EXHIBIT 29

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

Date: December 16, 2010
Chemical: Flubendiamide
PC Code: 027602
Barcodes: D376460, D376101, and D376102
Decision # 426760

MEMORANDUM

SUBJECT: Ecological Risk Assessment for the New Use of Flubendiamide on Alfalfa, Globe Artichoke, Low Growing Berry Subgroup (Except Cranberry), Peanut, Pistachio, Small Fruit Vine Climbing Subgroup (Except Fuzzy Kiwi Fruit), Sorghum, Sugarcane, Sunflower, Safflower and Turnip Greens, and Rate Increase on Brassica Leafy Vegetables

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TO: Richard Gebken, Risk Manager
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Registration Division (7505P)

The Environmental Fate and Effects Division (EFED) has completed the request from the Registration Division to provide an ecological risk assessment in support of the new use registration of the insecticide flubendiamide on alfalfa, globe artichoke, low growing berries (except cranberry), peanut, pistachio, small fruit vine climbing (except fuzzy kiwifruit), sorghum, sugarcane, sunflower, safflower, turnip greens and the proposed increased application rate on brassica leafy vegetables. The proposed new uses and increased rate include the formulations SYNAPSE™ WG (39%), a water dispersible granule formulation, and BELT™ SC (24% ai), a suspension concentrate formulation. The single maximum and seasonal maximum application rate for the proposed SYNAPSE™ WG new uses and rate increase are 0.075 and 0.225 lbs a.i./A, respectively; for the proposed BELT™ SC new uses, these rates are 0.125 and

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0.375 lbs a.i./A, respectively. Flubendiamide is proposed for ground, aerial (restricted for pistachio, and small fruit vine climbing group), and chemigation, and is re-applied at intervals of 3-7 days with the exception of alfalfa; It is assumed that the minimum efficacious application to alfalfa is 30 days due to the timing of cuttings. Flubendiamide toxicity in target pests occurs via larval ingestion of toxic residues on plants. Thus, these formulations are to be applied thoroughly to cover all plant parts coinciding with early threshold levels in developing larval populations.

Conclusions – Exposure Assessment

The major transformation product resulting from the environmental degradation of flubendiamide is the degradate, NN1-0001-des-iodo (referred to as des-iodo). Toxicity data on chronic freshwater invertebrates indicate that des-iodo is of similar toxicity to the parent flubendiamide. Ecotoxicity data on freshwater invertebrates also indicate that the SYNAPSE™ WG and BELT™ SC formulations are more toxic than the parent flubendiamide. Two different aquatic exposure estimates are thus calculated for applications of flubendiamide: the total residues of flubendiamide and des-iodo, based on contributions from runoff, spray drift, and erosion, and the formulations, based on contributions solely from spray drift. Terrestrial exposure estimates are based on the residue levels of flubendiamide alone. Fate data demonstrate flubendiamide is relatively stable to aerobic soil metabolism, decreasing less than 3% during 120 days of incubation; des-iodo formation was less than 2% of the applied (MRID 46816910). Based on the predominance of the parent, an exposure assessment based on flubendiamide residues only is appropriate for the terrestrial environment.

Conclusions – Risk Characterization

Aquatic Organisms:

Available data demonstrate that acute and chronic toxicity of flubendiamide to freshwater and estuarine/marine fish is limited by solubility. However, no data is available on the toxicity of the degradate to these same taxa. Based on lack of toxicity data on the des-iodo degradate, risk to freshwater and estuarine/marine fish from flubendiamide applications cannot be precluded. Unless data is generated that refutes the assumption of equal toxicity between flubendiamide and the degradate, acute and chronic toxicity to freshwater and estuarine/marine fish is presumed from exposure to the total residues of flubendiamide and the degradate-des-iodo.

No effects to freshwater fish resulted from acute exposure to the BELT™ SC formulation up to flubendiamide's limit of solubility. Risk to freshwater fish from exposure to the SC formulation is not expected. Risk to estuarine/marine fish from exposure to the WG formulation cannot be precluded.

No acute risk is expected to freshwater invertebrates from exposures to the total residues of flubendiamide and des-iodo degradate because toxicity is limited by solubility; however, due to the lack of toxicity data on the des-iodo degradate, acute risk is presumed for estuarine/marine invertebrates from exposures to the total residues of flubendiamide and des-iodo degradate.

There is chronic risk to freshwater invertebrates from exposures in the water column and pore water from the total residues of flubendiamide and des-iodo. Due to the lack of data on the des-iodo degradate, chronic risk to estuarine/marine invertebrates is presumed.

Applications of flubendiamide have the potential to adversely affect freshwater and estuarine/marine invertebrates from spray drift exposure to the formulations SC and WG. Chronic risk to freshwater and estuarine/marine invertebrates from exposure to flubendiamide formulations is not expected.

Based on lack of toxicity data on the des-iodo degradate, risk of the total residues of flubendiamide and des-iodo to aquatic vascular and nonvascular plants cannot be precluded; however, risk to aquatic plants from direct exposure to flubendiamide's formulations is expected to be minimal.

Terrestrial Organisms:

This chemical was designed to be effective against several Lepidoptera pests, but safe for beneficial natural predators of Lepidoptera so it could be used in integrated pest management (IPM) programs (Tohnishi *et al* 2005). The available data indicate there are effects on mortality to adult ladybird beetles due to ingestion of food items (aphids and pollen) containing flubendiamide residues at environmentally relevant concentrations of flubendiamide. No effects at environmentally relevant concentrations of flubendiamide's proposed uses were reported for larval ladybird beetle, parasitoid wasp, predatory mite, or green lacewing. Temporary effects on brood development was observed in honey bees exposed to flubendiamide, but recovery occurred by the end of the study. Because terrestrial invertebrates demonstrate a spectrum of sensitivity to flubendiamide at environmentally relevant exposures, this assessment concludes that terrestrial invertebrates, including Lepidoptera predators, are at risk from flubendiamide exposures.

Based on a screening assessment for flubendiamide's proposed new uses and new use rate, potential acute and chronic risk to birds and mammals is not expected. Risk quotients were calculated for chronic exposures to birds and were below the level of concern for all uses of flubendiamide. No effects were observed in vegetative vigor and seedling emergence toxicity studies conducted at levels exceeding the proposed single maximum application rates for the SC and WG formulations; As such, risks to listed and non-listed terrestrial plants are expected to be minimal.

Uncertainties and Data Gaps

The following uncertainties, limitations, and assumptions were identified in this environmental risk assessment:

Ecotoxicity

Acceptable acute avian oral toxicity data were submitted for exposures of bobwhite quail to flubendiamide; however, data are not available for passerines, which are required under the new 40 CFR Part 158 (Oct. 26, 2007) data requirements for conventional pesticides (72 FR 60934;

USEPA 2007*d*). The new Part 158 data requirements specify that avian acute oral toxicity data (OCSPP Guideline 850.2100) be submitted for either a mallard duck or bobwhite quail and a passerine species. Due to lack of reported toxicity in mallard duck and bobwhite quail to flubendiamide technical on an acute oral and subacute dietary exposure basis (MRIDs 46817003, 46817005, and 46817006), significant acute oral effects to passerines are not expected. Unless new information suggests passerines might be sensitive to flubendiamide, EFED will not otherwise (*i.e.* in the absence of data) assume acute risk for passerine species.

Registrant-submitted toxicity test results indicate that both the Synapse and Belt formulations are more toxic than the technical-grade active ingredient (TGAI) on an acute basis to freshwater invertebrates. No toxicity data have been submitted that evaluated the effects of the formulated products on marine/estuarine organisms. Therefore, the potential for acute risk to estuarine/marine invertebrates cannot be precluded based on exposure to the formulated products of flubendiamide. However, submittal of an estuarine/marine acute toxicity invertebrate study testing the formulated products in accordance with the guideline requirements would reduce the uncertainty regarding potential toxicity of the formulations to marine/estuarine invertebrates.

Two 28-day chronic toxicity studies indicate that flubendiamide and its des-iodo degradate are toxic to the midge, *Chironomus riparius*, in an overlying-water spiked system (MRID 46817022, MRID 46817023, respectively). Based on the RQs calculated from these studies' endpoints, there is a potential for direct effects to benthic invertebrates exposed to the parent and degradate. Neither of the two chronic toxicity midge studies followed sediment toxicity guidelines which require the sediment to be spiked as opposed to the overlying water. The mean measured pore water concentrations demonstrated in the study along with the available mesocosm data may provide sufficient evidence regarding the potential risk to benthic invertebrates. Additionally, a prolonged sediment test with *Chironomus riparius* using spiked sediment is available (MRID 48175605) but is currently under review. Thus, no new sediment toxicity data are requested at this time.

The current assessment assumes equal toxicity to flubendiamide and des-iodo degradate based on two spiked overlying-water benthic organism toxicity studies (MRID 46817022, MRID 46817023, respectively). As such, the assessment presumes risk to freshwater and estuarine/marine fish based on lack of toxicity data on the des-iodo degradate. However, there is uncertainty with the exposure concentrations in the benthic organism studies and thus uncertainty with the presumption of equal toxicity. Currently, toxic effects of flubendiamide have been demonstrated in the pelagic freshwater invertebrate, *Daphnia magna*; submittal of a chronic toxicity study of des-iodo using *Daphnia magna* would allow a comparison of toxicity between the parent and degradate and would reduce uncertainty with risk calls based on lack of data.

Fate

<u>Flubendiamide</u>
(Non-guideline) **Vegetative filter strip and vegetative buffer strip studies** – EFED is currently reviewing the submitted vegetative filter strip (MRID 48175806) and vegetative buffer strip (MRID 48175602) run-off studies. The studies were requested to determine the magnitude of the parent, flubendiamide, retained in buffer and filter strips of various widths. EFED believes

that the efficacy of buffer and filter strips for flubendiamide use is uncertain due the potential build up of both the parent and des-iodo in the strips with successive, yearly applications.

Des-iodo Degradate
(835.2120) **Hydrolysis** – The hydrolysis study is requested to establish the significance of chemical hydrolysis as a route of degradation for NNI-0001-des-iodo and to identify, if possible, the hydrolytic products formed which may adversely affect non-target organisms.

(835.2240) **Photodegradation in Water** – Pesticides introduced into aqueous systems in the environment can undergo photolytic transformation by sunlight. Data on rates of photolysis are needed to establish the importance of this transformation process and the persistence characteristics of the photoproducts formed.

(835.4400) **Anaerobic Aquatic Metabolism** – The anaerobic aquatic metabolism is needed to assess the effects, the nature, and extent of formation of NNI-0001-des-iodo residues in water and in hydrosoil since anaerobic conditions are more likely to exist in aquatic environments.

(835.4100) **Aerobic Aquatic Metabolism** – The requested study is needed to determine the effects on NNI-0001-des-iodo to aerobic conditions in water and sediments during the period of dispersal of NNI-0001-des-iodo throughout the aquatic environment and to compare rates and formation of metabolites. The data from this study would provide the aerobic aquatic input parameter for PRZM/EXAMS reducing modeling uncertainty.

(835.6100) **Terrestrial Field Dissipation Studies** – NNI-0001-des-iodo is persistent and moderately mobile which increases the likelihood for run-off and leaching. No definitive studies on the field dissipation and degradation properties of the major degradate have been submitted to the Agency.

Threatened and Endangered Species: Federally listed species co-located in states, districts, or commonwealths, known to produce the crops upon which the pesticide will be used were identified using the LOCATES database (query performed on 10/26/10). Species on which direct and indirect effects may occur due to the proposed new uses and rates are presented in **Appendix G** and summarized by taxa in **Table 1**.

Listed Species Risks Associated with the Proposed New Uses and Rates of Flubendiamide

Listed Taxa	Direct Effects	Indirect Effects[1]
Terrestrial and semi-aquatic plants – monocots	No	Yes
Terrestrial and semi-aquatic plants – dicots	No	Yes
Birds	No	Yes
Terrestrial phase amphibians	No	Yes
Reptiles	No	Yes
Mammals	No	Yes
Terrestrial insects	Yes	Yes
Aquatic plants	Yes	Yes

Freshwater fish	Yes[2]	Yes
Aquatic phase amphibians	Yes[2]	Yes
Freshwater invertebrates	Yes[2]	Yes
Mollusks	Yes[2]	Yes
Marine/estuarine fish	Yes[2]	Yes
Marine/estuarine invertebrates	Yes	Yes

[1]The Agency's Level of Concern was exceeded for insects and aquatic invertebrates (freshwater and estuarine/marine) only. However, the potential for adverse effects to those species that rely on the above taxa cannot be precluded.

[2] Risk to taxon based on direct effects is presumed due to lack of data.

Environmental Fate and Ecological Risk Assessment for the New Uses of Flubendiamide on Alfalfa, Globe Artichoke, Low Growing Berries (Except Cranberry), Peanut, Pistachio, Small Fruit Vine Climbing (Except Fuzzy Kiwifruit), Sorghum, Sugarcane, Sunflower, Safflower, and Turnip Greens, and New Use Rate on Brassica Leafy Vegetables

ASSOCIATED BARCODES:
D376460, D376101, and D376102

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1. PROBLEM FORMULATION

1.1 Nature of the Registration Action

This environmental risk assessment evaluates the potential ecological risks of the proposed new uses of the insecticide, flubendiamide, on alfalfa, globe artichoke, low growing berries (except cranberry), peanut, pistachio, small fruit vine climbing (except fuzzy kiwifruit), sorghum, sugarcane, sunflower, safflower, and turnip greens, and the proposed new use rate on brassica leafy vegetables. The proposed new uses and increased rate include the formulations SYNAPSE™ WG (39%), a water dispersible granule formulation, and BELT™ SC (24% ai), a suspension concentrate formulation. The single maximum and seasonal maximum application rate for the proposed SYNAPSE™ WG new uses and rate increase are 0.075 and 0.225 lbs a.i./A, respectively; for the proposed BELT™ SC new uses, these rates are 0.125 and 0.375 lbs a.i./A, respectively. Flubendiamide is proposed for ground, aerial (restricted for pistachio, and small fruit vine climbing group), and chemigation, and is re-applied at intervals of 3-7 days with the exception of alfalfa; It is assumed that the minimum efficacious application to alfalfa is 30 days due to the timing of cuttings. Flubendiamide toxicity in target pests occurs via larval ingestion of toxic residues on plants; ingestion leads to rapid feeding cessation, followed by death. Thus, these formulations are to be applied thoroughly to cover all plant parts coinciding with early threshold levels in developing larval populations.

1.2 Nature of the Chemical Stressor

Flubendiamide (N^2-[1,1-Dimethyl-2-(methylsulfonyl)ethyl]-3-iodo-N^1-[2-methyl-4-[1,2,2,2-tetrafluoro-1-(trifluoromethyl)ethyl]phenyl]-1,2-benzenedicarboxamide) belongs to the phthalic acid diamide class of insecticides for control of adult and larval Lepidoptera. It acts by targeting the ryanodine cell receptor and interfering with the calcium release channel, which is involved in muscle contraction. It is known to stabilize insect ryanodine receptors in an open state in a species-specific manner and to desensitize the calcium dependence of channel activity. Continuous stimulation of muscle contraction by "locking" the calcium channel in an "open" state, leads to muscle paralysis and eventual death of the organism. Whole organism symptoms may include feeding cessation, lethargy, paralysis, and death (Lahm et al 2005).

This assessment evaluates risks posed by the parent compound, the formulated products (with single active ingredient), and the primary degradate, NN1-0001-des-iodo (referred to as des-iodo), because the available fate and toxicity data indicate that each of these compounds are of toxicological concern.

1.3 Use Characterization

The crops covered in the proposed new uses and use rate registration of flubendiamide along with the corresponding target pests provided on the proposed label are presented in **Table 1**.

Table 1. The Proposed New Crop Uses for Flubendiamide		
Crop Group	**Crops**	**Target Insects**
Field Crops	Alfalfa	Alfalfa caterpillar, armyworm, army cutworm, alfalfa looper, alfalfa

		webworm, beet armyworm, corn earworm, cutworms, fall armyworms, green cloverworm, loopers, velvetbean caterpillar, yellowstriped armyworm
Vegetable and Small Fruit Crops	Globe artichoke	Artichoke plume moth, cutworms, painted lady butterfly, saltmarsh caterpillar
Strawberry and Low Growing Berry (Except Cranberry)	Bearberry, bilberry, blueberry, blueberry (lowbush), cloudberry, lingonberry, muntries, partridgeberry, strawberry, plus cultivars, varieties, and/or hybrids of these	Armyworm, corn earworm, cutworm, lesser cornstalk borer, omnivorous leadtier, strawberry leafroller
Brassica Leafy Greens and Turnip Greens	Broccoli, broccoli raab, brussel sprouts, cabbage, cauliflower, chinese broccoli, bok choy, Chinese cabbage, Chinese mustard cabbage, collards, kale, kohlrabi, mizuna, mustard greens, mustard spinach, rape greens, and turnip greens	Alfalfa looper, alfalfa caterpillar, armyworm, beet armyworm, cabbage looper, cabbage webworm, corn earworm, cross-striped cabbageworm, cutworm species, diamondback moth, fall armyworm, garden webworm, imported cabbage worm, saltmarsh caterpillar, southern armyworm, southern cabbageworm, tobacco budworm, yellowstriped armyworm
Field Crops	Peanut	Armyworm, beet armyworm, corn, earworm, cutworms, green cloverworm, fall armyworm, loopers, rednecked peanutworm, southern armyworm, velvetbean catepillar
Field Crops	Sorghum	Armyworm, beet armyworm, cutworms, European corn borer, fall armyworm, Mexican rice borer, Sorghum headworm, sorghum webworm, southern armyworm, southwestern corn borer, stalk borer, sugarcane borer, webworms, yellowstriped armyworm
Field Crops	Sugarcane	Suagarcan borer, Mexican rice borer
Field Crops	Sunflower and Safflower	Banded sunflower moth, cutworms, sunflower bud moth, sunflower moth, thistle caterpillar
Tree Fruit, Nut and Vine Crops	Pistachio	Codling moth, fall webworm, filbertworm, fruittree leadroller, hickory shuckworm, naval orangeworm, obliquebanded leafroller, omnivorous leadroller, peach twig borer, pecan nut casebearer, redhumped caterpillar, walnut caterpillar
Small Fruit Vine Climbing Subgroup (Except Fuzzy Kizifruit)	Armur river grape, gooseberry, kiwifruit (hardy), maypop, schisandra berry	Cutworm, grape berry moth, grape leaf folder, grape leaf skeletonizer, obliquebanded leafroller, omnivorous leafroller, orange tortrix, redbanded leafroller

Table 2 summarizes the application information for the proposed new uses and new use rate of flubendiamide. Flubendiamide is proposed for ground, chemigation, and aerial applications. Ground and chemigation applications are proposed for all uses. Aerial applications are prohibited for pistachio and the small fruit vine climbing subgroups.

For all uses, the label requires a 15-foot wide vegetative filter strip of grass or other permenant vegetation between field edge and down gradient aquatic habitat. Proposed spray drift reduction label language requires the applicator to release spray at ≤ 10 feet above crop canopy unless a greater height is required for aircraft safety. For ground boom applications, applications are required at ≤ 4 feet above the ground or crop canopy. ASAE (S572) medium to coarse spray nozzles are required for ground and non-ULV aerial applications. The proposed increased maximum seasonal application rate for brassica leafy vegetables is 0.225 lbs a.i./A; the previously assessed maximum seasonal application rate was 0.09 lbs a.i./A.

Table 2. Flubendiamide Application Information for the Proposed New Uses

Crop	Maximum Application Rate (lb ai/A)		Maximum Number of Applications Per Crop Season	Minimum Interval Between Applications (days)	Method of Application	Label/Label Restrictions
	Single	Crop Season				
Alfalfa	0.125 (max. per cutting)	0.375	3	30[1]	Ground Aerial Chemigation	BELT™ SC/Minimum application interval is equivalent to the shortest optimal period between cuttings. Minimum of 10 GPA volume for ground applications and 2 GPA for aerial applications.
Artichoke, globe	0.075	0.225	3	3	Ground Aerial Chemigation	SYNAPSE™ WG/Minimum of 10 GPA volume for ground applications and 2 GPA for aerial applications. Do not apply within 1 day of harvest.
Peanut	0.125	0.375	3	7	Ground Aerial Chemigation	BELT™ SC/Minimum of 10 GPA volume for ground applications and 2 GPA for aerial applications. Do not apply within 3 days of harvest.
Sorghum	0.125	0.375	3	7	Ground Aerial Chemigation	BELT™ SC/Minimum of 10 GPA volume for ground applications and 2 GPA for aerial applications. Do not apply within 3 days of forage harvest and 14 days of grain and stover harvest.
Sugarcane	0.125	0.375	3	7	Ground Aerial Chemigation	BELT™ SC/Minimum of 10 GPA volume for ground applications and 2 GPA for aerial applications. Do not apply within 14 days of harvest.
Sunflower and Safflower	0.125	0.375	3	7	Ground Aerial Chemigation	BELT™ SC/Minimum of 10 GPA volume for ground applications and 2 GPA for aerial applications. Do not apply within 14 days of harvest.
Pistachio	0.125	0.375	3	7	Ground Chemigation	BELT™ SC/Aerial application prohibited. Apply in sufficient water volume that provides thorough coverage of plant foliage and fruit. Do not apply within 7

						days of harvest.
Small Fruit Vine Climbing Subgroup	0.125	0.375	3	5	Ground Chemigation	BELT™ SC/Aerial application prohibited. Apply in sufficient water volume that provides thorough coverage of plant foliage and fruit. Do not apply within 7 days of harvest.
Brassica Leafy Vegetables and Turnip Greens	0.075	0.225	3	5	Ground Aerial Chemigation	SYNAPSE™ WG/Minimum of 10 GPA volume for ground applications and 2 GPA for aerial applications. Do not apply within 1 day of harvest.
Strawberry and Low Growing Berry Subgroup	0.075	0.225	3	3	Ground Aerial Chemigation	SYNAPSE™ WG/Minimum of 10 GPA volume for ground applications and 2 GPA for aerial applications. Do not apply within 1 day of harvest.

[1] Minimal application interval between cuttings is assumed to be 30 days (http://ucce.ucdavis.edu/files/filelibrary/2129/18789.pdf p.104-105)

1.4 Previous EFED Actions on Flubendiamide

The Environmental Fate and Effects Division completed two ecological risk assessments to date on the flubendiamide formulated products BELT™ SC and SYNAPSE™ WG (previously referred to as 480 SC and 24 WG, respectively). A Section 3 new chemical assessment was completed in June, 2008, for flubendiamide's uses on corn, cotton, tobacco, pome fruit, stone fruit, tree nuts, grape, cucurbit vegetables, fruiting vegetables, leafy vegetables, and brassica (cole) and leafy vegetables (DP Barcodes: 329594, 329613, 329606, and 329599). A Section 3 new use assessment was completed in May, 2010, for flubendiamide's uses on legume vegetables, including soybeans and Christmas trees (DP Barcodes: 368029, 368036, 368040, and 368055). The maximum use rates assessed in these previous risk assessments are presented in **Table 3**.

