval	**p**	***exp(-k × intv)***		
	Central	*0.9772*	proportion	Eq
	Lower	*0.9548*		Eq
	Upper	*0.9814*		Eq
Concentration on commodity immediately after last application.	**C_n**	$C_n = C_0 \times (1- p^n) \div (1- p)$		
	Central	*7*	mg/kg food item	Eq
	Lower	*3.2*		Eq
	Upper	*15*		Eq
Longer-term Concentrations				
Duration for time-weighted average exposure	**T**	**90**	Days	Worksheet A01
Time-weighted average concentration on commodity over time, T, after the last application.	**$Conc_{TWA}$**	$C_n \times (1-e^{-kT}) \div (k\ T)$		
	Central	*2.9455*	mg/kg food item	Eq
	Lower	*0.7574*		Eq
	Upper	*7.2485*		Eq
Maximum Time-weighted average concentration on commodity over time, T.	**$Conc_{TWA}$**	***See Documentation***		
	Central	*2.9455*	mg/kg food item	Eq
	Lower	*0.7574*		Eq
	Upper	*7.2485*		Eq

Table 17. Imazapyr concentration in contaminated small insects, from imazapyr worksheet B05b.

Concentration of Imazapyr in Contaminated Small Insects				
Short Title	Concentration in food item			FoodConcV6
Material consumed	Small Insects			Scenario parameter
Parameter/Assumption	**Code / Range**	**Equation / Value**	**Units**	**Reference/Designation**
Application Information				
Application Rate (lbs/acre	**ApRt**	**1**	lb/acre	Worksheet A01
Number of applications	**n**	**1**	unitless	Worksheet A01
Interval between applications	**intv**	**1**	days	Worksheet A01
Special Adjustments (See Note 1)				
Metabolite Adjustment Factor : (See risk assessment if this has a value other than 1.)	**MetFact**			
	Central	1	unitless	Default
	Lower	1		Default
	Upper	1		Default
Toxic Equivalency Factor for formulation: (See risk assessment if this has a value other than 1.)	**TEF**			
	Central	**1**	Unitless	Worksheet A01
	Lower	**1**		Worksheet A01
	Upper	**1**		Worksheet A01
Acute Concentrations				
Residue Rates	**rr**			
	Central	**45**	mg/kg food per lb/acre	Worksheet A01
	Lower	**15**		Worksheet A01
	Upper	**135**		Worksheet A01
Drift	**Drift**			
	Central	**1**	proportion	Worksheet A01
	Lower	**1**		Worksheet A01
	Upper	**1**		Worksheet A01
Concentration on commodity immediately after first application.	C_0	***ApR × rr × Drift × MetFact × TEF***		
	Central	*45*		Eq
	Lower	*15*		Eq
	Upper	*135*		Eq
Half-life on commodity	**Halflife**			
	Central	**30**	Days	Section 3.2.3.6
	Lower	**15**		Section 3.2.3.6
	Upper	**37**		Section 3.2.3.6
Decay Coefficient	**k**	***Ln(2)/Halflife***		
	Central	*0.0231*	$Days^{-1}$	Eq
	Upper	*0.0462*	Note 2	Eq
	Lower	*0.0187*	Note 2	Eq
Proportion remaining at end of each application interval	**p**	***exp(-k × intv)***		
	Central	*0.9772*	proportion	Eq
	Lower	*0.9548*		Eq
	Upper	*0.9814*		Eq
Concentration on commodity immediately after last application.	C_n	$C_n = C_0 \times (1- p^n) \div (1- p)$		
	Central	*45*	mg/kg food item	Eq
	Lower	*15*		Eq
	Upper	*135*		Eq
Longer-term Concentrations				
Duration for time-weighted average exposure	**T**	**90**	Days	Worksheet A01
Time-weighted average concentration on commodity over time, T, after the last application.	$Conc_{TWA}$	$C_n \times (1-e^{-kT}) \div (k\ T)$		
	Central	*18.935*	mg/kg food item	Eq
	Lower	*3.5504*		Eq
	Upper	*65.236*		Eq
Maximum Time-weighted average concentration on commodity over time, T.	$Conc_{TWA}$	***See Documentation***		
	Central	*18.935*	mg/kg food item	Eq
	Lower	*3.5504*		Eq
	Upper	*65.236*		Eq