Of the proposed new uses and use rate, the highest seasonal application rate is 0.375 lb ai/A for alfalfa, peanut, pistachio, small fruit vine climbing, sorghum, sugarcane, sunflower, and safflower. The maximum seasonal use rates proposed for globe artichoke, strawberry and low growing berry, brassica, and turnip greens, is 0.225 lbs ai/A. These maximum seasonal application rates are similar to use rates previously assessed, but are overall lower than the highest seasonal use rate previously assessed for pome fruit (0.468 lbs ai/A).

The ecological risk conclusions per taxon from the previous assessments are as follows:

Aquatic Invertebrates: The use of formulated products, BELT™ SC and SYNAPSE™ WG result in direct acute and chronic risk to freshwater invertebrates. Based on the lack of data, acute and chronic risk to estuarine/marine invertebrates is presumed for these formulations. Flubendiamide's technical product is not acutely toxic at its water solubility limit (29.9 mg/L) to freshwater or estuarine/marine organisms. Chronic LOCs were not exceeded for freshwater or estuarine/marine invertebrates at the solubility limit of flubendiamide.
Benthic Invertebrates: Chronic risk LOCs are exceeded for both flubendiamide and its des-iodo degradate.

Fish: Acute and chronic LOCs are not exceeded for freshwater or estuarine/marine fish.
Birds: Acute LOCs are not exceeded; chronic LOCs are exceeded for the proposed use on Christmas trees only.
Mammals: Acute and chronic LOCs are not exceeded for mammals for all of the proposed uses.
Terrestrial Invertebrates: Sensitive terrestrial invertebrates may be affected. Impacts to bees and earthworms are expected to be minimal.
Aquatic and Terrestrial Plants: RQs do not exceed LOCs for aquatic and terrestrial plants.

Table 3. Flubendiamide Crop Application Information for Registered BELT™ SC and SYNAPSE™ WG Uses

Crops	Max. Application Rate (lbs ai/A)	Max. # of Applications	Recommended Interval Between Apps. (days)	Max. Seasonal Use Rate (lbs ai/A)
Christmas Tree – Belt SC Formulation	0.156	2	7	0.312
Corn - Belt SC Formulation	0.094	4	3	0.375
Cotton– Belt SC Formulation	0.094	3	5	0.282
Soybean – Belt SC Formulation	0.094	2	5	0.188
Tobacco – Belt SC Formulation	0.094	4	5	0.375
Pome Fruit– Belt SC Formulation				
Apple/Crabapple/ Loquat/Mayhaw/ Pear/Oriental Pear/Quince	0.156	3	7	0.468
Stone Fruit– Belt SC Formulation				
Apricot/Cherry/Nectarine/Peach/Plum/ Plumcot/Prune	0.125	3	7	0.375
Tree Nut Crops– Belt SC Formulation				
Almond/Beech Nut/ Brazil Nut/Butter Nut/Cashew/Chestnut/ Chinquapin/Filbert/ Hickory Nut/Maca-damia Nut/Pecan Nut/Pistachio[1]/ Walnut/	0.125	3	7	0.375
Grapes– Belt SC Formulation				
American Bunch Grape/Muscadine/ Vinifera	0.125	3	5-7	0.375
Cucurbit Vegetables- SYNAPSE WG Formulation				
Chayote/Chinese Waxgourd/Citron Melon/Cucumber/Gherkin/ Edible Gourds/Momordica spp./Muskmelon/Pumpkin/ Summer Squash/Winter Squash/Watermelon	0.045	5	7	0.225
Fruiting Vegetables- SYNAPSE WG Formulation				
Eggplant/Groundcherry/ Pepino/Peppers/Tomatillo/ Tomato	0.045	5	3	0.225

Table 3. Flubendiamide Crop Application Information for Registered BELT™ SC and SYNAPSE™ WG Uses				
Crops	**Max. Application Rate (lbs ai/A)**	**Max. # of Applications**	**Recommended Interval Between Apps. (days)**	**Max. Seasonal Use Rate (lbs ai/A)**
Leafy Vegetables- SYNAPSE WG Formulation				
Amaranth/Arugula/ Cardoon/Celery/Chinese Celery/Celtuce/Chervil/ Edible Garland Chrysan-themum/Corn Salad/ Upland and Garden Cress/ Dandelion/Dock/Endive/ Fennel/Head and Lead/Lettuce/Orach/Parsley/ Purslane/Radicchio/Rhubarb/Spinach/Swiss Chard	0.045	5	3	0.225
Brassica Leafy Vegetables- SYNAPSE WG Formulation				
Broccoli/Brussell Spouts/Cabbage/ Cauliflower/Collards/Kale/Kohirabi/Mizuna/ Mustard Greens/Mustard Spinach/Rape Greens	0.03	3	3	0.09
Legume Vegetables except Soybean				
Bean (grain lupin, sweet lupin, white lupin, white sweet lupin, field bean, kidney bean, lima bean, navy bean, pinto bean, runner bean, snap bean, tepary bean, wax bean, adzuki bean, asparagus bean, blackeyed pea, catjang, Chinese longbean, cowpea, Crowder pea, moth bean, mung bean, rice bean, southern pea, Urd bean, yardlong bean), Pea (dwarf pea, edible-pod pea, English pea, field pea, garden pea, grean pea, snow pea, sugar snap pea), broad bean, chickpea, guar, jackbean, lablab bean, lentil, pigeon pea, sword bean	0.094	2	5	0.188

[1] It is thought that pistachio was erroneously assessed in the previous risk assessment since the approved labels did not include pistachio use.

1.5 Analysis Plan

This assessment on the proposed new uses and use rate, as described above, will closely follow the Section 3 new use assessment completed earlier this year (PC 027602; D368029+). Since the last assessment, two benthic organism toxicity studies have been received for flubendiamide and des-iodo:

MRID: 48175603: Benthic Organism Acute Toxicity Screens for Flubendiamide and des-iodo
MRID: 48175605: des-iodo [^{14}C] - A Prolonged Sediment Toxicity Test with *Chironomus riparius* using Spiked Sediment

These studies are currently under review; thus, no new data is included in the toxicity profile from the previous ecological effects risk characterization.

This assessment evaluates risks posed by the parent compound, the formulated products, and the primary degradate, des-iodo, because the available fate and toxicity data indicate that each of these compounds are of toxicological concern. In contrast to previous assessments, des-iodo is assumed to be similar in toxicity to flubendiamide. Aquatic exposure estimates are thus based on a total residue approach of flubendiamide + residues of concern (des-iodo), as well as the formulated products.

Estimated environmental concentrations (EECs) for aquatic systems are obtained by PRZM/EXAMS modeling which produces EECs resulting from spray drift and run-off. Since flubendiaimide primarily degrades into des-iodo in aquatic environments, flubendiamide was manually entered into PRZM and des-iodo was manually entered into EXAMS (no PE shell program was used) to better capture the degradation and dissipation characteristics of flubendiamide and des-iodo in terrestrial and aquatic compartments.

2. SUMMARY OF FLUBENDIAMIDE FATE PROPERTIES

Environmental fate and transport data indicate that flubendiamide is stable to hydrolysis, aerobic and anaerobic soil metabolism, and aerobic aquatic metabolism. In the laboratory studies using four soils ranging from loamy sand to silt, flubendiamide was stable with <5% of the applied dissipating at 371 days post treatment. Photolysis and anaerobic aquatic metabolism appear to be the main routes of degradation for flubendiamide. Flubendiamide degrades to des-iodo under anaerobic aquatic conditions ($T_{1/2}$=, 364 days) and direct aqueous photolysis ($T_{1/2}$ = 11.58 days) and by soil photolysis ($T_{1/2}$ = 35.3 days). Volatilization from soil and water surfaces is not expected to be an important process since flubendiamide has a relatively low vaporpressure (7.5 x 10^{-7} mm Hg) and Henry's Law constant (8.9 x 10^{-11} atm-m3/mol) and low solubility (29µg/L).

Flubendiamide is expected to be slightly to hardly mobile in the environment, and its transformation product, des-iodo, is expected to be moderately mobile (FAO, 2000). The octanol-water partition coefficients (log K_{ow}) of flubendiamide are 3.36 to 4.2 (pH 4-9) and the K_{foc} values are 1076 to 3318 mL/g. K_{foc} values for des-iodo are approximately 234 to 581 mL/g.

Flubendiamide and des-iodo have potential to contaminate surface water through run-off due to their persistence in soil. Flubendiamide and des-iodo also have the potential for groundwater contamination in vulnerable soils with low organic carbon content, after very heavy rainfall, andlor the presence of shallow groundwater. Flubendiamide and its degradate's overall stability and persistence suggests that they will accumulate in soils, water column, and sediments with each successive application.

Des-iodo is persistent (stable in an aerobic soil environment), and is expected to be moderately mobile (K_{foc} values were approximately 234 to 581 mL/g). Although des-iodo was only detected in minor amounts (<3.4% of the applied) at three field sites, under anaerobic aquatic conditions in the laboratory, 60.4% of the applied (total system) was identified as des-iodo at study termination (365 days).

Additional fate information can be found in the two previous ecological risk assessments dated June, 2008 (DP Barcode: 329594+) and May, 2010 (368029+).

3. EXPOSURE ESTIMATION

3.1 Monitoring Data

Flubendiamide was initially registered in 2008. Presumably because of its recent registration, there are no available monitoring data at this time for flubendiamide and des-iodo.

3.2 Aquatic Exposure Modeling

Table 4 summarizes all the modeled crop scenarios, first application date, application rates, maximum number of applications, minimum interval between applications and maximum seasonal use rates.

Table 4. PRZM/EXAMS Modeling Scenarios, Application Date, Number of Applications, and Maximum Application Rate for Proposed Flubendiamide Uses

Crop Scenario (App. Method: A = Aerial; G = Ground)	First Application Date (dd-mm)	Max Number of Applications	Minimum Application Interval (days)	Maximum Single Application Rate (lb ai/A)
Belt SC Label				
Alfalfa				
CAalfalfa_WirrigOP (A)	01-03	3	30	0.125
MNalfalfaOP (A)	01-04	3	30	0.125
NCalfalfaOP (A)	15-06	3	30	0.125
PAalfalfaOP (A)	15-06	3	30	0.125
TXalfalfaOP (A)	15-06	3	30	0.125
Sunflower				
CAcornOP (A)	01-07	4	3	0.094
Peanut				
NCpeanutSTD (A)	10-08	3	7	0.125
Sorghum				
KSsorghumSTD (A)	10-07	3	7	0.125
TXsorghumOP (A)	10-06	3	7	0.125
Sugarcane				
FLsugarcaneSTD (A)	10-04	3	7	0.125
LAsugarcaneSTD (A)	10-04	3	7	0.125
Sunflower				
CAcornOP (A)	10-05	3	7	0.125
Tree Nut Crops and Pistachio				
CAalmond_WirrigSTD (G)	15-03	3	7	0.125
GAPecansSTD (G)	15-03	3	7	0.125
ORfilbertsSTD (G)	15-03	3	7	0.125
Grape and Small Fruit Vine Climbing Subgroup				
CAgrapes_WirrigSTD (G)	15-03	3	5	0.125
NYGrapesSTD (G)	01-07	3	5	0.125
ORberriesOP (G)	01-07	3	5	0.125
Proposed Synapse WG Label				

Table 4. PRZM/EXAMS Modeling Scenarios, Application Date, Number of Applications, and Maximum Application Rate for Proposed Flubendiamide Uses				
Crop Scenario (App. Method: A = Aerial; G = Ground)	**First Application Date (dd-mm)**	**Max Number of Applications**	**Minimum Application Interval (days)**	**Maximum Single Application Rate (lb ai/A)**
Globe Artichoke				
CARowCropRLF_V2 (A)	15-02	3	3	0.075
Brassica (cole) leafy vegetables and turnip greens (crops of crop group 5 and turnip greens)				
CAColeCropRLF_V2 (A)	15-03	3	5	0.075
FLcabbageSTD (A)	15-03	3	5	0.075
Strawberry and Low Growing Berry Subgroup				
CAStrawberry-noplasticRLF_V2 (A)	15-03	3	3	0.075
FLstrawberry_WirrigSTD (A)	15-10	3	3	0.075
Existing Synapse 480 Label				
Cucurbit vegetables				
CAMelonsRLF_V2 (A)	10-07	3	3	0.047
FLcucumberSTD (A)	10-05	3	3	0.047
Brassica (cole) leafy vegetables and turnip greens (crops of crop group 5 and turnip greens)				
CAColeCropRLF_V2 (A)	15-03	2	3	0.03
FLcabbageSTD (A)	15-03	2	3	0.03

Estimated environmental concentrations (EECs) for aquatic systems are obtained by PRZM/EXAMS modeling which produces EECs resulting from spray drift and run-off. Since flubendiamide primarily degrades into des-iodo in aquatic environments, flubendiamide was run in the PRZM and des-iodo was manually entered (the PE5 shell program was not used) into EXAMS to better capture the degradation and dissipation characteristics of flubendiamide and des-iodo in terrestrial and aquatic compartments. The overall stability of the compound suggests that flubendiamide will likely accumulate in the soil and des-iodo in sediments with yearly applications. The steps for manually entering PRZM and EXAMS outside the PE 5 Shell are listed in **Appendix A**. PRZM and EXAMS input parameters are displayed in **Table 5.**

Table 5. PRZM Input Parameters for Flubendiamide and EXAMS Input Parameter for Des-iodo.		
Parameter	**Flubendiamide (PRZM)**	**Source**
Chemical Application Method (CAM)	2	EFED Model input Guidance, version 2.1 (2009)
Hydrolysis ($t_{1/2}$)	0	MRID 46816907
Spray drift and application efficiency	Spray Drift – Aerial: 0.05 Ground: 0.01	EFED Model input Guidance, version 2.1 (2009)
Aerobic soil metabolism ($t_{1/2}$)	0	MRID 46816910
Aerobic aquatic metabolism ($t_{1/2}$)	0	MRID 46816913
Anaerobic aquatic metabolism ($t_{1/2}$)	0	MRID 46816914
Aquatic photolysis ($t_{1/2}$)	11.58 days	MRID 46816909
Vapor pressure	2.85×10^{-12} mm Hg	MRID 46816902
Solubility in water (pH 7, 20°C)	0.03 mg/L	MRID 46816902
Molecular weight	682.4 g/mole	
Partition coefficient K_{FOC}^{c}	1954.2 mg/L	MRID 46816905

Table 5. PRZM Input Parameters for Flubendiamide and EXAMS Input Parameter for Des-iodo.		
Parameter	**Flubendiamide (PRZM)**	**Source**
Spray drift and application efficiency	Efficiency – Aerial : 0.95	EFED Model input Guidance, version 2.1 (2009)
Foliar Extraction Rate (FEXTRC)	0.5	EFED Model input Guidance, version 2.1 (2009) [a]
Parameter	**Desi-iodo (EXAMS)**	**Source**
Chemical Application Method (CAM)	N/A	
Hydrolysis ($t_{1/2}$)	0	Study Not submitted
Spray drift and application efficiency	Efficiency – Degradation Product: 1.00	
Aerobic soil metabolism ($t_{1/2}$)	0	Study Not Submitted
Aerobic aquatic metabolism ($t_{1/2}$)	0	Study Not Submitted
Anaerobic aquatic metabolism ($t_{1/2}$)	0	Study Not Submitted
Aquatic photolysis ($t_{1/2}$)	0	Study Not Submitted
Vapor pressure	1.59×10^{-14}	Product Chemistry
Solubility in water (pH 7, 20°C)	0.187 mg/L	Product Chemistry
Molecular weight	556.5	Product Chemistry
Partition coefficient K_{FOC} [c]	334 mg/L	Product Chemistry
Foliar Extraction Rate (FEXTRC)	N/A	

3.2.1 Aquatic Exposure Modeling Results

The high and low PRZM/EXAMS EECs for water column exposure through spray drift, runoff, and erosion of all scenarios modeled are presented in **Table 6**. Peak EEC values were used to determine acute risks to organisms associated with the water column. The 21-day average EEC values were used to determine chronic risks to aquatic invertebrates. The 60-day average EEC values were used to determine chronic risks to aquatic fish. The high and low PRZM/EXAMS output files are presented in **Appendix B**.

The FL sugarcane scenario generated the highest peak, (277.7/µg/L), 21-day (277.72/µg/L) and 60-day (276.8/µg/L) EECs. The FL sugarcane EECs in PRZM/EXAMS water column modeling exceed the limit of solubility for flubendiamide (29.9 µg/L) and des-iodo (187µ/L). The higher 187 µg/L solubility for des-iodo will serve as the practical limit of solubility for this assessment.

Since the estimated environmental concentrations of flubendiamide and des-iodo in PRZM/EXAMS surface water modeling exceed the limit of solubility, the higher 0.187 mg/L solubility limit for des-iodo will serve as the practical limit of solubility for this assessment.

Table 6. High and Low Estimated Concentrations of the Total Residues of Flubendiamide and Des-iodo in Surface Water Based on Aerial and Ground Applications to Florida Sugarcane and California Grape Scenarios				
Crop	Spray Application	Peak Conc. µg/L	21day Conc. µg/L	60 day Conc. µg/L
Sugarcane (0.125 lbs ai/acre × 3 applications with 7 days interval)				
Florida Sugarcane	Aerial	277.7[1]	277.7[1]	276.8[1]

Table 6. High and Low Estimated Concentrations of the Total Residues of Flubendiamide and Des-iodo in Surface Water Based on Aerial and Ground Applications to Florida Sugarcane and California Grape Scenarios				
Crop	Spray Application	Peak Conc. µg/L	21day Conc. µg/L	60 day Conc. µg/L
Small Fruit Vine Climbing Subgroup (0.075 lbs ai/acre × 3 applications with 3 days interval)				
California Grapes	Ground	8.79	8.78	8.76

[1] The 0.187 mg/L solubility for des-iodo will serve as the practical limit of solubility for this assessment

In Table 7, the PRZM/EXAMS benthic pore water EECs are presented for the scenarios that produced the highest and lowest water column EECs. All other modeled scenarios produce benthic pore water EECs within the range bounded by the aerial Florida Sugarcane and the ground California grape benthic pore water values.

Table 7. High and Low Estimated Concentrations of the Total Residues of Flubendiamide and Des-iodo in Benthic Pore Water Based on Aerial and Ground Applications to Florida Sugarcane and California Tomato Scenarios			
Spray Application	Peak Conc. (µg/L)	21day Conc. (µg/L)	60 day Conc. (µg/L)
FL Sugarcane (0.125 lbs ai/acre × 3 applications with 7 days interval)			
Aerial	275.7[1]	275.7[1]	274.7[1]
CA Small Fruit Vine Climbing Subgroup (0.075 lbs ai/acre × 3 applications with 3 days interval)			
Ground	8.69	8.69	8.68

[1] The 187µg /L solubility for des-iodo will serve as the practical limit of solubility for this assessment

Toxicity data indicate that the flubendiamide formulations are more toxic to freshwater invertebrates tested than the technical grade flubendiamide. Formulations may contain chemicals that help to keep the active ingredient in suspension, or keep the active ingredient stable, *etc*. For example, emulsifiers, which keep chemicals of low solubility in suspension may also be disruptive to biological membranes and therefore exhibit toxicity.

To assess the risk of toxicity from the formulations, it is assumed that the inert ingredient(s) degrade rapidly in the environment. Therefore, the inert ingredient(s) will not be transferred to aquatic environments through any pathways (runoff or erosion) other than spray drift. According to EFED policy, the spray drift fraction that falls on the standard PRZM/EXAMS pond is assumed to be 5% of the application rate for aerial applications and 1% for ground. The following equation was used to calculate EECs for comparison with the formulation toxicity endpoints (**Table 8**):

$$EEC = \frac{AppRate(\text{lbs./A}) \times 1.12 \frac{\text{kg/ha}}{\text{lbs./A}} \times SDFraction \times 10^9\ \mu\text{g/kg}}{2 \times 10^7\ \text{L/ha of Pond}}$$

Table 8. Estimated Water Column Concentrations of Flubendiamide Formulations Due to Spray Drift (No Runoff or Erosion Contributions) after Aerial and Ground Application		
Single Maximum Application Rate	**Field and Nut Crops[1] 0.125 lbs a.i./A**	**Vegetable and Low Growing Berry[2] 0.075 lbs a.i./A**
Aerial[3]	0.35 µg/L	0.21 µg/L
Ground	0.07 µg/L	0.04 µg/L

[1] Crops include alfalfa, peanut, sorghum, sugarcane, sunflower, safflower, pistachio, and the small fruit vine climbing crop group
[2] Crops include globe artichoke, turnip greens, brassica leafy vegetables, strawberries, and the low growing berry subgroup
[3] Aerial applications prohibited for pistachio and the small fruit vine climbing subgroup

3.3 Terrestrial Exposure

Terrestrial wildlife exposure estimates are typically calculated for birds and mammals emphasizing a dietary exposure route for uptake of pesticide residues on vegetative matter and insects. These exposures are considered as surrogates for terrestrial-phase amphibians as well as reptiles.

Determination of residue dissipation over time on food items following single and multiple applications are predicted using a first-order residue degradation half-life with EFED's T-REX_v1.4.1 model. The risk assessment uses a default foliar dissipation half-life estimate of 35 days. This default value is used in lieu of representative foliar dissipation data for flubendiamide, because no suitable data were provided to EFED that evaluated foliar dissipation. Residue dissipation in T-REX_v1.4.1 is based on flubendiamide residues only. Fate data demonstrate flubendiamide is relatively stable to aerobic soil metabolism, decreasing less than 3% during 120 days of incubation; des-iodo formation was less than 2% of the applied (MRID 46816910). Based on the predominance of the parent, an exposure assessment based on flubendiamide residues only is appropriate for the terrestrial environment. The Risk Description, **Section 5.2,** will further discuss the persistence of flubendiamide in the terrestrial environment.

The residues, or EECs, on food items may be compared directly with sub-acute dietary toxicity data or converted to an ingested whole-body dose (single oral dose, as is the latter case for small mammals and birds). Single-oral dose estimates represent, for many pesticides, an exposure scenario where absorption of the pesticide is maximized over a single ingestion event. Sub-acute dietary estimates provide for possible effects of the dietary matrix and more extended time of gut exposure to pesticide absorption across the gut. However, dietary exposure endpoints are limited in their utility because the current food ingestion estimates are uncertain and may not be directly comparable from laboratory conditions to field conditions. The EEC is converted to an oral dose by multiplying the EEC by the percentage of body weight consumed as estimated through allometric relationships. These consumption-weighted EECs (*i.e.,* EEC equivalent dose) are determined for each food source and body size for mammals (15, 35, and 1000 g) and birds (20, 100, and 1000 g). Exposure Concentration Estimates are predicted for birds (**Table 9**) and mammals (**Table 10**). An example T-REX output is provided in **Appendix C.**

Table 9. Avian Exposure Concentration Estimates (EECs) for the Proposed New Flubendiamide Uses and Rate Increase				
Feeding Category (application rate)	**Dietary-Based EECs (mg/kg-Food item)**	**Dose-Based EECs (mg/kg-bw)**		
		Small (20 g)	**Medium (100 g)**	**Large (1000 g)**
Alfalfa (0.125 lbs a.i./A x 3 apps/season)				
	Herbivores/Insectivores[1]			
Short grass	55.7	63.4	36.2	16.2

Tall grass	25.5	30.0	16.6	7.42
Broadleaf plants/small insects	31.3	35.7	20.4	9.11
Fruits/pods/seeds/large insects	3.48	3.97	2.26	1.01
	Granivores[2]			
Fruits/pods/seeds/large insects	3.48	0.88	0.50	0.22
Brassica Leafy Vegetables and Turnip Greens (0.075 lbs a.i./A x 3 apps/season)				
	Herbivores/Insectivores[1]			
Short grass	49.1	55.9	31.9	14.3
Tall grass	22.5	25.6	14.6	6.54
Broadleaf plants/small insects	27.6	31.4	17.9	8.03
Fruits/pods/seeds/large insects	3.07	3.49	1.99	0.89
	Granivores[2]			
Fruits/pods/seeds/large insects	3.07	0.78	0.44	0.20
Globe Artichoke; Strawberry and Low Growing Berry Subgroup (0.075 lbs a.i./A x 3 apps/season)				
	Herbivores/Insectivores[1]			
Short grass	51.0	58.2	33.1	14.8
Tall grass	23.4	26.6	15.2	6.80
Broadleaf plants/small insects	28.7	32.6	18.6	8.33
Fruits/pods/seeds/large insects	3.18	3.63	2.07	0.93
	Granivores[2]			
Fruits/pods/seeds/large insects	3.18	0.81	0.46	0.21
Peanut; Sorghum; Sugarcane; Sunflower and Safflower; Pistachio (0.125 lbs a.i./A x 3 apps/season)				
	Herbivores/Insectivores[1]			
Short grass	78.7	89.8	51.2	22.9
Tall grass	36.1	41.2	23.5	10.5
Broadleaf plants/small insects	44.4	50.5	28.8	12.9
Fruits/pods/seeds/large insects	4.93	5.61	3.20	1.43
	Granivores[2]			
Fruits/pods/seeds/large insects	4.93	1.25	0.71	0.32
Small Fruit Vine Climbing Subgroup (0.125 lbs a.i./A x 3 apps/season)				
	Herbivores/Insectivores[1]			
Short grass	81.8	93.1	53.1	23.8
Tall grass	37.5	42.7	24.3	10.9
Broadleaf plants/small insects	46.0	52.4	29.9	13.4
Fruits/pods/seeds/large insects	5.11	5.82	3.32	1.49
	Granivores[2]			
Fruits/pods/seeds/large insects	5.11	1.29	0.74	0.33

[1] Percent body weight consumed for a 20, 100, and 1000 gram herbivore/insectivore bird equals 114%, 65%, and 29%, respectively.

[2] Percent body weight consumed for a 20, 100, and 1000 gram granivore bird equals 25%, 14%, and 6%, respectively.

Table 10. Mammalian Exposure Concentration Estimates (EECs) for the Proposed New Flubendiamide Uses and Rate Increase

Feeding Category	**Dose-Based EECs (mg/kg-bw)**		
	Small (15 g)	**Medium (35 g)**	**Large (1000 g)**
Alfalfa (0.125 lbs a.i./A x 3 apps/season)			

	Herbivores/Insectivores[1]		
Short grass	53.1	36.7	8.51
Tall grass	24.3	16.8	3.90
Broadleaf plants/small insects	29.9	20.7	4.79
Fruits/pods/seeds/large insects	3.32	2.29	0.53
	Granivores[2]		
Fruits/pods/seeds/large insects	0.74	0.51	0.12
Brassica Leafy Vegetables and Turnip Greens (0.075 lbs a.i./A x 3 apps/season)			
	Herbivores/Insectivores[1]		
Short grass	46.8	32.3	7.50
Tall grass	21.4	14.8	3.44
Broadleaf plants/small insects	26.3	19.2	4.22
Fruits/pods/seeds/large insects	2.92	2.02	0.47
	Granivores[2]		
Fruits/pods/seeds/large insects	0.65	0.45	0.10
Globe Artichoke; Strawberry and Low Growing Berry Subgroup (0.075 lbs a.i./A x 3 apps/season)			
	Herbivores/Insectivores[1]		
Short grass	48.6	33.6	7.78
Tall grass	22.3	15.4	3.57
Broadleaf plants/small insects	27.3	18.9	4.38
Fruits/pods/seeds/large insects	3.04	2.10	0.49
	Granivores[2]		
Fruits/pods/seeds/large insects	0.67	0.47	0.11
Peanut; Sorghum; Sugarcane; Sunflower and Safflower; Pistachio (0.125 lbs a.i./A x 3 apps/season)			
	Herbivores/Insectivores[1]		
Short grass	75.2	52.0	12.1
Tall grass	34.5	23.8	5.52
Broadleaf plants/small insects	42.3	29.2	6.78
Fruits/pods/seeds/large insects	4.70	3.25	0.75
	Granivores[2]		
Fruits/pods/seeds/large insects	1.04	0.72	0.17
Small Fruit Vine Climbing Subgroup (0.125 lbs a.i./A x 3 apps/season)			
	Herbivores/Insectivores[1]		
Short grass	78.0	53.0	12.5
Tall grass	35.7	24.7	5.73
Broadleaf plants/small insects	43.9	30.3	7.03
Fruits/pods/seeds/large insects	4.87	3.3.37	0.78
	Granivores[2]		
Fruits/pods/seeds/large insects	1.08	0.75	0.17

[1] Percent body weight consumed for a 15, 35, and 1000 gram herbivore/insectivore mammalian equals 95%, 66%, and 15%, respectively.

[2] Percent body weight consumed for a 15, 35, and 1000 gram granivore mammal equals 21%, 15%, and 3%, respectively.

4. ECOLOGICAL EFFECTS CHARACTERIZATION

A summary of the available toxicity data is presented below. Additional information can be found in the two previous ecological risk assessments dated June, 2008 (DP Barcodes: 329594, 329613, 329606, and 329599) and May, 2010 (368029, 368036, 368040, and 368055).

In screening-level ecological risk assessments, effects characterization describes the types of effects a pesticide can produce in an animal or plant. This characterization is based on registrant-submitted studies that describe acute and chronic effects toxicity information for various aquatic and terrestrial animals and plants. Typically open literature studies are identified through U.S. EPA's ECOTOX public database (http://cfpub.epa.gov/ecotox/), which employs a literature search engine for locating chemical toxicity data for aquatic life, terrestrial plants, and wildlife. Three studies classified Acceptable were identified in previous assessments (**Appendix D**); however the data were not used because they evaluated the insecticidal activity of flubendiamide on target species and did not provide information on toxicity to non-target species. No new "acceptable" ECOTOX studies have been identified for this assessment.

The previous assessment (PC 027602; D368029+) summarizes the results of all of the registrant-submitted toxicity studies for this risk assessment. Toxicity testing reported in this section does not represent all species of birds, mammals, or aquatic organisms. Only a few surrogate species for both freshwater fish and birds are used to represent all freshwater fish (2000+) and bird (680+) species in the United States. For mammals, toxicity studies are typically limited to the laboratory rat. Estuarine/marine testing is limited to a crustacean, a mollusk, and a fish. Also, neither reptiles nor amphibians are tested. The risk assessment assumes that avian and reptilian and terrestrial-phase amphibian toxicities are similar. The same assumption is used for fish and aquatic-phase amphibians. The most sensitive ecological toxicity endpoints for aquatic organisms, terrestrial organisms, and aquatic and terrestrial plants were used for risk characterization.

Registrant-submitted data are available for flubendiamide technical, the formulations BELT™ SC and SYNAPSE™ WG, and the degradate des-iodo. The ecological toxicity endpoints for aquatic organisms (**Table 11**), aquatic and terrestrial plants (**Table 12**), terrestrial vertebrates (**Table 13**), and terrestrial invertebrates (**Table 14**) which were used for risk characterization of flubendiamide, des-iodo, and the formulations are summarized below. A comparison of toxicity between flubendiamide and the degradate des-iodo is also discussed.

Table 11. Summary of acute toxicity data on aquatic organisms used for risk determination for flubendiamide applications.

	Acute Toxicity (LC/EC_{50} µg a.i./L)				Chronic Toxicity (NOAEC/LOAEC µg a.i./L)		
Species	**Technical**	**Degradate Des-iodo**	**Formulation SYNAPSE™ WG**	**Formulation BELT™ SC**	**Technical**	**Degradate Des-iodo**	**Formulation BELT™ SC**
Freshwater Fish Rainbow trout(*Oncorhynchus mykiss*)	>65.1 No Effects at Limit of Solubility [1] (468169-40)	-----	----	>91.1 No Effects at Limit of Solubility [1] (468169-43)	----	----	----
Freshwater Fish Bluegill sunfish (*Lepomis macrochirus*)	>67.7 No Effects at Limit of Solubility [1] (468169-39)	----	----	>80.2 No Effects at Limit of Solubility [1] (468169-42)	----	----	----

Table 11. Summary of acute toxicity data on aquatic organisms used for risk determination for flubendiamide applications.							
	Acute Toxicity (LC/EC_{50} µg a.i./L)				**Chronic Toxicity (NOAEC/LOAEC µg a.i./L)**		
Species	**Technical**	**Degradate Des-iodo**	**Formulation SYNAPSE™ WG**	**Formulation BELT™ SC**	**Technical**	**Degradate Des-iodo**	**Formulation BELT™ SC**
Freshwater Fish Fathead minnow (*Pimephales promales*)	>66.5 No Effects at Limit of Solubility [1] (468169-37)	----	----	----	60.5/>60.5 No Effects (468169-47)	----	---
Freshwater Invertebrate Water flea (*Daphnia magna*)	>54.8 No Effects at Limit of Solubility[1] (468169-30)	>881 No Effects at Limit of Solubility[2] (468169-33)	1.5 Very Highly Toxic (468169-32)	2.6 Very Highly Toxic (468169-31)	41.1/68.5 # of Aborted Eggs, # of Dead Neonates, Sub-Lethal Effects of Neonates (468169-44)	----	0.38/1.18 Parental mortality, time to first brood (468169-45)
Estuarine/Marine Fish Sheepshead minnow	>29.8 No Effects at Limit of Solubility[1] (468169-38)	----	----	----	----	----	----
Estuarine/Marine Invertebrate Mysid shrimp *Americamysis bahia*	>28 No Effects at Limit of Solubility[1] (468169-36)	----	----	----	20/>20 No Effects (468169-46)	----	----
Estuarine/Marine Mollusks Eastern oyster *Crassostrea virginica*	>49 No Effects at Limit of Solubility[1] (468169-35)	----	----	----	----	----	----
Freshwater Benthic Midge *Chironomus riparius*	LOAEC[3] = 3[4] (based on pore water measured) Emergence Inhibition (468170-22)	NOAEC[3] = 0.28 LOAEC = ND[5] (based on pore water measured) Emergence Inhibition (468170-23)	130 Mortality (468170-14)	1650 Mortality (468170-13)	----	----	----

[1] The established water solubility limit of flubendiamide is 29.9 µg/L.
[2] The established water solubility limit of des-iodo is 187 µg/L.
[3] Sub-acute 28-day study assessing growth, survival, and emergence.
[4] During this study measured concentrations were only taken in the 10, 80, and 160 µg a.i./L treatment groups. Therefore, the pore water concentration at the NOAEC level is unknown. The time-weighted average pore water concentration at the LOAEC is 3 µg a.i./L. Using the LOAEC as a NOAEC, RQs were calculated to demonstrate the

risk to benthic organisms by estimated benthic pore water concentrations of flubendiamide. The NOAEC and LOAEC values based on emergence were 40 µg a.i./L (nominal) and 80 µg a.i./L (nominal, 69 µg a.i./L 1-hr initial water column measurement), respectively.

[5] The overlying water concentrations evaluated in the study were 0.25, 0.50, 1, 2, 4, 8, 16, and 32 µg a.i./L. The mean measured pore water concentrations were only measured in the 4 µg a.i./L (the determined NOAEC) and 32 µg a.i./L overlying water concentration compartment which had a mean measured pore water concentrations of 0.28 µg a.i./L and 3.91 µg a.i./L respectively. The LOAEC based on the **overlying water** concentration was 8 µg a.i./L however the pore water concentration for this value was "Not Determined".

Table 12. Summary of aquatic and terrestrial plant toxicity data used for risk determination for flubendiamide application.

Species	**Technical**	**Formulation 480 SC**	**Formulation 24 WG**
Vascular Plant Duckweed *Lemna gibba*	>54.6 **µg a.i./L** No effects (468170-39)	----	----
Nonvascular Plant Green algae	>69.3 **µg a.i./L** No effects Pseudokirchneriella subcapitata (468170-41)	>50,500 **µg a.i./L** No effects Pseudokirchneriella subcapitata (468170-40)	----
Terrestrial Plants: Seedling Emergence	----	EC25 > 0.363 lb a.i./A NOAEC =0.363 lb a.i./A (468170-36 (a))	EC25 >0.158 lb a.i./A NOAEC = 0.158 lb a.i./A (468170-34) (468170-38)
Terrestrial Plants: Vegetative vigor	----	EC25 > 0.426 lb a.i./A NOAEC = 0.426 lb a.i./A (468170-36 (b))	EC25 >0.158 lb a.i./A NOAEC =0.158 lb a.i./A (468170-37)

Table 13. Summary of terrestrial acute and chronic toxicity data used for risk determination for flubendiamide application.

	Acute Oral Toxicity (mg/kg bw)		**Subacute Toxicity (mg/kg diet)**	**Chronic Toxicity (mg/kg diet)**	
Species	**Technical**	**Formulation 480 SC**	**Technical**	**Technical**	**Affected Endpoints (MRID)**
Northern Bobwhite Quail *Colinus virginianus*	LD_{50}>2,000 Practically Non-Toxic (468170-03)	LD_{50}>2,000 Practically Non-Toxic (468170-04)	LC_{50}>5,199 Practically Non-Toxic (468170-06)	LOAEC > 1,059 NOAEC= 1,059	No Effects (468170-08)
Mallard duck *Anas platyrhynchos*	----	----	LC_{50}>4,535 At the most, slightly toxic (468170-05)	LOAEC = 289 NOAEC= 98	viable embryos of eggs set (17% reduction and percentage of hatchling survivors (3%, reduction) (468170-07)
Laboratory rat (*Rattus norvegicus*)	>5,000 Practically non-toxic (468171-43)	----	----	LOAEC> 20,000 mg/kg-diet NOAEC= 20,000 mg/kg-diet	No effects on survival, reproduction, and growth (468172-16)

Table 14. Summary of terrestrial invertebrate acute and chronic toxicity data used for risk determination for flubendiamide application.						
	Acute Toxicity				**Chronic Toxicity**	
Species	**Technical**	**Degradate Des-iodo**	**Formulation BELT™ SC**	**Formulation SYNAPSE™ WG**	**Formulation BELT™ SC**	**Formulation SYNAPSE™ WG**
Earthworm (*Eisenia fetida*)	14-day LD50>1000 mg a.i./kg NOAEC = 1000 mg a.i./kg (468170-28)	14-day LD50 > 1000 mg a.i./kg NOAEC = 1000 mg a.i./kg (468170-30)	14-day LD50>1000 mg a.i./kg NOAEC = 1000 mg a.i./kg (468170-29)	----	28-day LD50>1000 mg a.i./kg 56-day NOAEC = 1000 mg a.i./kg (468170-31)	28-day LD50 >1000 mg a.i./kg 56-day NOAEC = 562 mg a.i./kg reproduction effects (468170-32)
Honey bee (*Apis mellifera*)	LD50 > 200 µg a.i./bee (468170-09)	----	LD50>200 µg a.i./bee (468170-10)	----	----	----
Parasitoid Wasp (*Aphidius rhopalosiphi*)	----	----	Rate response test LD50>0.423 lb a.i./A (468170-21)	LD50>0.55 lb a.i./A (468170-20)	----	----
Predatory mite (*Typhlodromas pyri*)	----	----	----	LD50>0.55 lb a.i./A (468170-19)	----	----
Ladybird Beetle (*Coccinella septempunctata*)	----	----	----	----	45-day LD50=0.089 lb a.i./A NOAEC = 0.04 lb a.i./A (468170-15)	----
	----	----	----	----	47-day Life Cycle LD50=0.41 lb a.i./A NOAEC = 0.24 lb a.i./A (468170-17)	----
White springtail soil arthropod (*Folsomia candida*)	----	----	----	----	NOAEC = 31.6 mg a.i./kg (dw) LOAEC= 31.6 mg a.i./kg (dw) (468170-27)	----
Green lacewing (*Chrysoperla carnea*)	----	----	----	----	LD50=0.160 lb a.i./A (468170-18)	----

Table 11 and **Table 14** present a comparison of toxicity between flubendiamide and the degradate des-iodo. Based on the spiked overlying water studies with the freshwater benthic invertebrate, *Chironomus riparius*, the degradate des-iodo demonstrates similar toxicity to flubendiamide. The des-iodo NOAEC, based on measured pore water concentrations was 0.28 µg a.i./L (MRID 468170-23). The flubendiamide NOAEC, based on measured pore water

concentrations, could not be determined (MRID 468170-22); however, the pore water concentrations of the LOAEC were measured. The 28-day sediment toxicity test determined a NOAEC of 40 μg a.i./L and a LOAEC of 80μg a.i./L based on nominal overlying water concentrations. The study reported measured time weighted average concentrations in pore water corresponding to some of the nominal dose groups. For example, the pore water concentration corresponding to the LOAEC was 3 μg a.i./L, while the pore water was not measured at the NOAEC. The relationship between nominal overlying water and measured pore water at the LOAEC, when applied to the NOAEC, would yield an estimated pore water concentration of 1 μg/L. Based on the LOAEC and estimated NOAEC for flubendiamide, the toxicity of the degradate is within one order of magnitude of flubendiamide. However, these studies were conducted with spiked water and not spiked sediment, and the sediment concentrations of the chemicals were not measured lending uncertainty to the bioavailable concentrations in the pore water. Thus, these studies suggest that flubendiamide and des-iodo are of equal toxicity to the freshwater midge, *Chironomus riparius*. Unless additional data is available that determines otherwise, flubendiamide and the des-iodo degradate are considered equally toxic to aquatic organisms for the purposes of this ecological risk assessment. The NOAEC for des-iodo will be used to calculate risk to freshwater benthic invertebrates.

Table 11 also presents a comparison of toxicity between the formulations and the parent and degradate. Flubendiamide and des-iodo degradate did not demonstrate acute toxicity to the freshwater invertebrate, *Daphnia magna*, up to their respective limits of water solubility. In contrast, both the SC and WG formulation are considered very highly toxic to the freshwater invertebrate, *Daphnia magna* (EC_{50} = 2.6 and 1.5 μg a.i./L, respectively). A comparion of toxicity could also be made based on the available chronic data for freshwater invertebrates. The SC formulation impacted survival and reproduction in *Daphnia magna* (NOAEC = 0.38 μg a.i./L) at concentrations 2 orders of magnitude lower than at concentrations of TGAI flubendiamide that produced reproductive effects in the same species (NOAEC = 41.1 μg a.i./L). These data indicate that the formulations are markedly different in toxicity to freshwater inverterbrates. The available data on freshwater fish indicate the parent and WG formulation are both limited in toxicity by their solubilities.

Aquatic Field Study

In a mesocosm study (468170-02), the ecological effects of the SC formulation were determined for different trophic levels including phytoplankton, zooplankton, aquatic macroinvertebrates, and emergent insects (no fish). The SC formulation was applied once onto the water surface in May 2003 and included five treatment levels 0.4, 1.0, 2.3, 5.3 and 12 μg a.i./L. There were two replicates of the 0.4 – 5.3 μg a.i./L groups and no replication of the 12 μg a.i./L treatment group. There were three control tanks. The mesocosms were observed two weeks before and 16 weeks after treatment.

A significant number of taxa developed in the mesocosms: 36 zooplankton species, 21 macrozoobenthic organisms, 49 emerging insect species, and 7 classes of phytoplankton. Of these, the Cladocera *Daphnia longispina* was the most sensitive species.

Based on the observed effects on *Daphnia longispina* as the most sensitive species, the NOAEC on the population and community level for the zooplankton was 1.0 μg/L. Persistent effects were not observed for any taxon in the study up to the highest treatment level (12 μg/L), but there was no replication at this level. As a result, the NOAEC for this study is 5.3 μg/L for the zooplankton.

Regarding macroinvertebrates, the artificial substrate samplers did not indicate persistent effects for any taxon as well as for the macroinvertebrate community for all treatment levels. Additionally, no direct effects were observed on the phytoplankton.

This study is classified as supplemental due to deviations from guidelines including a finfish population was not investigated; the 12 μg/L level was not replicated, and only two replicates were included for the remainder of treatment levels (excluding controls, where three replicate ponds were maintained); and flubendiamide levels in biota were not determined.

5. RISK CHARACTERIZATION

5.1 Risk Estimation

Results of the exposure and toxicity effects data are used to evaluate the likelihood of adverse ecological effects on non-target species. For the risk assessment of flubendiamide, the des-iodo degradate, and the SC and WG formulations, the risk quotient (RQ) method is used to compare exposure and measured toxicity values:

RQ = EEC / (Acute or Chronic Toxicity Values)

where: *EEC* is the estimated environmental concentration generated by the exposure scenarios (see **Appendix E** for the Risk Quotient Method). The RQs are compared to the Agency's levels of concern (LOCs) (See **Appendix F** for Risk Presumptions and LOCs). These LOCs are the Agency's interpretive policy and are used to analyze potential risk to non-target organisms and the need to consider regulatory action. These criteria are used to indicate when a pesticide's use as directed on the label has the potential to cause adverse effects on non-target organisms.

5.1.1 Risk to Aquatic Organisms

The toxicity data does not refute the assumption that flubendiamide and des-iodo degradate are equally toxic to aquatic organisms. Thus, surface water concentrations of the total residues of flubendiamide and degradate, des-iodo, combined, were estimated for each proposed new use and rate increase based on spray drift, runoff, and erosion contributions. The most sensitive toxicity endpoint per taxa between the parent and degradate will be used to derive risk quotients. Surface water concentrations were also estimated for the SC and WG formulations based on the contribution of spray drift alone.

Peak EECs are compared to acute toxicity endpoints to derive acute risk quotients. The 21-day EECs are compared to chronic toxicity endpoints (NOAEC values) to derive chronic risk quotients for aquatic invertebrates. The 60-day EECs are compared to chronic toxicity endpoints (NOAEC values) to derive chronic risk quotients (RQs) for fish.

Freshwater and Estuarine/Marine Fish

No acute toxicity was observed in freshwater fish up to the limits of solubility of flubendiamide (>67.7 μg a.i./L, MRID 46816939), nor in estuarine/marine fish (>29.8 μg a.i./L, MRID 46816938). Similarly, no chronic effects in freshwater fish were observed at the solubility limit for flubendiamide (>60.5 μg a.i./L, MRID 46816947). No chronic toxicity data on estuarine/marine fish are available. Because freshwater and estuarine/marine fish have not been tested up to the highest estimated surface water concentrations for peak and prolonged exposures of the total residues (187 μg/L), risk to freshwater and estuarine/marine fish from flubendiamide applications cannot be precluded.

Available data indicate that the SC formulation is not toxic to freshwater fish up to limit of solubilty of flubendiamide (>91.1 μg a.i./L, MRID 46816943). Risk quotients based on spray-drift only EECs for freshwater fish were not derived and risk to this taxon is expected to be low based on limited exposure. Based on lack of data, risk to estuarine/marine fish from direct exposure to the formulations cannot be precluded.

Freshwater Invertebrates

Acute Risk

No acute toxicity was observed at the solubility limits of flubendiamide and des-iodo degradate for the freshwater invertebrate, *Daphnia magna* (flubendiamide and des-iodo LC50, >54.8 μg a.i./L and >881 μg a.i./L, respectively). Because no effects on *Daphnia magna* was reported for des-iodo at the limit of its solubility (187 μg/L), freshwater invertebrate acute risk quotients were not calculated. Because acute toxicity to Daphnia magna is limited by solubility, acute risk to freshwater invertebrates from exposures to the total residues of flubendiamide and des-iodo degradate is not expected.

However, the formulated products of flubendiamide are expected to enter surface primarily via spray drift. Thus, freshwater invertebrate acute RQs were calculated to assess the risk posed by the formulation entering surface water by spray drift only.

The BELT™ SC formulation is classified "very highly toxic" to freshwater invertebrates (daphnids) on an acute basis. Based on the EC50 of 2.6 μg a.i./L, acute RQs exceed the acute listed species LOC (0.05) for proposed aerial uses on field and nut crops (uses with a single maximum application rate of 0.125 μg a.i./L) and exceed the acute restricted use LOC (0.1) for the proposed aerial applications on the vegetable and low growing berry subgroup (uses with a single maximum application rate of 0.075 μg a.i./L) (**Table 15**). There are no LOC exceedances for ground applications of BELT™ SC formulation.

The SYNAPSE™ WG formulation is also classified "very highly toxic" to freshwater invertebrates (daphnids) on an acute basis. Based on the EC50 of 1.5 μg a.i./L, acute RQs exceed the acute listed species LOC and the acute restricted use LOC for the aerial uses on all proposed crops. For ground applications, RQs exceed the acute listed species LOC for proposed uses on field and nut crops (single maximum application rate of 0.125 μg a.i./L) (**Table 15**). There are no other RQ exceedances for ground applications of SYNAPSE™ WG formulation.

Table 15. Acute Risk Quotients for freshwater invertebrates based on formulation drift only EECs following one application and formulation toxicity values				
Crops (application rate)	**Formulation EEC (µg/L)**		**BELT™ SC RQ EC_{50} = 2.6 µg/L**	**SYNAPSE™ WG RQ EC_{50} = 1.5 µg/L**
Field and Nut Crops (0.125 µg a.i./L)	Aerial	0.35	**0.1***	**0.23***
	Ground	0.07	0.03	**0.05****
Vegetable and Low Growing Berry (0.075 µg a.i./L)	Aerial	0.21	**0.08****	**0.14***
	Ground	0.04	0.02	0.03

* Exceeds Acute Federally Listed Species Risk LOC (0.05) and Acute Restricted Use LOC (0.1)

** Exceeds Acute Federally Listed Species Risk LOC (0.05)

[1] Aerial application prohibited for the proposed applications on pistachio and the small fruit vine climbing subgroup

Chronic Risk

In the daphnid life cycle test on flubendiamide, an increase in the number of eggs aborted and the number of dead neonates was observed at 68.5 µg a.i./L (LOAEC) which was the highest concentration of the technical grade flubendiamide tested; the NOAEC for the study was 41.1 µg a.i./L. These concentrations are above the solubility limit of 29 µg a.i./L for flubendiamide technical, presumably because the use of the solvent, dimethylformamide, increased the solubility of the chemical. Based on the maximum expected concentration of flubendiamide and des-iodo in the water, the resulting RQ for the highest EEC calculated for the proposed new uses and use rates exceeded the chronic risk LOC, while the lowest EEC calculated did not.

Table 16. Chronic Risk Quotients for Freshwater Invertebrates based on the High and Low Estimated Concentrations of the Total Residues of Flubendiamide and Des-iodo in Surface Water		
Crop (application)	**1 in 10 year 21-day av. concentration (µg/L; ppb)**	**Risk Quotient NOAEC = 41.1 µg a.i./L**
Sugarcane (aerial)	187	**4.5***
Stawberry and Low Growing Berry Subgroup (ground)	8.78	0.22

* Value Exceeds Aquatic Invertebrate Chronic Risk LOC (1.0) for Listed and Non-listed Species

In a 28-day subacute toxicity study of des-iodo degradate with the midge, *Chironomus riparius,* (MRID 468170-23), the percent emergence was adversely affected at 8.0, 16 and 32.0 µg metabolite/L, based on nominal overlying water concentrations. The NOAEC value is 1.9 µg metabolite/L (time-weighted measured overlying water) and 0.28 µg metabolite/L (time-weighted measured pore water), based on 16.7% reductions in percent emergence compared to the control. As presented in **Table 17**, the high and low chronic RQs based on these NOAEC values for the water column and pore water EECs exceed the Agency's chronic risk LOC; thus, chronic RQs for all modeled use scenarios exceed the Agency's LOC.

Chronic risk to freshwater invertebrates from exposures to the total residues of flubendiamide in the water column and pore water is expected.

Table 17. Chronic Risk Quotients for Freshwater Invertebrates based on the High and Low Estimated Concentrations of the Total Residues of Flubendiamide and Des-iodo in Pore Water

	Water Column Concentrations		Pore Water Concentrations	
Use (application)	1 in 10-year 21-day av. EEC in Water Column (µg/L)	RQ MRID 468170-23 NOAEC = 1.9 µg/L	1 in 10-years 21-day av. EEC in Benthic Pore Water (µg/L)	RQ MRID 468170-23 NOAEC = 0.28 µg/L
Sugarcane (aerial)	187	98*	187	670*
Stawberry and Low Growing Berry Subgroup (ground)	8.78	4.62*	8.69	31.0*

* Value Exceeds Aquatic Invertebrate Chronic Risk LOC (1.0) for Listed and Non-listed Species

In a daphnid life-cycle test with the formulation BELT™ SC, the NOAEC and LOAEC were 0.38 µg a.i./L and 1.18 µg a.i./L, respectively, based on parental mortality and sub-lethal effects. Other adverse effects reported in the study included inhibition in time to first offspring emergence. In comparing the NOAEC to the formulation drift-only EECs following one application, the resulting RQs for aerial and ground applications of all proposed new uses do not exceed the Agency's chronic risk to aquatic invertebrate LOC of 1.0 (**Table 18**). Considering multiple spray applications, risk to freshwater invertebrates from repeated, or chronic, immediate exposure to the spray drift from formulation BELT™ SC is not expected. Chronic freshwater invertebrate effects data on the SYNAPSE™ WG formulation are not available; however, because the acute freshwater invertebrate EC50 values based on the SC and WG formulations are almost identical, risk to freshwater invertebrates from chronic exposure to the WG formulation is not expected.

Table 18. Chronic Risk Quotients for freshwater invertebrates based on formulation drift only EECs following one application and formulation toxicity values

Crops (application rate)		Formulation EEC (µg/L)	BELT™ SC RQ NOAEC = 0.38 µg/L
Field and Nut Crops (0.125 µg a.i./L)	Aerial	0.35	0.92
	Ground	0.07	0.18
Vegetable and Low Growing Berry (0.075 µg a.i./L)	Aerial	0.21	0.55
	Ground	0.04	0.11

* Value Exceeds Aquatic Invertebrate Chronic Risk LOC (1.0) for Listed and Non-listed Species

Mesocosm Study

The study designated as MRID 468170-02 is a mesocosm study involving application of flubendiamide product 480 SC to the aqueous compartment. Initial evaluation of effects endpoints expressed the values in terms of nominal additions of the active ingredient per liter of overlying water. Reliance on overlying water concentration units for effects endpoints might be appropriate for organisms residing in the pelagic zone; it is not the optimal expression of effects endpoints for benthic and sediment-dwelling organisms.

<u>Consideration of cladoceran effects data in comparison with the mesocosm results</u>

The EFED risk assessment identifies an acute effects endpoint (EC50) for the cladoceran, Daphnia magna, of 2.6 µg/L active ingredient when introduced to the test system as BELT™ SC formulation. The no observed adverse effect concentration (NOAEC) for this same study is 0.45 µg/L. The risk assessment also reports a chronic reproduction NOAEC of 0.38 and a lowest adverse effect concentration (LOAEC) of 1.18 µg a.i./L for the same formulation in the same cladoceran species. These endpoints can be compared to cladoceran endpoints from the mesocosm study, expressed as overlying water concentrations to determine if the two suggest similar effects levels.

Figure 27 from the mesocosm study presents the results of the cladoceran D. longispina at 0 through 112 days following administration of the SC formulation to the overlying water. At the highest introduction rate, 12 µg a.i./L, the product produced marked decreases in the number of individuals through 35 days post treatment with indications of an upward recovery in the species occurring at 28 days post treatment. The following **Table 19** presents the corresponding measured water concentrations for this time period.

Table 19. Estimates of bioavailable water column flubendiamide concentrations in the first 35 days of the mesocosm study

Day	Water Concentration µg a.i./L	Bioavailable Water Concentration µg a.i./L*
0	3.52	2.8
2	10.4	8.3
4	9.88	7.9
7	9.1	7.3
14	9.1	7.3
21	8.0	6.4
28	7.4	5.9
35**	6.2	5.0

* Assumes 80% dissolved fraction as per page 204 of the study
** Recovery potentially observed for *D. longispina*

From the above table it appears that daphnia show recovery as the concentration of the active ingredient falls below 6 µg a.i./L. This concentration falls just above the EC_{50} for single species water only testing of the other cladoceran *D. magna* (2.6 µg a.i./L) for the SC formulation. It is also remarkably close to the chronic LOAEC for *D. magna* (1.8 µg a.i./L). Taken as a whole, all these lines of evidence support effects endpoints for the SC formulation somewhere in the vicinity of 0.4 to 6 µg a.i./L for certain water column dwelling invertebrates, both over the short term of a few days to multiple weeks of exposure (**Table 20**).

Table 20. Risk Quotients for flubendiamide in the water column (MRID 46817002) based on formulation drift only EECs following one application to sugarcane and small fruit vine climbing crop groups, respectively

Spray Application		21-day EEC in Water Column (µg/L)	Low Estimate of NOAEC = 0.4 µg a.i./L	High Estimate of NOAEC = 6 µg a.i./L
Field and Nut Crops (0.125 µg a.i./L)	Aerial	0.35	0.88	0.06
	Ground	0.07	0.18	0.01
Vegetable and Low Growing Berry (0.075 µg a.i./L)	Aerial	0.21	0.53	0.04
	Ground	0.04	0.10	0.01

* Exceeds Chronic Risk Listed and Nonlisted Invertebrate LOC (1.0)

Consideration of benthic fauna effects data in comparison with the mesocosm results

No chronic formulation toxicity data on benthic fauna are available, however data are available on flubendiamide technical. The EFED risk assessment reports a 28-day sediment toxicity test NOAEC of 40 µg a.i./L and a LOAEC of 80 µg a.i./L nominal in overlying water (MRID 468170-22). However, the study only reports measured time weighted average concentrations in pore water for some of these treatment groups; as such, the pore water concentration of the LOAEC (3 µg a.i./L) was measured, but the NOAEC was not. While the pore water was not measured at the NOAEC, a rough estimate can be made using the ratio at the LOAEC between the nominal overlying water concentration and the time-weighted averaged measured pore water concentration. Applying this ratio to the nominal overlying water concentration at the NOAEC yields an estimated pore water concentration of 1 µg/L. These pore water concentrations can be compared to benthic invertebrate results from the mesocosm study.

The mesocosm study does not present sediment concentrations in pore water units. However, the study does present total dry weight sediment concentrations and the data from the study suggest that there were no effects on chironomid numbers or general benthic invertebrate abundance at even the highest dose group of 12 µg a.i./L in overlying water. Measured sediment concentrations at this dose group ranged from 21 to 57 µg a.i./kg dry weight. Converting this range of sediment concentrations to a conservative estimate of a corresponding pore water concentration can be made using the following formula:

Concentration in pore water = Concentration in bulk sediment/($K_{oc} \times F_{oc}$)

where: Dry weight sediment is a conservative substitute for bulk sediment concentration
K_{oc} is 1954 for the active ingredient
F_{oc} is 0.039 as reported in the mesocosm study

This yields a range in estimated pore water concentrations of 0.27 to 0.74 µg a.i./L. It should be noted that these are likely overestimates of pore water concentrations as the water fraction of sediment is removed in the dry sediment measurements, thereby inflating the bulk sediment concentrations.

It can be seen from a comparison of estimated mesocosm pore water to chironomid chronic sediment NOAEC and LOAEC values, that the mesocosm study does not achieve sufficient pore water concentrations (0.27 to 0.74 µg a.i./L) to approach concentrations in single species sediment testing that elicit adverse effects (LOAEC = 3 µg a.i./L). Therefore there is insufficient information in the mesocosm study to refute the accuracy of effects concentrations achieved with a single species sediment toxicity study.

Estuarine/Marine Invertebrates

For acute risk to marine crustaceans (mysid) ($EC_{50} > 28$ µg a.i./L, MRID 46816936) and marine mollusks (oyster) ($EC_{50} > 49$ µg a.i./L, MRID 46816935), there was no toxicity observed at the highest concentration of the technical grade flubendiamide tested, which was at the limit of solubility. Because estuarine/marine invertebrates have not been tested up to the highest estimated surface water concentrations for peak and prolonged exposures of the total residues (187 µg/L), risk to estuarine/marine invertebrates from flubendiamide applications cannot be precluded.

Due to lack of data, and the acute toxicity of the formulations to freshwater invertebrates, there is uncertainty regarding risk to estuarine/marine invertebrates. Acute risk to estuarine/marine invertebrates from exposure to the SC and WG formulations is presumed. Due to the low chronic risk for freshwater invertebrates exposed to the SC formulation, chronic risk to estuarine/marine invertebrates is expected to be low.

Aquatic Plants

RQs were not derived for aquatic plants because no toxicity to flubendiamide was observed in the available studies with aquatic vascular and non-vascular plants at the limit of flubendiamide's solubility. These toxicity concentrations are lower than the assumed surface water concentrations for peak and prolonged exposures of the total residues (187 µg/L) of flubendiamide and des-iodo. Thus, based on lack of toxicity data on the des-iodo degradate, risk to aquatic vascular and nonvascular plants cannot be precluded. In addition, no toxicity was observed at the highest concentration of the BELT™ SC formulation tested in the non-vascular aquatic plant study (*Pseudokirchneriella subcapitata*).

5.1.1 Risk to Terrestrial Organisms

Birds

Acute RQs were not derived for birds exposed to Flubendiamide technical based on non-definitive endpoints. The LD_{50} and LC_{50} for birds were >2000 mg/kg bw (MRID 46817003) and >4535 mg/kg diet (MRID 46817005), respectively, and no treatment related mortalities (or sublethal effects) were observed. In a similar fashion, the LD_{50} for bobwhite quail exposed to the BELT™ SC formulation (MRID 46817004) was non-definitive, > 2000 mg/kg bw, and RQs were not derived. No treatment related mortalities (or sublethal effects) were observed in the formulation study. Flubendiamide is considered practically non-toxic to birds on an acute dose basis, and at the most, slightly toxic to birds on a subacute dietary basis.

The most sensitive chronic avian NOAEC and LOAEC were 98 mg a.i./kg and 298 mg a.i./kg, respectively, based on the results of a mallard duck reproductive toxicity study (MRID 46817005). The effects reported in the study included a 17% reduction in the number of viable embryos of eggs set and a 3% decrease in percentage of hatchling survivors relative to controls. Chronic LOCs are not exceeded for any use (**Table 21**). Chronic risk to birds from flubendiamide exposure is not expected.

Table 21. Avian Chronic Dietary Risk Quotients[1] (Dietary-based EEC/ NOAEC) based on Maximum Use Rates

USE	Avian Dietary Item			
	Short Grass	**Tall Grass**	**Broadleaf plants/small insects**	**Fruits/pods/seeds/ large insects**
Alfalfa	0.57	0.26	0.32	0.04
Brassica Leafy Vegetables and Turnip Greens	0.50	0.23	0.28	0.03
Globe Artichoke	0.52	0.24	0.29	0.03
Peanut, Sorghum, Sugarcane,	0.80	0.37	0.45	0.05

Sunflower, Safflower, Pistachio,				
Small Fruit Vine Climbing	0.83	0.38	0.47	0.05

[1] Chronic Terrestrial Animal LOC = 1.0

Mammals

Because the LD_{50} for mammals was >5000 mg/kg bw (MRID 46817143), RQs were not calculated. No treatment related mortality was reported in the acute mammalian studies. Flubendiamide is classified practically non-toxic on an acute basis.

In a two-generation rat reproduction study with flubendiamide, frank developmental and reproductive effects were not observed (MRID 46817216). No reproductive toxicity was observed up to the limit concentration, 20,000 mg/kg diet. Risk Quotients were not calculated because of the lack of frank reproductive effects.

Terrestrial Plants

Potential exposures to terrestrial plants were not evaluated because available data suggest that effects are not expected to occur at up to the maximum labeled application rate. Therefore, potential risks to terrestrial plants are presumably lower than levels of concern.

Terrestrial Invertebrates

EFED currently does not routinely quantify risks to terrestrial non-target insects; thus, an RQ is not calculated. Instead, risk to terrestrial invertebrates is based on a qualitative, weight-of-evidence approach accounting for available toxicity data and the proposed use patterns (*e.g.*, single maximum use rates).

Flubendiamide end use products were designed to be effective against Lepidoptera pests, but safe for beneficial natural predators of Lepidoptera so it could be used in integrated pest management (IPM) programs (Tohnishi *et al* 2005).

Lepidotera species

Nontarget Lepidoptera species (including Federally listed species) are at risk from flubendiamide applications due to flubendiamide's known toxicity to target Lepidopteran pests.

Lepidoptera predators

Extended laboratory studies were conducted by exposing the parasitoid wasp (Aphidius rhopalosiphi) and predatory mite (Typhlodromas pyri) to the SYNAPSE™ WG and the BELT™ SC formulations. The WG formulation resulted in significant reductions in survival and reproduction for the wasp yielding NOAEC = 0.17 and LD50 >0.55 lb a.i./A (MRID 46817020). The results of the predatory mite study exposed to the 24 WG formulation showed significant reductions in survival (14%) and reproduction (24%) with reported NOAEC and LOAEC values of 0.31 and 0.55 lb a.i./A, respectively (MRID 46817019). The LD50 was >0.55 lb ai/A. However, because the single maximum application rates to the proposed new uses and use rate

(0.125 lb a.i./A) are below the NOAEC; significant adverse effects to parasitoid wasps and predatory mite are not expected for the WG formulation.

The SC formulation resulted in significant reductions in survival in the parasitoid wasp in two tests (different range of concentrations tested), and the resulting NOAEC values were <0.2 and 0.39 lb a.i./A. The LD50 values were 0.423 and 0.60 lb a.i./A. In the first test, significant mortality was observed at all test concentrations resulting in NOAEC <0.2 lb a.i./A (MRID 46817021). However, mortality was not observed in the second test at the same concentration (MRID 46817021); therefore, there is uncertainty regarding the NOAEC values for mortality. Because the single maximum application rate to the proposed new uses for the SC formulation, 0.075 lb a.i./A, are below the LD50 (and the NOAEC for test #2), significant adverse effects to parasitoid wasps are not expected for the SC formulation.

Three extended laboratory experiments were conducted exposing the ladybird beetle (*Coccinella septempunctata*) to the BELT™ SC formulation. When the ladybird beetle larvae were placed on apple leaves (*Malus domestica*) treated with the test material, larval survival was affected yielding LD50, NOAEC, and LOAEC values of 0.41, 0.24, and 0.60 lb a.i./A, respectively (MRID 46817017). Because the proposed single maximum application rate (0.075 lb a.i./A) for the SC formulation is less than the NOAEC, adverse effects to ladybird beetles due to contact with residues are not expected for the SC formulation. When the beetles were exposed to freshly-dried and 14-day old residues on vine (*Vicia faba*) plants and fed treated aphids, survival and reproduction remained unaffected during both assays, yielding LD50, NOAEC, and LOAEC values of >0.17, 0.17, and >0.17 lb a.i./A, respectively (MRID 46817016). However, there is a potential for adverse effects to adult ladybird beetles due to ingestion of food items (aphids and pollen) containing flubendiamide residues. When the ladybird beetles were exposed to treated apple leaves and fed treated aphids (*Acyrthosiphon pisum*) and pollen, adult survival was affected yielding LD50, NOAEC, and LOAEC values of 0.089, 0.04, and 0.079 lb a.i./A, respectively (MRID 46817015). There were no effects to larval survival or reproduction.

An extended toxicity study was conducted with the green lacewing (*Chrysoperla carnea*) to determine the effect of BELT™ SC on larval mortality and reproduction (MRID 46817018). There was no significant dose-response relationship for larval mortality (LD50> 0.16 lb a.i./A) and no significant effect on reproduction (hatching rate and fertile eggs/female/day) (NOAEC = 0.16 lb ai/A). Because the proposed single maximum application rate (0.125 lb a.i./A) for the SC formulation is below the NOAEC, adverse effects to green lacewings due to contact with residues are not expected for SC formulation.

As the comparison of toxicity and exposure demonstrates, lepidopteran predators range in sensitivity to flubendiamide based on environmentally relavent concentrations of the proposed new uses and rate increase. Based on adverse effects to the ladybird beetle, lepidopteran predators have the potential to be adversely affected by the proposed new flubendiamide applications.

Soil dwelling invertebrates

Data from the acute earthworm toxicity studies demonstrated that flubendiamide technical, formulations SYNAPSE™ WG and BELT™ SC (MRIDs 46817029, -7032, -7031, and -7029), and the des-iodo degradate (MRID 46817030) all have a LD50 > 1000 mg a.i./kg (based on mortality). Considering all earthworm chronic toxicity data (MRIDs 46817032 and -7031), only the WG formulation demonstrated effects with a resulting NOAEC of 562 mg a.i./kg based on a significant reduction in the number of juveniles.

Chronic toxicity data for the white springtail soil arthropod (MRID 46817027) demonstrated a chronic toxicity NOAEC of 31.6 mg a.i./kg dw based on the number of juveniles produced.

As an exercise to characterize the soil dwelling invertebrate toxicity at relevant environmental concentrations, EFED calculated estimated concentrations of flubendiamide in the soil based on the following factors:

1) a single maximum application rate of 0.125 lbs a.i./acre

2) the range of bulk densities in the PRZM EXAMS scenario soils which were 1.3 to 1.84 g/cm3 in the top 10 cm of soil

3) an assumed soil incorporation depth of 1 cm (assumed depth since this is not a soil incorporated product. Using

Thus based on these factors, soil concentrations were calculated as follows:

$$C_{Soil} = \frac{\text{Application Rate (mg/cm}^2\text{)}}{\text{Soil Incorporation Depth (cm)} \times \text{Bulk Density (kg/cm}^3\text{)}}$$

When bulk density = 1.3 g/cm3, Csoil = 1.078 mg /kg soil; below all acute and chronic toxicity endpoint values for soil dwelling terrestrial invertebrates.

When bulk density = 1.84 g/cm3, Csoil = 0.7614 mg /kg soil; below all acute and chronic toxicity endpoint values for soil dwelling terrestrial invertebrates.

Based on the above calculations, the estimated concentrations of flubendiamide in the soil are below any levels that have been shown to cause adverse toxic effects to earthworms and white springtail arthropods.

Toxicity to Bees - Beneficial Pollinators

Flubendiamide technical and BELT™ SC formulation were classified as practically non-toxic to honey bees (LD50 >200 µg/bee) based on an acute contact exposure (MRID 46817009); therefore, acute contact adverse effects on bees are not expected from flubendiamide exposures.

The effects of the BELT™ SC formulation on the honey bee were also evaluated under semi-field conditions by exposing honey bees to plots of the wildflower, lacy phacelia (*Phacelia tanacetifolia*), treated at application rates of 0.08 and 0.16 lb a.i./A (MRID 46817010). No adverse effects were observed in mortality, flight intensity, or behavior during the test. Brood development was slightly reduced following initiation in the 0.16 lb a.i./A, but recovery was observed. The effects of the SYNAPSE™ WG formulation on the bumblebee (*Bombus terrestris*) exposed for 27 days to plots of tomatoes (*Lycopersicon esculentum*) treated with the WG formulation at 0.160 lb a.i./A in a greenhouse was studied. The test material did not yield any deleterious impacts on pollination activity, flight frequency, or hive condition. Based on the proposed single maximum application rate of 0.125 lb ai/A, significant effects to bumble bees and honey bees are not expected following application of both formulations to the proposed crops.

5.2 Risk Description

The results of the risk estimation indicate that applications of the proposed uses and rates of flubendiamide may have direct adverse effects on, or that effects cannot be precluded to, freshwater and estuarine/marine fish, invertebrates, and aquatic plants. Sensitive beneficial arthropods, particularly Lepidoptera species, including endangered species, may also be impacted by the labeled use of flubendiamide. Lepidoptera may occur in areas adjacent to treated fields (where they may be exposed to spray drift) and will likely move through treated fields. Additionally, the larvae of some lepidopteran species are aquatic (Merrit and Cummins, 1984) and, therefore, may be exposed to the TGAI, formulations, and/or des-iodo degradate in the water column. Based on the potential for direct effects to these taxa, there may be potential indirect effects to species of concern that depend on these taxa as a source of food or pollination.

5.2.1 Risks to Aquatic Organisms

Fish

Available data on flubendiamide demonstrate that acute and chronic toxicity to freshwater and estuarine/marine fish is limited by solubility. However, no data is available on the toxicity of the degradate to these same taxa. Based on lack of toxicity data on the des-iodo degradate, and that EECs exceed the concentrations tested in fish, risk to freshwater and estuarine/marine fish from flubendiamide applications cannot be precluded. Unless data is generated that refutes the assumption of equal toxicity between flubendiamide and the degradate, acute and chronic toxicity to freshwater and estuarine/marine fish is presumed from exposure to the total residues of flubendiamide and the des-iodo degradate.

No effects to freshwater fish resulted from acute exposure to the BELT™ SC formulation up to flubendiamide's limit of solubility. Risk to freshwater fish from exposure to the SC formulation is not expected. However, risk to estuarine/marine fish from direct exposure to the formulations cannot be precluded based on lack of data.

Aquatic Invertebrates

No acute risk is expected to freshwater invertebrates from exposures to the total residues of flubendiamide and the des-iodo degradate because toxicity is limited by solubility; however, due to the lack of toxicity data on the des-iodo degradate, and that EECs are higher than the highest concentrations tested, acute risk is presumed for estuarine/marine invertebrates from exposures to the total residues of flubendiamide and des-iodo degradate. Freshwater and estuarine/marine invertebrates are at acute risk from spray drift exposure to the formulations SC and WG.

There is chronic risk to freshwater invertebrates from exposures in the water column and pore water from the total residues of flubendiamide and des-iodo. Due to the lack of data on the des-iodo degradate, and that EECs are higher than the highest concentrations tested, chronic risk to estuarine/marine invertebrates is presumed. Chronic risk to freshwater and estuarine/marine invertebrates from exposure to flubendiamide formulations is not expected.

Based on the available guideline toxicity data, formulations of flubendiamide are more toxic to freshwater invertebrates than the active ingredient. This conclusion is supported by the results of the formulation-based mesocosm study results for daphnid species which show effects concentrations on par with single species testing endpoints for the same formulation. Confidence in the risk conclusions is high given that the laboratory data are supported by results of mesocosm studies for aquatic organisms.

Some larvals stages of lepidopteran species are aquatic (Merrit and Cummins, 1984). The degree to which the mode of action of flubendiamide is conserved across aquatic invertebrates is unknown. Because none of the surrogate aquatic invertebrates are lepidopertan species, toxicity and risk to aquatic invertebrates could potentially be greater than this risk assessment indicate.

Implications for aquatic resources

The acute and chronic endpoints based on chironomid toxicity data serve as the primary basis for conducting the freshwater invertebrate risk assessment. It is not surprising that aquatic insect larvae, such a chironomids, are sensitive to flubendiamide and its toxic degradates, given that flubendiamide is an insecticide. However, it is notable that, compared to the other freshwater invertebrates tested, insect larvae may possibly be more sensitive than other tested freshwater invertebrate species. The following provides a discussion on the ecological implications of effects to chironomids and other aquatic invertebrates.

Coffman and Ferrington (1996) provide some insight in their characterization of the family. They maintain that the Chironomidae family is an ecologically important group of aquatic insects that often is found in high densities. Densities of up to 50,000 larvae per square meter of benthic substrate have been reported. Aquatic systems exhibit a high diversity of chironomids as well. The number of chironomid species in most systems accounts for at least 50% of the total macroinvertebrates present. Natural lakes, ponds, and streams may exhibit 50, 100, or more chironomid species. The short life cycles of these organisms, coupled with the large larval biomass in aquatic systems indicates a significance in the overall energy flow through aquatic systems. Chironomids feed on a great variety of organic substrates including coarse leaf litter, medium and fine detrital particulate, algae, vascular plants, fungi, and animals. In turn, most aquatic predators feed extensively on chironomids (larvae, pupae, or adults) at some point in their life cycles. Pennak (1978) further states that, from and economic standpoint, chironomid larvae form an important item in the food of young and adult fishes.

Even more significant is the degree to which the disparate sensitivity among freshwater aquatic invertebrates is cause for concern that other potentially high sensitivity species may exist in aquatic taxonomic groups. There exists considerable uncertainty as to the potential for even more sensitive invertebrates, in particular other families of aquatic insects. Representative aquatic insect families may be found in 11 of the 30 to 35 orders of insects (Pennak, 1978).

Aquatic Plants

Based on lack of toxicity data on the des-iodo degradate, risk of the total residues of flubendiamide and des-iodo to aquatic vascular and nonvascular plants cannot be precluded; however, risk to aquatic plants from direct exposure to flubendiamide's formulations is expected to be minimal.

5.2.2 Risks to Terrestrial Organisms

Flubendiamide is expected to be persistent in soil environments. While risk conclusions are based on one season of use, uncertainty exists regarding the build-up of total residues in soil or on dietary items and plants from multiple seasons of use.

Birds and Mammals

Based on a screening assessment for flubendiamide's proposed new uses and new use rate, potential acute and chronic risk to birds and mammals is not expected. Risk quotients were calculated for chronic exposures to birds and were below the level of concern for all uses of flubendiamide.

In a subacute dietary toxicity study, mallard duck was tested up to a dietary concentration of 4535 mg a.i./kg diet, slightly lower than the limit concentration of 5,000 mg a.i./kg diet (MRID 46817005). No treatment-related mortalities or sublethal effects were observed. Based on the acute toxicity categories, flubendiamide is considered "slightly toxic" to mallard duck on a subacute dietary basis. To characterize the risk of this potential toxicity, exposure concentrations are compared to the highest concentration tested in the mallard duck study. The highest EEC calculated is 81.8 mg a.i./kg diet for the proposed new uses for the small fruit vine climbing crop group. This EEC is 60 times lower than 4535 mg a.i./kg diet, the highest concentration tested with mallard duck. Risk to birds on an subacute dietary basis is not expected.

In the mallard duck toxicity test, significant reproductive effects were observed at the treatment levels of 289 and 960 mg a.i./kg diet; therefore the NOAEC is 98 mg a.i./kg diet. In the bobwhite quail toxicity test, no treatment related effects were observed and the NOAEC is 1059 mg a.i./kg diet.

In a two-generation rat reproduction study, frank developmental and reproductive effects were not observed (MRID 46817216). There was no evidence of reproductive impairment in males or females. The NOAEC for reproductive toxicity is 20,000 ppm in that no reproductive toxicity was observed. Risk Quotients were not calculated because of the lack of frank reproductive effects. However, the highest EEC in mammals is not expected to approach 20,000 mg/kg-food.

Terrestrial Plants

Terrestrial and semi-aquatic plants may be exposed to pesticides from runoff, spray drift or volatilization. Based on the proposed maximum single application rate for the proposed new uses and rate increase, risks to terrestrial plants are unlikely.

Terrestrial Invertebrates

The available toxicity data on four Lepidopteran predators was compared to the single maximum application rates for the Synapse and Belt formulations. The comparisons indicate there are effects on mortality to adult ladybird beetles due to ingestion of food items (aphids and pollen) containing environmentally relevant concentrations of flubendiamide residues. No effects at environmentally relevant concentrations of flubendiamide were reported for larval ladybird beetle, parasitoid wasp, predatory mite, or green lacewing; however, effects were observed at concentrations slightly higher than the single maximum application rates of flubendiamide new uses. Based on the observed adverse effects to ladybird beetles, and the expected spectrum of sensitivity across taxa to environmentally-relevant concentrations of flubendiamide, EFED concludes Lepidoptera predators are at risk from the proposed new uses and rate increase of flubendiamide.

Field and laboratory data demonstrate no prolonged effects to honey bees, bumble bees, earthworms or soil arthropods from exposures to environmentally relevant concentrations of flubendiamide's new uses after a single application; however, short-term adverse effects occurred to brood development of honey bees, with recovery demonstrated. Based on these effects, and that an established spectrum of sensitivity exists across invertebrate species to flubendiamide, risks to all terrestrial invertebrates from the proposed new uses and rate increase of flubendiamide cannot be precluded.

6. THREATENED AND ENDANGERED SPECIES CONCERN

To determine whether flubendiamide new use sites are geographically associated with known locations of listed species, a screening-level search of the LOCATES (version 2.10.4) database was conducted (query performed on 10/26/2010). The database compares county-level location data for listed species with county-level crop production data (as available in the 2002 agricultural census) to identify any coarse overlaps of listed species with the proposed labeled uses of flubendiamide.

Based on the endangered species LOC exceedances, concerns for direct effects are identified for non-target insects and aquatic invertebrates in both freshwater and estuarine/marine environments on acute and chronic exposure basis for the proposed new uses of flubendiamide (**Table 22**). There is also a concern for indirect effects to species that have obligate feeding requirements or general dependency on freshwater and/or estuarine/marine invertebrates as a resource. **Appendix G** lists the Federally listed species (1268 species) on which direct and indirect effects could potentially occur due to the co-occurrence with flubendiamide proposed new uses and rates.

Table 22. Listed Species Risks Associated with the Proposed New Uses and Rates of Flubendiamide

Listed Taxa	Direct Effects	Indirect Effects[1]
Terrestrial and semi-aquatic plants – monocots	No	Yes
Terrestrial and semi-aquatic plants – dicots	No	Yes
Birds	No	Yes
Terrestrial phase amphibians	No	Yes
Reptiles	No	Yes
Mammals	No	Yes
Terrestrial insects	Yes	Yes
Aquatic plants	No	Yes
Freshwater fish	Yes[2]	Yes
Aquatic phase amphibians	Yes[2]	Yes
Freshwater invertebrates	Yes[2]	Yes
Mollusks	Yes[2]	Yes
Marine/estuarine fish	Yes[2]	Yes
Marine/estuarine invertebrates	Yes	Yes

[1]The Agency's Level of Concern was exceeded for insects and aquatic invertebrates (freshwater and estuarine/marine) only. However, the potential for adverse effects to those species that rely on the above taxa cannot be precluded.
[2] Risk to taxon based on direct effects is presumed due to lack of data.

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APPENDIX A: Manually Modeling PRZM/EXAMS

- Input flubendiamide parameters into PRZM/EXAMS PE5 shell and run application

- Copy PRZM3.IMP and PRZM3.RUN files to the PRZM3 directory.

- Edit both of the PRZM3.RUN output file paths to the PRZM3.RUN directory address. It is necessary to end the directory file path with a forward slash (\).

- Run the PRZM3122 application within the PRZM3 directory (08-26-08 application creation Date).

- Copy: 1) the PRZM outputs files 61-90 from the PRZM3 directory to the EXAMS folder.
  2) the pz2ex file from the PRZM3 directory to the EXAMS folder.

- Edit the pz2ex file in the EXAMS folder in order to enter des-iodo input parameters.
  set MWT(1) = 682.4
  set VAPR(1) = 1.59e-14
  set SOL(1,1) = 0.187
  set KDP(1,1) = 0.0
  set KOC(1) = 334

- Open the EXAMS application (04-26-05) in the EXAMS folder
  1) Set mode = 3 (press enter)
  2) do pz2ex.exa (press enter)

- Find the Report.xms file and place it in the same directory as Table 20.

- Open the Table 20 application and enter:
  Report.xms (press enter),
  N (press enter),
  Water (press enter),
  B (press enter),
  Y (press enter),
  Pore (press enter),
  Benthos(press enter),
  A (press enter),
  Benthic (press enter),
  B (press enter),
  1960 (press enter),
  1961 (press enter),
  1990 (press enter).

- Run Table 20 Application with the Report.xms file in the same directory.

APPENDIX B: PRZM/EXAMS OUTPUT FILES

<u>Flubendiamide PE5 Shell Inputs for Aerial Applicaton to FL Sugar Cane</u>

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:
Output File: FLSugA
Metfile: w12844.dvf
PRZM scenario: FLsugarcaneSTD.txt
EXAMS environment file: pond298.exv
Chemical Name: Flu-des

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	682.4	g/mol	
Henry's Law Const.	henry		atm-m^3/mol	
Vapor Pressure	vapr	2.85e-12	torr	
Solubility	sol	0.03	mg/L	
Kd	Kd		mg/L	
Koc	Koc	1954.2	mg/L	
Photolysis half-life	kdp	11.58	days	Half-life
Aerobic Aquatic Metabolism	kbacw	0	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	0	days	Halfife
Aerobic Soil Metabolism	asm	0	days	Halfife
Hydrolysis:	pH 7	0	days	Half-life
Method:	CAM	2	integer	See PRZM manual
Incorporation Depth:	DEPI	0	cm	
Application Rate:	TAPP	0.14	kg/ha	
Application Efficiency:	APPEFF	0.95	fraction	
Spray Drift	DRFT	0.05	fraction of application rate applied to pond	
Application Date	Date	10-04	dd/mm or dd/mmm or dd-mm or dd-mmm	
Interval 1	interval	7	days	Set to 0 or delete line for single app.
app. rate 1	apprate	0.14	kg/ha	
Interval 2	interval	7	days	Set to 0 or delete line for single app.
app. rate 2	apprate	0.14	kg/ha	
Record 17:	FILTRA			
	IPSCND	1		
	UPTKF			
Record 18:	PLVKRT			
	PLDKRT			
	FEXTRC	0.5		
Flag for Index Res. Run	IR		EPA Pond	
Flag for runoff calc.	RUNOFF		none	none, monthly or total(average of entire run)

FL Sugarcane przm3.inp File Copied into PRZM3. directory

Fl Sugarcane; 8/10/2001
"Hendry County; MLRA 156A; Metfile: W12844.dvf (old: Met156A.met),"
*** Record 3:
0.78 0 0 32.5 1 1
*** Record 6 -- ERFLAG

```
     4
*** Record 7:
   0.1    0.2      1     10            4      1   356.8
*** Record 8
     1
*** Record 9
     1    0.1     100     100      2  94  91  92      0     300
*** Record 9a-e
     1     25
0101 1601 0102 1602 0103 1603 0104 1604 2504 0105 1605 0106 1606 0107 1607 0108
.194 .215 .240 .268 .300 .334 .358 .584 .638 .673 .675 .666 .662 .650 .631 .636
.014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014
  91   91   91   91   91   91   91   91   91   91   91   91   91   91   91   91
1608 0109 1609 0110 1610 0111 1611 0112 1612
.659 .680 .699 .717 .699 .669 .624 .551 .468
.014 .014 .014 .014 .014 .014 .014 .014 .014
  91   91   91   91   91   91   91   91   91
*** Record 10 -- NCPDS, the number of cropping periods
    30
*** Record 11
  010161  020161  311261      1
  010162  020162  311262      1
  010163  020163  311263      1
  010164  020164  311264      1
  010165  020165  311265      1
  010166  020166  311266      1
  010167  020167  311267      1
  010168  020168  311268      1
  010169  020169  311269      1
  010170  020170  311270      1
  010171  020171  311271      1
  010172  020172  311272      1
  010173  020173  311273      1
  010174  020174  311274      1
  010175  020175  311275      1
  010176  020176  311276      1
  010177  020177  311277      1
  010178  020178  311278      1
  010179  020179  311279      1
  010180  020180  311280      1
  010181  020181  311281      1
  010182  020182  311282      1
  010183  020183  311283      1
  010184  020184  311284      1
  010185  020185  311285      1
  010186  020186  311286      1
```

```
 010187 020187 311287      1
 010188 020188 311288      1
 010189 020189 311289      1
 010190 020190 311290      1
*** Record 12 -- PTITLE
Flub-Desi - 3 applications @ 0.14     0.14     0.14 kg/ha
*** Record 13
    90     1     0     0
*** Record 15 -- PSTNAM
Flub-Desi
*** Record 16
 100461  0 2  0.0  0.14  .95  .05
 170461  0 2  0.0  0.14  .95  .05
 240461  0 2  0.0  0.14  .95  .05
 100462  0 2  0.0  0.14  .95  .05
 170462  0 2  0.0  0.14  .95  .05
 240462  0 2  0.0  0.14  .95  .05
 100463  0 2  0.0  0.14  .95  .05
 170463  0 2  0.0  0.14  .95  .05
 240463  0 2  0.0  0.14  .95  .05
 100464  0 2  0.0  0.14  .95  .05
 170464  0 2  0.0  0.14  .95  .05
 240464  0 2  0.0  0.14  .95  .05
 100465  0 2  0.0  0.14  .95  .05
 170465  0 2  0.0  0.14  .95  .05
 240465  0 2  0.0  0.14  .95  .05
 100466  0 2  0.0  0.14  .95  .05
 170466  0 2  0.0  0.14  .95  .05
 240466  0 2  0.0  0.14  .95  .05
 100467  0 2  0.0  0.14  .95  .05
 170467  0 2  0.0  0.14  .95  .05
 240467  0 2  0.0  0.14  .95  .05
 100468  0 2  0.0  0.14  .95  .05
 170468  0 2  0.0  0.14  .95  .05
 240468  0 2  0.0  0.14  .95  .05
 100469  0 2  0.0  0.14  .95  .05
 170469  0 2  0.0  0.14  .95  .05
 240469  0 2  0.0  0.14  .95  .05
 100470  0 2  0.0  0.14  .95  .05
 170470  0 2  0.0  0.14  .95  .05
 240470  0 2  0.0  0.14  .95  .05
 100471  0 2  0.0  0.14  .95  .05
 170471  0 2  0.0  0.14  .95  .05
 240471  0 2  0.0  0.14  .95  .05
 100472  0 2  0.0  0.14  .95  .05
 170472  0 2  0.0  0.14  .95  .05
```

240472	0	2	0.0	0.14	.95	.05
100473	0	2	0.0	0.14	.95	.05
170473	0	2	0.0	0.14	.95	.05
240473	0	2	0.0	0.14	.95	.05
100474	0	2	0.0	0.14	.95	.05
170474	0	2	0.0	0.14	.95	.05
240474	0	2	0.0	0.14	.95	.05
100475	0	2	0.0	0.14	.95	.05
170475	0	2	0.0	0.14	.95	.05
240475	0	2	0.0	0.14	.95	.05
100476	0	2	0.0	0.14	.95	.05
170476	0	2	0.0	0.14	.95	.05
240476	0	2	0.0	0.14	.95	.05
100477	0	2	0.0	0.14	.95	.05
170477	0	2	0.0	0.14	.95	.05
240477	0	2	0.0	0.14	.95	.05
100478	0	2	0.0	0.14	.95	.05
170478	0	2	0.0	0.14	.95	.05
240478	0	2	0.0	0.14	.95	.05
100479	0	2	0.0	0.14	.95	.05
170479	0	2	0.0	0.14	.95	.05
240479	0	2	0.0	0.14	.95	.05
100480	0	2	0.0	0.14	.95	.05
170480	0	2	0.0	0.14	.95	.05
240480	0	2	0.0	0.14	.95	.05
100481	0	2	0.0	0.14	.95	.05
170481	0	2	0.0	0.14	.95	.05
240481	0	2	0.0	0.14	.95	.05
100482	0	2	0.0	0.14	.95	.05
170482	0	2	0.0	0.14	.95	.05
240482	0	2	0.0	0.14	.95	.05
100483	0	2	0.0	0.14	.95	.05
170483	0	2	0.0	0.14	.95	.05
240483	0	2	0.0	0.14	.95	.05
100484	0	2	0.0	0.14	.95	.05
170484	0	2	0.0	0.14	.95	.05
240484	0	2	0.0	0.14	.95	.05
100485	0	2	0.0	0.14	.95	.05
170485	0	2	0.0	0.14	.95	.05
240485	0	2	0.0	0.14	.95	.05
100486	0	2	0.0	0.14	.95	.05
170486	0	2	0.0	0.14	.95	.05
240486	0	2	0.0	0.14	.95	.05
100487	0	2	0.0	0.14	.95	.05
170487	0	2	0.0	0.14	.95	.05
240487	0	2	0.0	0.14	.95	.05

```
 100488  0 2  0.0  0.14  .95  .05
 170488  0 2  0.0  0.14  .95  .05
 240488  0 2  0.0  0.14  .95  .05
 100489  0 2  0.0  0.14  .95  .05
 170489  0 2  0.0  0.14  .95  .05
 240489  0 2  0.0  0.14  .95  .05
 100490  0 2  0.0  0.14  .95  .05
 170490  0 2  0.0  0.14  .95  .05
 240490  0 2  0.0  0.14  .95  .05
*** Record 17
    0     1     0
*** Record 18
    0     0    0.5
*** Record 19 -- STITLE
Wabasso Fine Sand;  HYDG: D
*** Record 20
   100         0  0  1  0  0  0  0  0  0
*** Record 26
    0     0     0
*** Record 30
    4  1954.2
*** Record 33
    2
    1     10   1.45  0.066     0      0      0
          0      0      0
        0.1   0.066  0.036   2.32     0
    2     90   1.75  0.178     0      0      0
          0      0      0
          5  0.178  0.078   0.29     0
***Record 40
    0
      YEAR     10          YEAR     10          YEAR     10   1
    1
    1 -----
    7   YEAR
  PRCP   TCUM  0  0
  RUNF   TCUM  0  0
  INFL   TCUM  1  1
  ESLS   TCUM  0  0  1.0E3
  RFLX   TCUM  0  0  1.0E5
  EFLX   TCUM  0  0  1.0E5
  RZFX   TCUM  0  0  1.0E5
```

Edited PRZM3.RUN File (path edited to C:\Models\PRZM3\)

```
*** Options
PRZM            ON
VADOFT            OFF
MONTE CARLO           OFF
TRANSPORT           OFF
*** Zone records
PRZM ZONES           1
ENDRUN
*** input file records
 METEOROLOGY      1  C:\models\INPUTS\metfiles\w12844.dvf
 PRZM INPUT      1  przm3.inp
*** output file records
 PATH            C:\Models\PRZM3\
 TIME SERIES      1  FLSugA.zts
 PRZM OUTPUT      1  FLSugA.zpm
*** scratch file records
 PATH            C:\Models\PRZM3\
 PRZM RESTART        RESTART.PRZ
ENDFILES
*** global records
 START DATE         010161
 END DATE          311290
NUMBER OF CHEMICALS    1
ENDDATA
*** display records
ECHO            8
TRACE            ON
```

FL Sugar Cane Pz2ex.exa File Copied into EXAMS Directory

```
set mode = 3
set outfil(1)  to Y
set outfil(4) to Y
set outfil(2) to N
READ ENV C:\models\INPUTS\EXAMSenv\pond298.exv
READ MET C:\models\INPUTS\Metfiles\w93193.dvf
SET YEAR1 = 1961
recall chem 1
chemical name is TTR
set MWT(1) = 556.5
set VAPR(1) = 1.59e-14
set SOL(1,1) = 0.187
set KDP(1,1) = 0.0
set KOC(1) = 334
set QTBAS(*,1,1) = 2
set QTBAW(*,1,1) = 2
```

```
READ PRZM P2E-C1.D61
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
RUN
READ PRZM P2E-C1.D62
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D63
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D64
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D65
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D66
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D67
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
```

```
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D68
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D69
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D70
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D71
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D72
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D73
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D74
```

```
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D75
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D76
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D77
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D78
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D79
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D80
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
```

```
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D81
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D82
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D83
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D84
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D85
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D86
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D87
set STFLO(1,*) = 0.0
```

```
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D88
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D89
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
READ PRZM P2E-C1.D90
set STFLO(1,*) = 0.0
set EVAP(*,*) = 0.0
set NPSFL(*,*)=0.0
set NPSED(*,*)=0.0
set RAIN(*) = 0.0
CONTINUE
QUIT
```

Water File Copied from EXAMS Directory for FL Sugar Cane

WATER COLUMN DISSOLVED CONCENTRATION (PPB)

YEAR	PEAK	96 HOUR	21 DAY	60 DAY	90 DAY	YEARLY
----	----	-------	------	------	------	------
1961	3.986	3.970	3.953	3.909	3.756	1.878
1962	12.450	12.410	12.310	12.180	12.090	8.259
1963	22.040	21.990	21.800	21.660	21.570	16.500
1964	35.710	35.690	35.610	35.430	35.160	28.880
1965	46.600	46.530	46.380	46.080	45.330	39.700
1966	57.170	57.150	57.060	56.900	56.850	51.930
1967	65.300	65.270	65.140	65.000	64.910	60.650
1968	79.750	79.710	79.620	79.480	79.380	72.810
1969	89.770	89.740	89.660	89.560	89.420	84.710
1970	96.780	96.760	96.720	96.650	96.600	93.600
1971	107.000	107.000	106.000	106.000	106.000	101.000
1972	120.000	120.000	120.000	120.000	120.000	115.000

1973	128.000	128.000	128.000	128.000	128.000	124.000
1974	136.000	136.000	135.000	135.000	135.000	132.000
1975	143.000	143.000	143.000	143.000	143.000	139.000
1976	153.000	153.000	153.000	153.000	153.000	148.000
1977	167.000	166.000	166.000	166.000	166.000	160.000
1978	176.000	176.000	176.000	176.000	175.000	171.000
1979	189.000	189.000	189.000	189.000	189.000	183.000
1980	197.000	197.000	197.000	197.000	197.000	193.000
1981	207.000	207.000	207.000	207.000	207.000	202.000
1982	221.000	221.000	221.000	221.000	220.000	215.000
1983	229.000	229.000	229.000	229.000	229.000	225.000
1984	241.000	241.000	240.000	240.000	239.000	235.000
1985	248.000	248.000	248.000	248.000	248.000	244.000
1986	257.000	256.000	256.000	256.000	255.000	252.000
1987	266.000	266.000	266.000	266.000	266.000	261.000
1988	279.000	279.000	279.000	278.000	278.000	273.000
1989	284.000	284.000	284.000	284.000	284.000	281.000
1990	295.000	295.000	295.000	295.000	295.000	290.000

SORTED FOR PLOTTING

PROB	PEAK	96 HOUR	21 DAY	60 DAY	90 DAY	YEARLY
.032	295.000	295.000	295.000	295.000	295.000	290.000
.065	284.000	284.000	284.000	284.000	284.000	281.000
.097	279.000	279.000	279.000	278.000	278.000	273.000
.129	266.000	266.000	266.000	266.000	266.000	261.000
.161	257.000	256.000	256.000	256.000	255.000	252.000
.194	248.000	248.000	248.000	248.000	248.000	244.000
.226	241.000	241.000	240.000	240.000	239.000	235.000
.258	229.000	229.000	229.000	229.000	229.000	225.000
.290	221.000	221.000	221.000	221.000	220.000	215.000
.323	207.000	207.000	207.000	207.000	207.000	202.000
.355	197.000	197.000	197.000	197.000	197.000	193.000
.387	189.000	189.000	189.000	189.000	189.000	183.000
.419	176.000	176.000	176.000	176.000	175.000	171.000
.452	167.000	166.000	166.000	166.000	166.000	160.000
.484	153.000	153.000	153.000	153.000	153.000	148.000
.516	143.000	143.000	143.000	143.000	143.000	139.000
.548	136.000	136.000	135.000	135.000	135.000	132.000
.581	128.000	128.000	128.000	128.000	128.000	124.000
.613	120.000	120.000	120.000	120.000	120.000	115.000
.645	107.000	107.000	106.000	106.000	106.000	101.000
.677	96.780	96.760	96.720	96.650	96.600	93.600

.710	89.770	89.740	89.660	89.560	89.420	84.710
.742	79.750	79.710	79.620	79.480	79.380	72.810
.774	65.300	65.270	65.140	65.000	64.910	60.650
.806	57.170	57.150	57.060	56.900	56.850	51.930
.839	46.600	46.530	46.380	46.080	45.330	39.700
.871	35.710	35.690	35.610	35.430	35.160	28.880
.903	22.040	21.990	21.800	21.660	21.570	16.500
.935	12.450	12.410	12.310	12.180	12.090	8.259
.968	3.986	3.970	3.953	3.909	3.756	1.878
1/10	277.700	277.700	277.700	276.800	276.800	271.800

MEAN OF ANNUAL VALUES = 146.764

STANDARD DEVIATION OF ANNUAL VALUES = 88.831

UPPER 90% CONFIDENCE LIMIT ON MEAN = 170.847

APPENDIX C: Example T-REX Calculation of Avian and Mammalian Risk Quotients for Sorghum, Sugarcane, Sunflower, Safflower, and Pistachio

Chemical Name:	Flubendiamide	
Use	Peanut, Sorghum, Sugarcane, Sunflower, Safflower and Pistachio	
Formulation	BELT SC	
Application Rate	0.125	lbs a.i./acre
Half-life	35	days
Application Interval	7	days
Maximum # Apps./Year	3	
Length of Simulation	1	year

Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs

Table X. Upper Bound Kenaga, Acute Avian Dose-Based Risk Quotients

Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
20	0.00	89.80	#DIV/0!	41.16	#####	50.52	#####	5.61	#####	1.25	#####
100	0.00	51.21	#DIV/0!	23.47	#####	28.81	#####	3.20	#####	0.71	#####
1000	0.00	22.93	#DIV/0!	10.51	#####	12.90	#####	1.43	#####	0.32	#####

Table X. Upper Bound Kenaga, Subacute Avian Dietary Based Risk Quotients

	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
LC50	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	78.85	#####	36.14	#####	44.35	#DIV/0!	4.93	#####

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients								
NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
98	78.85	0.80	36.14	0.37	44.35	0.45	4.93	0.05

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Acute Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted LD50	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	0.00	75.18	#DIV/0!	34.46	#####	42.29	#####	4.70	#####	1.04	#####
35	0.00	51.96	#DIV/0!	23.81	#####	29.23	#####	3.25	#####	0.72	#####
1000	0.00	12.05	#DIV/0!	5.52	#####	6.78	#####	0.75	#####	0.17	#####

Table X. Upper Bound Kenaga, Acute Mammalian Dietary Based Risk Quotients								
LC50 (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	78.85	#####	36.14	#####	44.35	#DIV/0!	4.93	#####

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dietary Based Risk Quotients								
NOAEC (ppm)	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
0	78.85	#####	36.14	#####	44.35	#DIV/0!	4.93	#####

Size class not used for dietary risk quotients

Table X. Upper Bound Kenaga, Chronic Mammalian Dose-Based Risk Quotients											
Size Class (grams)	Adjusted NOAEL	EECs and RQs									
		Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects		Granivore	
		EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
15	0.00	75.18	#DIV/0!	34.46	#####	42.29	#####	4.70	#####	1.04	#####
35	0.00	51.96	#DIV/0!	23.81	#####	29.23	#####	3.25	#####	0.72	#####
1000	0.00	12.05	#DIV/0!	5.52	#####	6.78	#####	0.75	#####	0.17	#####

APPENDIX D: ECOTOX Papers

Acceptable for ECOTOX and OPP

1. Dhawan, A.K., Singh,K., Singh R., and Kumar, T. (2006). Field Evaluation of Flubendiamide (NNI 0001 480 SC) Against Bollworms Complex on Upland Cotton. J. *Cotton Res.Dev.* 20:232-235.

   EcoReference No.: 92630
   Chemical of Concern: FDB,ES; Habitat: T; Effect Codes: POP; Rejection Code: LITE EVAL CODED(FBD).

2. Narayana, S.L. and Rajasri, M. (2006). Flubendiamide 20 WDG (RIL-038) – a new Molecule for the Management of the American Bollworm Helicoverpa armigera on Cottor. *Pestology* 30: 16-18

   EcoReference No.: 92813
   Chemical of Concern: SS,IDC,FBD; Habitat: T; Effect Codes: POP,GRO; Rejection Code: LITE EVAL CODED(FBD).

3. Tomar, S.P.S, Choudhary, R.K., and Shrivastava, V.K (2005). Evaluation of Bioefficacy of Flubendiamide 20 WDG (Ril 038) Against Bollworms on Cotton. J. *Cotton Res.Dev.* 19: 231-233.

   EcoReference No.: 92816
   Chemical of Concern: LCYT,SS,IDC,FBD; Habitat: T; Effect Codes: POP;GRO Rejection Code: LITE EVAL CODED(FBD).

Acceptable for ECOTOX, but not OPP

1. Tohnishi, M., Nakao, H. Furuya, T., Seo, A., Kodama, H., Tsubata, K., Fujioka,S., A., Kodama, H., Hirooka, T., and Nishimatsu, T. (2005). Flubendiamide, a Novel Insecticide Highly Active Against Lepidopterous Insect Pests. *J.Pesitic.Sci.* 30:354-360.

   EcoReference No.: 92541
   Chemical of Concern: FBD,MOM,CYH,EMMBCFP; Habitat: T; Effect Codes: PHY,MOR; Rejection Code: NO ENDPOINT(FBD,MOM).

FLUBENDIAMIDE
Papers that Were Excluded from ECOTOX

1. Ebbinghaus-Kintscher, Ulrich, Luemmen, Peter, Lobitz, Nicole, Schulte, Thomas, Funke, Christian, Fischer, Rudiger, Masaki, Takao, Yasokawa, Noriaki, and Tohnishi, Masanori (2006). Phthalic acid diamides activate ryanodine-sensitive Ca2+ release channels in insects. *Cell Calcium* 39: 21-33.

   Chemical of Concern: FBD; Habitat: T

2. Javaregowda and Naik, L. K (2005). Bio-efficacy of Flubendiamide 20 WDG (RIL-038) Against Paddy Pests and Their Natural Enemies. *Pestology* 29: 58-60.

   Chemical of Concern: FBD; Habitat: T; Rejection Code: NO SOURCE(FBD).

3. Luemmen, Peter, Ebbinghaus-Kintscher, Ulrich, Funke, Christian, Fischer, Ruediger, Masaki, Takao, Yasokawa, Noriaki, and Tohnishi, Masanori (2007). Phthalic acid diamides activate insect ryanodine receptors. *ACS Symposium Series, Synthesis and Chemistry of Agrochemicals VII* 948: 235-248.

   Chemical of Concern: FBD; Habitat: T

4. Lummen, Peter, Ebbinghaus-Kintscher, Ulrich, Lobitz, Nicole, Schulte, Thomas, Funke, Christian, and Fischer, Rudiger (2005). Phthalic acid diamides activate ryanodine-sensitive calcium release channels in insects. *Abstracts of Papers, 230th ACS National Meeting, Washington, DC, United States, Aug. 28-Sept. 1, 2005* AGRO-025.

   Chemical of Concern: FBD; Habitat: T

5. Masaki, T., Yasokawa, N., Tohnishi, M., Nishimatsu, T., Tsubata, K., Inoue, K., Motoba, K., and Hirooka, T. (2006). Flubendiamide, a Novel Ca2+ Channel Modulator, Reveals Evidence for Functional Cooperation Between Ca2+ Pumps and Ca2+ Release. *Mol.Pharmacol.* 69: 1733-1739.

   Chemical of Concern: FBD; Habitat: T; Rejection Code: NO IN VITRO(FBD).

6. Masaki, Takao, Yasokawa, Noriaki, Tohnishi, Masanori, Nishimatsu, Tetsuyoshi, Tsubata, Kenji, Inoue, Kazuyoshi, Motoba, Kazuhiko, and Hirooka, Takashi (2006). Flubendiamide, a novel Ca2+ channel modulator, reveals evidence for functional cooperation between Ca2+ pumps and Ca2+ release. *Molecular Pharmacology* 69: 1733-1739.

   Chemical of Concern: FBD; Habitat: T

7. Nauen, R. (2006). Insecticide Mode of Action: Return of the Ryanodine Receptor. *Pest Manag.Sci.* 62: 690-692.

   Chemical of Concern: FBD; Habitat: T; Rejection Code: NO REVIEW(FBD).

8. Nishimatsu, T., Hirooka, T., Kodama, H., Tohnishi, M., and Seo, A (2005). Flubendiamide - a new insecticide for controlling lepidopterous pests. *BCPC International Congress: Crop Science & Technology, Congress Proceedings, Glasgow, United Kingdom, Oct. 31-Nov. 2 2005* 1: 57-64.

   Chemical of Concern: FBD; Habitat: T

9. Tohnishi, Masanori, Nakao, Hayami, Furuya, Takashi, Seo, Akira, Kodama, Hiroki, Tsubata, Kenji, Fujioka, Shinsuke, Kodama, Hiroshi, Hirooka, Takashi, and Nishimatsu, Tetsuyoshi (2005). Novel class insecticide, flubendiamide: Synthesis and biological activity. *Abstracts of Papers, 230th ACS National Meeting, Washington, DC, United States, Aug. 28-Sept. 1, 2005* AGRO-009.

Chemical of Concern: FBD; Habitat: T

APPENDIX E: Risk Quotient Method

The Risk Quotient Method is the means used by EFED to integrate the results of exposure and ecotoxicity data. For this method, risk quotients (RQs) are calculated by dividing exposure estimates by ecotoxicity values (i.e., RQ = EXPOSURE/TOXICITY), both acute and chronic. These RQs are then compared to OPP's levels of concern (LOCs). These LOCs are criteria used by OPP to indicate potential risk to non-target organisms and the need to consider regulatory action. EFED has defined LOCs for acute risk, potential restricted use classification, and for endangered species.

The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on nontarget organisms. LOCs currently address the following risk presumption categories:

(1) acute - there is a potential for acute risk; regulatory action may be warranted in addition to restricted use classification;

(2) acute restricted use - the potential for acute risk is high, but this may be mitigated through restricted use classification

(3) acute endangered species - the potential for acute risk to endangered species is high, regulatory action may be warranted, and

(4) chronic risk - the potential for chronic risk is high, regulatory action may be warranted.

Currently, EFED does not perform assessments for acute or chronic risks to non-target insects, or chronic risk from granular/bait formulations to mammalian or avian species. EFED also does not designate whether plant toxicity studies are acute or chronic.

The ecotoxicity test values (i.e., measurement endpoints) used in the acute and chronic risk quotients are derived from required studies. Examples of ecotoxicity values derived from short-term laboratory studies that assess acute effects are: (1) LC_{50} (fish and birds), (2) LD_{50} (birds and mammals), (3) EC_{50} (aquatic plants and aquatic invertebrates), and (4) EC_{25} (terrestrial plants). Examples of toxicity test effect levels derived from the results of long-term laboratory studies that assess chronic effects are: (1) LOAEL (birds, fish, and aquatic invertebrates), and (2) NOAEL (birds, fish and aquatic invertebrates). The NOAEL is generally used as the ecotoxicity test value in assessing chronic effects.

Risk presumptions, along with the corresponding RQs and LOCs are summarized in **Appendix F**.

APPENDIX F: Risk Presumptions and LOCs

Risk Presumption	RQ	LOC
Birds[1]		
Acute Risk	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or $LD_{50} < 50$ mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1
Wild Mammals[1]		
Acute Risk	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day (or $LD_{50} < 50$ mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/sqft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1
Aquatic Animals[2]		
Acute Risk	EEC/LC_{50} or EC_{50}	0.5
Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
Acute Endangered Species	EEC/LC_{50} or EC_{50}	0.05
Chronic Risk	EEC/NOAEC	1
Terrestrial and Semi-Aquatic Plants		
Acute Risk	EEC/EC_{25}	1
Acute Endangered Species	EEC/EC_{05} or NOAEC	1
Aquatic Plants[2]		
Acute Risk	EEC/EC_{50}	1
Acute Endangered Species	EEC/EC_{05} or NOAEC	1

[1] LD_{50}/sqft = (mg/sqft) / (LD_{50} * wt. of animal); LD_{50}/day = (mg of toxicant consumed/day) / (LD_{50} * wt. of animal)
[2] EEC = ppb or ug/L in water

APPENDIX G: Preliminary Effects Determinations (Direct and Indirect Effects) for Species Co-Located with Flubendiamide New Uses and Rates

Federally Listed Species Co-occurrence with Flubendiamide Proposed New Uses and Rates

No species were excluded

Minimum of 1 Acre

All Medium Types Reported

Mammal, Marine mml, Bird, Amphibian, Reptile, Fish, Crustacean, Bivalve, Gastropod, Arachnid, Insect, Dicot, Monocot, Ferns, Conf/cycds, Coral, Lichen

broccoli, brussels sprouts, cabbage - head, collards, mustard cabbage (bok choy), mustard greens (mizuna), turnip greens, berries - other, blueberries, wild, strawberries, sorghum for grain, sorghum for silage or greenchop, alfalfa hay, alfalfa hay (irrigated), alfalfa seed, alfalfa seed (irrigated), artichokes, blueberries, tame, kiwifruit, peanuts for nuts, peanuts for nuts (irrigated), pistachios, sorghum for grain (irrigated), sorghum for silage or greenchop (irrigated), sorghum for syrup, sorghum for syrup (irrigated), sugarcane - total (PR), sugarcane for seed, sugarcane for seed (irrigated), sugarcane for sugar, sugarcane for sugar (irrigated), sugarcane not harvested, sugarcane not harvested (irrigated), sunflower seed, all, sunflower seed, all (irrigated), sunflower seed, non-oil varieties, sunflower seed, non-oil varieties (irrigated), sunflower seed, oil varieties, sunflower seed, oil varieties (irrigated)

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

1268 Species Affected:

Inverse Name:	Taxa	Co. occurence:	Status:
(ncn)	Dicot	44	Endangered
Abalone, White	Gastropod	59	Endangered
Abutilon eremitopetalum (ncn)	Dicot	13	Endangered
Abutilon sandwicense (ncn)	Dicot	5	Endangered
Achyranthes mutica (ncn)	Dicot	7	Endangered
Achyranthes splendens var. rotundata (ncn)	Dicot	5	Endangered
A'e (Zanthoxylum dipetalum var. tomentosum)	Dicot	7	Endangered
A'e (Zanthoxylum hawaiiense)	Dicot	31	Endangered
'Aiea (Nothocestrum breviflorum)	Dicot	7	Endangered
'Aiea (Nothocestrum peltatum)	Dicot	11	Endangered
'Akepa, Hawaii	Bird	7	Endangered
'Akepa, Maui	Bird	13	Endangered
'Akia Loa, Kauai (Hemignathus procerus)	Bird	11	Endangered
'Akia Pola'au (Hemignathus munroi)	Bird	7	Endangered
Akoko	Dicot	11	Endangered
'akoko	Dicot	11	Endangered
'Akoko (Chamaesyce celastroides var. kaenana)	Dicot	5	Endangered
'Akoko (Chamaesyce deppeana)	Dicot	5	Endangered
'Akoko (Chamaesyce herbstii)	Dicot	5	Endangered
'Akoko (Chamaesyce kuwaleana)	Dicot	5	Endangered
'Akoko (Chamaesyce rockii)	Dicot	5	Endangered
'Akoko (Chamaesyce skottsbergii var. skottsbe	Dicot	18	Endangered
'Akoko (Euphorbia haeleeleana)	Dicot	16	Endangered
alani	Dicot	33	Endangered
Alani (Melicope adscendens)	Dicot	13	Endangered

Alani (Melicope balloui)	Dicot	13	Endangered
Alani (Melicope haupuensis)	Dicot	11	Endangered
Alani (Melicope knudsenii)	Dicot	24	Endangered
Alani (Melicope lydgatei)	Dicot	5	Endangered
Alani (Melicope mucronulata)	Dicot	13	Endangered
Alani (Melicope munroi)	Dicot	13	Endangered
Alani (Melicope ovalis)	Dicot	13	Endangered
Alani (Melicope pallida)	Dicot	11	Endangered
Alani (Melicope quadrangularis)	Dicot	11	Endangered
Alani (Melicope reflexa)	Dicot	13	Endangered
Alani (Melicope saint-johnii)	Dicot	5	Endangered
Alani (Melicope zahlbruckneri)	Dicot	7	Endangered
Albatross, Short-tailed	Bird	5	Endangered
Allocarya, Calistoga	Dicot	7	Endangered
Alopecurus, Sonoma	Monocot	28	Endangered
Alsinidendron obovatum (ncn)	Dicot	5	Endangered
Alsinidendron trinerve (ncn)	Dicot	5	Endangered
Alsinidendron viscosum (ncn)	Dicot	11	Endangered
Amaranthus brownii (ncn)	Dicot	5	Endangered
Ambersnail, Kanab	Gastropod	5	Endangered
Ambrosia, San Diego	Dicot	29	Endangered
Ambrosia, South Texas	Dicot	54	Endangered
Amphipod, Illinois Cave	Crustacean	14	Endangered
Amphipod, Kauai Cave	Crustacean	11	Endangered
Amphipod, Noel's	Crustacean	9	Endangered
Amphipod, Peck's Cave	Crustacean	44	Endangered
'Anaunau (Lepidium arbuscula)	Dicot	5	Endangered
'Anunu (Sicyos alba)	Dicot	7	Endangered

Aristida chaseae (ncn)	Monocot	2	Endangered
Arrowhead, Bunched	Monocot	31	Endangered
Asplenium fragile var. insulare (ncn)	Ferns	7	Endangered
Aster, Florida Golden	Dicot	18	Endangered
Aster, Ruth's Golden	Dicot	2	Endangered
Aupaka (Isodendrion hosakae)	Dicot	7	Endangered
Aupaka (Isodendrion laurifolium)	Dicot	16	Endangered
Avens, Spreading	Dicot	72	Endangered
awikiwiki	Dicot	11	Endangered
'Awikiwiki (Canavalia molokaiensis)	Dicot	13	Endangered
'Awiwi (Centaurium sebaeoides)	Dicot	24	Endangered
'Awiwi (Hedyotis cookiana)	Dicot	18	Endangered
Ayenia, Texas	Dicot	52	Endangered
Barberry, Island	Dicot	13	Endangered
Barberry, Nevin's	Dicot	29	Endangered
Bariaco	Dicot	1	Endangered
Bat, Gray	Mammal	990	Endangered
Bat, Hawaiian Hoary	Mammal	36	Endangered
Bat, Indiana	Mammal	5072	Endangered
Bat, Lesser (=Sanborn's) Long-nosed	Mammal	75	Endangered
Bat, Mexican Long-nosed	Mammal	9	Endangered
Bat, Ozark Big-eared	Mammal	28	Endangered
Bat, Virginia Big-eared	Mammal	112	Endangered
Beardtongue, Penland	Dicot	2	Endangered
Beargrass, Britton's	Monocot	30	Endangered
Bear-poppy, Dwarf	Dicot	5	Endangered
Bedstraw, El Dorado	Dicot	10	Endangered
Bedstraw, Island	Dicot	13	Endangered
Beetle, American Burying	Insect	262	Endangered
Beetle, Coffin Cave Mold	Insect	7	Endangered
Beetle, Comal Springs Dryopid	Insect	44	Endangered
Beetle, Comal Springs Riffle	Insect	44	Endangered
Beetle, Helotes Mold	Insect	11	Endangered
Beetle, Hungerford's Crawling Water	Insect	13	Endangered
Beetle, Kretschmarr Cave Mold	Insect	4	Endangered
Beetle, Mount Hermon June	Insect	10	Endangered
Beetle, Ohlone Tiger	Insect	10	Endangered
Beetle, Salt Creek Tiger	Insect	25	Endangered
Beetle, Tooth Cave Ground	Insect	11	Endangered
Bellflower, Brooksville	Dicot	10	Endangered
Bird's-beak, Palmate-bracted	Dicot	103	Endangered
Bird's-beak, Pennell's	Dicot	20	Endangered
Bird's-beak, salt marsh	Dicot	71	Endangered
Bird's-beak, Soft	Dicot	29	Endangered
Bittercress, Small-anthered	Dicot	28	Endangered
Blackbird, Yellow-shouldered	Bird	4	Endangered
Bladderpod, Kodachrome	Dicot	2	Endangered
Bladderpod, San Bernardino Mountains	Dicot	15	Endangered
Bladderpod, Spring Creek	Dicot	7	Endangered
Bladderpod, White	Dicot	1	Endangered
Bladderpod, Zapata	Dicot	6	Endangered
Blazing Star, Scrub	Dicot	10	Endangered
Bluegrass, Hawaiian	Monocot	11	Endangered
Bluegrass, Mann's (Poa mannii)	Monocot	11	Endangered
Bluegrass, Napa	Monocot	7	Endangered
Bluegrass, San Bernardino	Monocot	26	Endangered
Blue-star, Kearney's	Dicot	7	Endangered

Bluet, Roan Mountain	Dicot	31	Endangered
Boa, Puerto Rican	Reptile	5	Endangered
Bobwhite, Masked	Bird	7	Endangered
Bonamia menziesii (ncn)	Dicot	36	Endangered
Boxwood, Vahl's	Dicot	1	Endangered
Broom, San Clemente Island	Dicot	11	Endangered
Buckwheat, Cushenbury	Dicot	15	Endangered
Buckwheat, Ione (incl. Irish Hill)	Dicot	3	Endangered
Buckwheat, Steamboat	Dicot	3	Endangered
Bulrush, Northeastern (=Barbed Bristle)	Monocot	137	Endangered
Bush-mallow, San Clemente Island	Dicot	11	Endangered
Bush-mallow, Santa Cruz Island	Dicot	13	Endangered
Buttercup, Autumn	Dicot	2	Endangered
Butterfly, Behren's Silverspot	Insect	31	Endangered
Butterfly, Callippe Silverspot	Insect	13	Endangered
Butterfly, El Segundo Blue	Insect	11	Endangered
Butterfly, Fender's Blue	Insect	40	Endangered
Butterfly, Karner Blue	Insect	309	Endangered
Butterfly, Lange's Metalmark	Insect	5	Endangered
Butterfly, Lotis Blue	Insect	11	Endangered
Butterfly, Mission Blue	Insect	16	Endangered
Butterfly, Mitchell's Satyr	Insect	153	Endangered
Butterfly, Myrtle's Silverspot	Insect	28	Endangered
Butterfly, Palos Verdes Blue	Insect	11	Endangered
Butterfly, Quino Checkerspot	Insect	29	Endangered
Butterfly, Saint Francis' Satyr	Insect	21	Endangered
Butterfly, San Bruno Elfin	Insect	8	Endangered
Butterfly, Schaus Swallowtail	Insect	3	Endangered
Butterfly, Smith's Blue	Insect	11	Endangered
Butterfly, Uncompahgre Fritillary	Insect	19	Endangered
Button-celery, San Diego	Dicot	29	Endangered
Cactus, Arizona Hedgehog	Dicot	31	Endangered
Cactus, Bakersfield	Dicot	20	Endangered
Cactus, Black Lace	Dicot	29	Endangered
Cactus, Brady Pincushion	Dicot	2	Endangered
Cactus, Knowlton	Dicot	17	Endangered
Cactus, Kuenzler Hedgehog	Dicot	29	Endangered
Cactus, Nellie Cory	Dicot	2	Endangered
Cactus, Nichol's Turk's Head	Dicot	20	Endangered
Cactus, Peebles Navajo	Dicot	4	Endangered
Cactus, Pima Pineapple	Dicot	9	Endangered
Cactus, San Rafael	Dicot	6	Endangered
Cactus, Sneed Pincushion	Dicot	41	Endangered
Cactus, Star	Dicot	42	Endangered
Cactus, Tobusch Fishhook	Dicot	27	Endangered
Cactus, Wright Fishhook	Dicot	12	Endangered
Campeloma, Slender	Gastropod	8	Endangered
Campion, Fringed	Dicot	26	Endangered
Caribou, Woodland	Mammal	11	Endangered
Catesbaea Melanocarpa (ncn)	Dicot	1	Endangered
Cat's-eye, Terlingua Creek	Dicot	2	Endangered
Cavefish, Alabama	Fish	7	Endangered
Cavesnail, Tumbling Creek	Gastropod	3	Endangered
Ceanothus, Coyote	Dicot	11	Endangered
Ceanothus, Pine Hill	Dicot	10	Endangered
Chaffseed, American	Dicot	183	Endangered
Chamaesyce Halemanui (ncn)	Dicot	11	Endangered

Checker-mallow, Keck's	Dicot	43	Endangered
Checker-mallow, Kenwood Marsh	Dicot	20	Endangered
Checker-mallow, Pedate	Dicot	15	Endangered
Checker-mallow, Wenatchee Mountains	Dicot	5	Endangered
Chub, Bonytail	Fish	101	Endangered
Chub, Borax Lake	Fish	2	Endangered
Chub, Gila	Fish	50	Endangered
Chub, Humpback	Fish	54	Endangered
Chub, Mohave Tui	Fish	57	Endangered
Chub, Oregon	Fish	58	Endangered
Chub, Owens Tui	Fish	4	Endangered
Chub, Pahranagat Roundtail	Fish	2	Endangered
Chub, Virgin River	Fish	13	Endangered
Chub, Yaqui	Fish	9	Endangered
Chupacallos	Dicot	1	Endangered
Cladonia, Florida Perforate	Lichen	36	Endangered
Clarkia, Pismo	Dicot	12	Endangered
Clarkia, Presidio	Dicot	5	Endangered
Clarkia, Vine Hill	Dicot	20	Endangered
Cliffrose, Arizona	Dicot	30	Endangered
Clover, Leafy Prairie	Dicot	73	Endangered
Clover, Monterey	Dicot	11	Endangered
Clover, Running Buffalo	Dicot	253	Endangered
Clover, Showy Indian	Dicot	28	Endangered
Combshell, Southern (=Penitent mussel)	Bivalve	10	Endangered
Combshell, Upland	Bivalve	49	Endangered
Condor, California	Bird	108	Endangered
Coneflower, Smooth	Dicot	285	Endangered
Coneflower, Tennessee Purple	Dicot	16	Endangered
Coot, Hawaiian (=Alae keo keo)	Bird	36	Endangered
Coyote-thistle, Loch Lomond	Dicot	5	Endangered
Crane, Mississippi Sandhill	Bird	6	Endangered
Crane, Whooping	Bird	2655	Endangered
Cranichis Ricartii	Monocot	1	Endangered
Crayfish, Cave (Cambarus aculabrum)	Crustacean	8	Endangered
Crayfish, Cave (Cambarus zophonastes)	Crustacean	2	Endangered
Crayfish, Nashville	Crustacean	8	Endangered
Crayfish, Shasta	Crustacean	12	Endangered
Creeper, Hawaii	Bird	7	Endangered
Creeper, Molokai (Kakawahie)	Bird	13	Endangered
Creeper, Oahu (Alauwahio)	Bird	5	Endangered
Crow, Hawaiian ('Alala)	Bird	7	Endangered
Crownscale, San Jacinto Valley	Dicot	18	Endangered
Cui-ui	Fish	3	Endangered
Curlew, Eskimo	Bird	35	Endangered
Cyanea undulata (ncn)	Dicot	11	Endangered
Cypress, Santa Cruz	Conf/cycds	18	Endangered
Dace, Ash Meadows Speckled	Fish	8	Endangered
Dace, Clover Valley Speckled	Fish	2	Endangered
Dace, Independence Valley Speckled	Fish	2	Endangered
Dace, Kendall Warm Springs	Fish	2	Endangered
Dace, Moapa	Fish	7	Endangered
Daisy, Willamette	Dicot	48	Endangered
Darter, Amber	Fish	21	Endangered
Darter, Bluemask (=jewel)	Fish	19	Endangered
Darter, Boulder	Fish	18	Endangered
Darter, Duskytail	Fish	18	Endangered

Darter, Etowah	Fish	15	Endangered
Darter, Fountain	Fish	47	Endangered
Darter, Maryland	Fish	10	Endangered
Darter, Okaloosa	Fish	16	Endangered
Darter, Relict	Fish	8	Endangered
Darter, Vermilion	Fish	6	Endangered
Darter, Watercress	Fish	6	Endangered
Dawn-flower, Texas Prairie (=Texas Bitterweed)	Dicot	25	Endangered
Deer, Columbian White-tailed	Mammal	48	Endangered
Delissea rhytodisperma (ncn)	Dicot	11	Endangered
Diellia erecta (ncn)	Ferns	25	Endangered
Diellia falcata (ncn)	Ferns	5	Endangered
Diellia pallida (ncn)	Ferns	11	Endangered
Diellia unisora (ncn)	Ferns	18	Endangered
Diplazium molokaiense (ncn)	Ferns	13	Endangered
Dogweed, Ashy	Dicot	9	Endangered
Dragonfly, Hine's Emerald	Insect	81	Endangered
Dropwort, Canby's	Dicot	221	Endangered
Dubautia latifolia (ncn)	Dicot	11	Endangered
Dubautia pauciflorula (ncn)	Dicot	11	Endangered
Duck, Hawaiian (Koloa)	Bird	23	Endangered
Duck, Laysan	Bird	5	Endangered
Dudleya, Santa Clara Valley	Dicot	71	Endangered
Elepaio, Oahu	Bird	5	Endangered
Elktoe, Appalachian	Bivalve	68	Endangered
Eugenia Woodburyana	Dicot	2	Endangered
Evening-primrose, Antioch Dunes	Dicot	25	Endangered
Evening-primrose, Eureka Valley	Dicot	2	Endangered
Fairy Shrimp, Conservancy Fairy	Crustacean	94	Endangered
Fairy Shrimp, Longhorn	Crustacean	53	Endangered
Fairy Shrimp, Riverside	Crustacean	64	Endangered
Fairy Shrimp, San Diego	Crustacean	11	Endangered
Falcon, Northern Aplomado	Bird	231	Endangered
Fanshell	Bivalve	305	Endangered
Fern, Aleutian Shield	Ferns	3	Endangered
Fern, Pendant Kihi (Adenophorus periens)	Ferns	31	Endangered
Fern, Thelypteris inabonensis	Ferns	1	Endangered
Fern, Thelypteris verecunda	Ferns	2	Endangered
Ferret, Black-footed	Mammal	998	Endangered
Fiddleneck, Large-flowered	Dicot	32	Endangered
Finch, Laysan	Bird	5	Endangered
Finch, Nihoa	Bird	5	Endangered
Flannelbush, Mexican	Dicot	11	Endangered
Flannelbush, Pine Hill	Dicot	10	Endangered
Fly, Delhi Sands Flower-loving	Insect	46	Endangered
Flycatcher, Southwestern Willow	Bird	325	Endangered
Fox, San Joaquin Kit	Mammal	223	Endangered
Fox, San Miguel Island	Mammal	13	Endangered
Fox, Santa Catalina Island	Mammal	11	Endangered
Fox, Santa Cruz Island	Mammal	13	Endangered
Fox, Santa Rosa Island	Mammal	13	Endangered
Frankenia, Johnston's	Dicot	9	Endangered
Fringe Tree, Pygmy	Dicot	24	Endangered
Fringepod, Santa Cruz Island	Dicot	13	Endangered
Fritillary, Gentner's	Monocot	18	Endangered
Frog, Dusky Gopher (Mississippi DPS)	Amphibian	8	Endangered
Frog, Mountain Yellow-legged	Amphibian	44	Endangered

Gahnia Lanaiensis (ncn)	Monocot	13	Endangered
Gambusia, Big Bend	Fish	2	Endangered
Gambusia, Clear Creek	Fish	2	Endangered
Gambusia, Pecos	Fish	34	Endangered
Gambusia, San Marcos	Fish	44	Endangered
Gecko, Monito	Reptile	1	Endangered
Geranium, Hawaiian Red-flowered	Dicot	13	Endangered
Gerardia, Sandplain	Dicot	58	Endangered
Gilia, Hoffmann's Slender-flowered	Dicot	13	Endangered
Gilia, Monterey	Dicot	11	Endangered
Goby, Tidewater	Fish	175	Endangered
Golden Sunburst, Hartweg's	Dicot	56	Endangered
Goldenrod, Short's	Dicot	24	Endangered
Goldfields, Burke's	Dicot	36	Endangered
Goldfields, Contra Costa	Dicot	80	Endangered
Goose, Hawaiian (Nene)	Bird	31	Endangered
Gouania hillebrandii (ncn)	Dicot	13	Endangered
Gouania meyenii (ncn)	Dicot	16	Endangered
Gouania vitifolia (ncn)	Dicot	5	Endangered
Gourd, Okeechobee	Dicot	17	Endangered
Grass, California Orcutt	Monocot	42	Endangered
Grass, Eureka Dune	Monocot	2	Endangered
Grass, Fosberg's Love	Monocot	5	Endangered
Grass, Hairy Orcutt	Dicot	136	Endangered
Grass, Sacramento Orcutt	Dicot	23	Endangered
Grass, Solano	Monocot	40	Endangered
Grass, Tennessee Yellow-eyed	Monocot	21	Endangered
Grasshopper, Zayante Band-winged	Insect	10	Endangered
Ground-plum, Guthrie's	Dicot	9	Endangered
haha	Dicot	22	Endangered
Haha (Cyanea acuminata)	Dicot	5	Endangered
Haha (Cyanea asarifolia)	Dicot	11	Endangered
Haha (Cyanea copelandii ssp. copelandii)	Dicot	7	Endangered
Haha (Cyanea copelandii ssp. haleakalaensis)	Dicot	13	Endangered
Haha (Cyanea Crispa) (=Rollandia crispa)	Dicot	5	Endangered
Haha (Cyanea dunbarii)	Dicot	13	Endangered
Haha (Cyanea glabra)	Dicot	13	Endangered
Haha (Cyanea grimesiana ssp. grimesiana)	Dicot	18	Endangered
Haha (Cyanea grimesiana ssp. obatae)	Dicot	5	Endangered
Haha (Cyanea hamatiflora ssp. carlsonii)	Dicot	7	Endangered
Haha (Cyanea hamatiflora ssp. hamatiflora)	Dicot	13	Endangered
Haha (Cyanea humboldtiana)	Dicot	5	Endangered
Haha (Cyanea koolauensis)	Dicot	5	Endangered
Haha (Cyanea longiflora)	Dicot	5	Endangered
Haha (Cyanea Macrostegia var. gibsonii)	Dicot	13	Endangered
Haha (Cyanea mannii)	Dicot	13	Endangered
Haha (Cyanea mceldowneyi)	Dicot	13	Endangered
Haha (Cyanea pinnatifida)	Dicot	5	Endangered
Haha (Cyanea platyphylla)	Dicot	7	Endangered
Haha (Cyanea procera)	Dicot	13	Endangered
Haha (Cyanea remyi)	Dicot	11	Endangered
Haha (Cyanea shipmanii)	Dicot	7	Endangered
Haha (Cyanea stictophylla)	Dicot	7	Endangered
Haha (Cyanea St-Johnii) (=Rollandia St-Johnii)	Dicot	5	Endangered
Haha (Cyanea superba)	Dicot	5	Endangered
Ha'Iwale (Cyrtandra crenata)	Dicot	5	Endangered
Ha'Iwale (Cyrtandra dentata)	Dicot	5	Endangered

Ha'Iwale (Cyrtandra giffardii)	Dicot	7	Endangered
Ha'Iwale (Cyrtandra munroi)	Dicot	13	Endangered
Ha'Iwale (Cyrtandra polyantha)	Dicot	5	Endangered
Ha'Iwale (Cyrtandra subumbellata)	Dicot	5	Endangered
Ha'Iwale (Cyrtandra tintinnabula)	Dicot	5	Endangered
Ha'Iwale (Cyrtandra viridiflora)	Dicot	5	Endangered
Hala Pepe (Pleomele hawaiiensis)	Monocot	7	Endangered
Haplostachys Haplostachya (ncn)	Dicot	7	Endangered
Harebells, Avon Park	Dicot	10	Endangered
Harperella	Dicot	165	Endangered
Harvestman, Bee Creek Cave	Arachnid	18	Endangered
Harvestman, Bone Cave	Arachnid	11	Endangered
Harvestman, Robber Baron Cave	Arachnid	11	Endangered
Hau Kauhiwi (Hibiscadelphus woodi)	Dicot	11	Endangered
Hau Kuahiwi (Hibiscadelphus distans)	Dicot	11	Endangered
Hawaiian picture-wing Fly	Insect	11	Endangered
Hawk, Hawaiian (Io)	Bird	7	Endangered
Heau (Exocarpos luteolus)	Dicot	11	Endangered
Hedyotis degeneri (ncn)	Dicot	5	Endangered
Hedyotis parvula (ncn)	Dicot	5	Endangered
Hedyotis St.-Johnii (ncn)	Dicot	11	Endangered
Hesperomannia arborescens (ncn)	Dicot	18	Endangered
Hesperomannia arbuscula (ncn)	Dicot	18	Endangered
Hesperomannia lydgatei (ncn)	Dicot	11	Endangered
Hibiscus, Clay's	Dicot	11	Endangered
Higuero De Sierra	Dicot	1	Endangered
Hiiwale	Dicot	11	Endangered
Hilo Ischaemum (Ischaemum byrone)	Monocot	31	Endangered
ho'awa	Dicot	11	Endangered
Holei (Ochrosia kilaueaensis)	Dicot	7	Endangered
Holly, Cook's	Dicot	1	Endangered
Honeycreeper, Crested ('Akohekohe)	Bird	13	Endangered
Hypericum, Highlands Scrub	Dicot	10	Endangered
'Ihi'Ihi (Marsilea villosa)	Ferns	18	Endangered
Iliau (Wilkesia hobdyi)	Dicot	11	Endangered
Ipomopsis, Holy Ghost	Dicot	4	Endangered
Irisette, White	Monocot	25	Endangered
Isopod, Lee County Cave	Crustacean	5	Endangered
Isopod, Socorro	Crustacean	5	Endangered
Jacquemontia, Beach	Dicot	19	Endangered
Jaguar	Mammal	45	Endangered
Jaguarundi, Gulf Coast	Mammal	140	Endangered
Jaguarundi, Sinaloan	Mammal	88	Endangered
Jewelflower, California	Dicot	100	Endangered
Jewelflower, Tiburon	Dicot	8	Endangered
kamakahala	Dicot	22	Endangered
Kamakahala (Labordia cyrtandrae)	Dicot	5	Endangered
Kamakahala (Labordia lydgatei)	Dicot	11	Endangered
Kamakahala (Labordia tinifolia var. lanaiensis)	Dicot	13	Endangered
Kamakahala (Labordia tinifolia var. wahiawaen)	Dicot	11	Endangered
Kamakahala (Labordia triflora)	Dicot	13	Endangered
Kamanomano (Cenchrus agrimonioides)	Monocot	18	Endangered
Kanaloa kahoolawensis (ncn)	Dicot	13	Endangered
Kangaroo Rat, Fresno	Mammal	72	Endangered
Kangaroo Rat, Giant	Mammal	143	Endangered
Kangaroo Rat, Morro Bay	Mammal	12	Endangered
Kangaroo Rat, San Bernardino Merriam's	Mammal	33	Endangered

Kangaroo Rat, Stephens'	Mammal	44	Endangered
Kangaroo Rat, Tipton	Mammal	49	Endangered
Kauai creeper	Bird	11	Endangered
Kauila (Colubrina oppositifolia)	Dicot	7	Endangered
Kaulu (Pteralyxia kauaiensis)	Dicot	11	Endangered
Kidneyshell, Triangular	Bivalve	94	Endangered
Kio'Ele (Hedyotis coriacea)	Dicot	20	Endangered
Kiponapona (Phyllostegia racemosa)	Dicot	7	Endangered
Kite, Everglade Snail	Bird	99	Endangered
Koki'o (Kokia drynarioides)	Dicot	7	Endangered
Koki'o (Kokia kauaiensis)	Dicot	11	Endangered
Koki'o Ke'oke'o (Hibiscus arnottianus ssp. immaculatus)	Dicot	13	Endangered
Koki'o Ke'oke'o (Hibiscus waimeae ssp. hannerae)	Dicot	11	Endangered
kolea	Dicot	11	Endangered
Kolea (Myrsine juddii)	Dicot	5	Endangered
Ko'oko'olau (Bidens micrantha ssp. kalealaha)	Dicot	13	Endangered
Ko'oko'olau (Bidens wiebkei)	Dicot	13	Endangered
Ko'oloa'ula (Abutilon menziesii)	Dicot	20	Endangered
Kopa (Hedyotis schlechtendahliana var. remyi)	Dicot	13	Endangered
kopiko	Dicot	22	Endangered
Kuawawaenohu (Alsinidendron lychnoides)	Dicot	11	Endangered
Kulu'I (Nototrichium humile)	Dicot	18	Endangered
Ladies'-tresses, Canelo Hills	Monocot	11	Endangered
Ladies'-tresses, Navasota	Monocot	67	Endangered
Larkspur, Baker's	Dicot	28	Endangered
Larkspur, San Clemente Island	Dicot	11	Endangered
Larkspur, Yellow	Dicot	28	Endangered
Lau'ehu (Panicum niihauense)	Monocot	11	Endangered
Laukahi Kuahiwi (Plantago hawaiensis)	Dicot	7	Endangered
Laukahi Kuahiwi (Plantago princeps)	Dicot	29	Endangered
Laulihilihi (Schiedea stellarioides)	Dicot	11	Endangered
Layia, Beach	Dicot	43	Endangered
Lead-plant, Crenulate	Dicot	3	Endangered
Leather-flower, Alabama	Dicot	20	Endangered
Leather-flower, Morefield's	Dicot	9	Endangered
lehua makanoe	Dicot	11	Endangered
Lessingia, San Francisco	Dicot	8	Endangered
Lichen, Rock Gnome	Lichen	85	Endangered
Lily, Minnesota Trout	Monocot	21	Endangered
Lily, Pitkin Marsh	Monocot	20	Endangered
Lily, Western	Monocot	13	Endangered
Limpet, Banbury Springs	Gastropod	10	Endangered
Lipochaeta venosa (ncn)	Dicot	7	Endangered
Liveforever, Santa Barbara Island	Dicot	13	Endangered
Lizard, Blunt-nosed Leopard	Reptile	171	Endangered
lo`ulu	Monocot	11	Endangered
Lo`ulu (Pritchardia affinis)	Monocot	7	Endangered
Lo`ulu (Pritchardia kaalae)	Monocot	5	Endangered
Lo`ulu (Pritchardia munroi)	Monocot	13	Endangered
Lo`ulu (Pritchardia napaliensis)	Monocot	11	Endangered
Lo`ulu (Pritchardia remota)	Monocot	5	Endangered
Lo`ulu (Pritchardia schattaueri)	Monocot	7	Endangered
Lo`ulu (Pritchardia viscosa)	Monocot	11	Endangered
Lobelia monostachya (ncn)	Dicot	5	Endangered
Lobelia niihauensis (ncn)	Dicot	16	Endangered
Lobelia oahuensis (ncn)	Dicot	5	Endangered
Logperch, Conasauga	Fish	10	Endangered

Logperch, Roanoke	Fish	91	Endangered
Lomatium, Bradshaw's	Dicot	48	Endangered
Lomatium, Cook's	Dicot	18	Endangered
Loosestrife, Rough-leaved	Dicot	176	Endangered
Lousewort, Furbish	Dicot	7	Endangered
Lupine, Clover	Dicot	54	Endangered
Lupine, Nipomo Mesa	Dicot	12	Endangered
Lupine, Scrub	Dicot	10	Endangered
Lyonia truncata var. proctorii (ncn)	Dicot	2	Endangered
Lysimachia filifolia (ncn)	Dicot	16	Endangered
Lysimachia lydgatei (ncn)	Dicot	18	Endangered
Lysimachia maxima (ncn)	Dicot	13	Endangered
Madtom, Pygmy	Fish	12	Endangered
Madtom, Scioto	Fish	17	Endangered
Madtom, Smoky	Fish	9	Endangered
Mahoe (Alectryon macrococcus)	Dicot	29	Endangered
Malacothrix, Island	Dicot	13	Endangered
Malacothrix, Santa Cruz Island	Dicot	26	Endangered
Mallow, Kern	Dicot	20	Endangered
Mallow, Peter's Mountain	Dicot	2	Endangered
Manatee, West Indian	Marine mml	376	Endangered
Manioc, Walker's	Dicot	27	Endangered
Manzanita, Del Mar	Dicot	22	Endangered
Manzanita, Santa Rosa Island	Dicot	13	Endangered
Ma'o Hau Hele (Hibiscus brackenridgei)	Dicot	25	Endangered
Ma'oli'oli (Schiedea apokremnos)	Dicot	11	Endangered
Ma'oli'oli (Schiedea kealiae)	Dicot	5	Endangered
Mapele (Cyrtandra cyaneoides)	Dicot	11	Endangered
Mariscus fauriei (ncn)	Monocot	20	Endangered
Mariscus pennatiformis (ncn)	Monocot	36	Endangered
Marstonia, Royal (=Royal Snail)	Gastropod	3	Endangered
Meadowfoam, Butte County	Dicot	31	Endangered
Meadowfoam, Large-flowered Woolly	Dicot	11	Endangered
Meadowfoam, Sebastopol	Dicot	20	Endangered
Meadowrue, Cooley's	Dicot	46	Endangered
Mehamehame (Flueggea neowawraea)	Dicot	36	Endangered
Meshweaver, Braken Bat Cave	Arachnid	11	Endangered
Milkpea, Small's	Dicot	3	Endangered
Milk-vetch, Applegate's	Dicot	9	Endangered
Milk-vetch, Braunton's	Dicot	35	Endangered
Milk-vetch, Clara Hunt's	Dicot	27	Endangered
Milk-vetch, Coachella Valley	Dicot	18	Endangered
Milk-vetch, Coastal Dunes	Dicot	11	Endangered
Milk-vetch, Cushenbury	Dicot	15	Endangered
Milk-vetch, Holmgren	Dicot	8	Endangered
Milk-vetch, Jesup's	Dicot	11	Endangered
Milk-vetch, Lane Mountain	Dicot	15	Endangered
Milk-vetch, Mancos	Dicot	19	Endangered
Milk-vetch, Osterhout	Dicot	2	Endangered
Milk-vetch, Sentry	Dicot	2	Endangered
Milk-vetch, Shivwits	Dicot	5	Endangered
Milk-vetch, Triple-ribbed	Dicot	33	Endangered
Milk-vetch, Ventura Marsh	Dicot	26	Endangered
Millerbird, Nihoa	Bird	5	Endangered
Minnow, Rio Grande Silvery	Fish	51	Endangered
Mint, Garrett's	Dicot	2	Endangered
Mint, Lakela's	Dicot	3	Endangered

Mint, Longspurred	Dicot	11	Endangered
Mint, Otay Mesa	Dicot	29	Endangered
Mint, San Diego Mesa	Dicot	11	Endangered
Mint, Scrub	Dicot	2	Endangered
Mitracarpus Maxwelliae	Dicot	1	Endangered
Mitracarpus Polycladus	Dicot	1	Endangered
Monardella, Willowy	Dicot	11	Endangered
Monkey-flower, Michigan	Dicot	38	Endangered
Moorhen, Hawaiian Common	Bird	29	Endangered
Morning-glory, Stebbins	Dicot	10	Endangered
Moth, Blackburn's Sphinx	Insect	20	Endangered
Mountain Beaver, Point Arena	Mammal	11	Endangered
Mountainbalm, Indian Knob	Dicot	12	Endangered
Mountain-mahogany, Catalina Island	Dicot	11	Endangered
Mouse, Alabama Beach	Mammal	12	Endangered
Mouse, Anastasia Island Beach	Mammal	5	Endangered
Mouse, Choctawhatchee Beach	Mammal	12	Endangered
Mouse, Pacific Pocket	Mammal	33	Endangered
Mouse, Perdido Key Beach	Mammal	19	Endangered
Mouse, Salt Marsh Harvest	Mammal	81	Endangered
Mucket, Pink (Pearlymussel)	Bivalve	526	Endangered
Munroidendron racemosum (ncn)	Dicot	11	Endangered
Mussel, Acornshell Southern	Bivalve	23	Endangered
Mussel, Black (=Curtus' Mussel) Clubshell	Bivalve	4	Endangered
Mussel, Clubshell	Bivalve	354	Endangered
Mussel, Coosa Moccasinshell	Bivalve	34	Endangered
Mussel, Cumberland Combshell	Bivalve	83	Endangered
Mussel, Cumberland Elktoe	Bivalve	26	Endangered
Mussel, Cumberland Pigtoe	Bivalve	16	Endangered
Mussel, Dark Pigtoe	Bivalve	20	Endangered
Mussel, Dwarf Wedge	Bivalve	326	Endangered
Mussel, Fine-rayed Pigtoe	Bivalve	128	Endangered
Mussel, Flat Pigtoe (=Marshall's Mussel)	Bivalve	4	Endangered
Mussel, Gulf Moccasinshell	Bivalve	130	Endangered
Mussel, Heavy Pigtoe (=Judge Tait's Mussel)	Bivalve	45	Endangered
Mussel, Heelsplitter Carolina	Bivalve	68	Endangered
Mussel, Ochlockonee Moccasinshell	Bivalve	12	Endangered
Mussel, Oval Pigtoe	Bivalve	169	Endangered
Mussel, Ovate Clubshell	Bivalve	100	Endangered
Mussel, Oyster	Bivalve	104	Endangered
Mussel, Ring Pink (=Golf Stick Pearly)	Bivalve	213	Endangered
Mussel, Rough Pigtoe	Bivalve	257	Endangered
Mussel, Scaleshell	Bivalve	112	Endangered
Mussel, Shiny Pigtoe	Bivalve	104	Endangered
Mussel, Shiny-rayed Pocketbook	Bivalve	150	Endangered
Mussel, Southern Clubshell	Bivalve	90	Endangered
Mussel, Southern Pigtoe	Bivalve	46	Endangered
Mussel, Speckled Pocketbook	Bivalve	7	Endangered
Mussel, Winged Mapleleaf	Bivalve	45	Endangered
Mustard, Carter's	Dicot	11	Endangered
Mustard, Slender-petaled	Dicot	15	Endangered
Myrcia Paganii	Dicot	1	Endangered
na`ena`e	Dicot	55	Endangered
Na'ena'e (Dubautia herbstobatae)	Dicot	5	Endangered
Na'ena'e (Dubautia plantaginea ssp. humilis)	Dicot	13	Endangered
Nani Wai'ale'ale (Viola kauaensis var. wahiawaensis)	Dicot	11	Endangered
Nanu (Gardenia mannii)	Dicot	5	Endangered

Na'u (Gardenia brighamii)	Dicot	18	Endangered
Naupaka, Dwarf (Scaevola coriacea)	Dicot	13	Endangered
Navarretia, Few-flowered	Dicot	69	Endangered
Navarretia, Many-flowered	Dicot	69	Endangered
Nehe (Lipochaeta fauriei)	Dicot	11	Endangered
Nehe (Lipochaeta kamolensis)	Dicot	13	Endangered
Nehe (Lipochaeta lobata var. leptophylla)	Dicot	5	Endangered
Nehe (Lipochaeta micrantha)	Dicot	11	Endangered
Nehe (Lipochaeta tenuifolia)	Dicot	5	Endangered
Nehe (Lipochaeta waimeaensis)	Dicot	11	Endangered
Neraudia angulata (ncn)	Dicot	5	Endangered
Neraudia ovata (ncn)	Dicot	7	Endangered
Neraudia sericea (ncn)	Dicot	20	Endangered
Nightjar, Puerto Rico	Bird	3	Endangered
Nioi (Eugenia koolauensis)	Dicot	5	Endangered
Niterwort, Amargosa	Dicot	8	Endangered
nohoanu	Dicot	11	Endangered
Nohoanu (Geranium multiflorum)	Dicot	20	Endangered
Nuku Pu'u	Bird	24	Endangered
Ocelot	Mammal	163	Endangered
'Oha (Delissea rivularis)	Dicot	11	Endangered
'Oha (Delissea subcordata)	Dicot	5	Endangered
'Oha (Delissea undulata)	Dicot	7	Endangered
'Oha (Lobelia gaudichaudii koolauensis)	Dicot	5	Endangered
'Oha Wai (Clermontia drepanomorpha)	Dicot	7	Endangered
'Oha Wai (Clermontia lindseyana)	Dicot	20	Endangered
'Oha Wai (Clermontia oblongifolia ssp. brevipes)	Dicot	13	Endangered
'Oha Wai (Clermontia oblongifolia ssp. mauiensis)	Dicot	13	Endangered
'Oha Wai (Clermontia peleana)	Dicot	7	Endangered
'Oha Wai (Clermontia pyrularia)	Dicot	7	Endangered
'Oha Wai (Clermontia samuelii)	Dicot	13	Endangered
'Ohai (Sesbania tomentosa)	Dicot	36	Endangered
'Ohe'ohe (Tetraplasandra gymnocarpa)	Dicot	5	Endangered
'Olulu (Brighamia insignis)	Dicot	11	Endangered
Onion, Munz's	Monocot	18	Endangered
'O'o, Kauai (='A'a)	Bird	11	Endangered
Opuhe (Urera kaalae)	Dicot	5	Endangered
'O'u (Honeycreeper)	Bird	18	Endangered
Oxytheca, Cushenbury	Dicot	15	Endangered
Pa'iniu	Monocot	22	Endangered
Paintbrush, San Clemente Island Indian	Dicot	11	Endangered
Paintbrush, Soft-leaved	Dicot	13	Endangered
Paintbrush, Tiburon	Dicot	26	Endangered
Palila	Bird	7	Endangered
Palo de Nigua	Dicot	2	Endangered
Pamakani (Viola chamissoniana ssp. chamissoniana)	Dicot	5	Endangered
Panicgrass, Carter's (Panicum fauriei var.carteri)	Monocot	18	Endangered
Panther, Florida	Mammal	49	Endangered
Papala	Dicot	11	Endangered
Parrotbill, Maui	Bird	13	Endangered
Pauoa (Ctenitis squamigera)	Ferns	18	Endangered
Pawpaw, Beautiful	Dicot	7	Endangered
Pawpaw, Four-petal	Dicot	18	Endangered
Pawpaw, Rugel's	Dicot	8	Endangered
Pearlymussel, Alabama Lamp	Bivalve	20	Endangered
Pearlymussel, Appalachian Monkeyface	Bivalve	43	Endangered
Pearlymussel, Birdwing	Bivalve	97	Endangered

Pearlymussel, Cracking	Bivalve	96	Endangered
Pearlymussel, Cumberland Bean	Bivalve	88	Endangered
Pearlymussel, Cumberland Monkeyface	Bivalve	95	Endangered
Pearlymussel, Curtis'	Bivalve	15	Endangered
Pearlymussel, Dromedary	Bivalve	112	Endangered
Pearlymussel, Fat Pocketbook	Bivalve	254	Endangered
Pearlymussel, Green-blossom	Bivalve	54	Endangered
Pearlymussel, Higgins' Eye	Bivalve	230	Endangered
Pearlymussel, Little-wing	Bivalve	108	Endangered
Pearlymussel, Orange-footed	Bivalve	229	Endangered
Pearlymussel, Pale Lilliput	Bivalve	34	Endangered
Pearlymussel, Purple Cat's Paw	Bivalve	61	Endangered
Pearlymussel, Tubercled-blossom	Bivalve	167	Endangered
Pearlymussel, Turgid-blossom	Bivalve	39	Endangered
Pearlymussel, White Cat's Paw	Bivalve	19	Endangered
Pearlymussel, White Wartyback	Bivalve	121	Endangered
Pearlymussel, Yellow-blossom	Bivalve	83	Endangered
Pebblesnail, Flat	Gastropod	5	Endangered
Pelos del Diablo	Monocot	4	Endangered
Penny-cress, Kneeland Prairie	Dicot	11	Endangered
Pennyroyal, Todsen's	Dicot	10	Endangered
Penstemon, Blowout	Dicot	47	Endangered
Pentachaeta, Lyon's	Dicot	24	Endangered
Pentachaeta, White-rayed	Dicot	26	Endangered
Petrel, Hawaiian Dark-rumped	Bird	31	Endangered
Phacelia, Clay	Dicot	10	Endangered
Phacelia, Island	Dicot	13	Endangered
Phlox, Texas Trailing	Dicot	14	Endangered
Phlox, Yreka	Dicot	13	Endangered
Phyllostegia hirsuta (ncn)	Dicot	5	Endangered
Phyllostegia kaalaensis (ncn)	Dicot	5	Endangered
Phyllostegia knudsenii (ncn)	Dicot	11	Endangered
Phyllostegia mannii (ncn)	Dicot	13	Endangered
Phyllostegia mollis (ncn)	Dicot	18	Endangered
Phyllostegia parviflora (ncn)	Dicot	5	Endangered
Phyllostegia velutina (ncn)	Dicot	7	Endangered
Phyllostegia waimeae (ncn)	Dicot	11	Endangered
Phyllostegia warshaueri (ncn)	Dicot	7	Endangered
Phyllostegia wawrana (ncn)	Dicot	11	Endangered
Pilo (Hedyotis mannii)	Dicot	13	Endangered
pilo kea lau li'i	Dicot	11	Endangered
Pinkroot, Gentian	Dicot	19	Endangered
Piperia, Yadon's	Monocot	11	Endangered
Pitaya, Davis' Green	Dicot	2	Endangered
Pitcher-plant, Alabama Canebrake	Dicot	19	Endangered
Pitcher-plant, Green	Dicot	68	Endangered
Pitcher-plant, Mountain Sweet	Dicot	38	Endangered
Platanthera holochila (ncn)	Monocot	24	Endangered
Plover, Piping	Bird	1995	Endangered
Plum, Scrub	Dicot	18	Endangered
Poa siphonoglossa (ncn)	Monocot	11	Endangered
Po'e (Portulaca sclerocarpa)	Dicot	20	Endangered
Polygala, Lewton's	Dicot	29	Endangered
Polygala, Tiny	Dicot	25	Endangered
Polygonum, Scott's Valley	Dicot	10	Endangered
Pondberry	Dicot	153	Endangered
Pondweed, Little Aguja Creek	Monocot	2	Endangered

Poolfish, Pahrump (= Pahrump Killifish)	Fish	13	Endangered
Po'ouli	Bird	13	Endangered
Popcornflower, Rough	Dicot	8	Endangered
Popolo 'Aiakeakua (Solanum sandwicense)	Dicot	16	Endangered
Popolo Ku Mai (Solanum incompletum)	Dicot	7	Endangered
Poppy, Sacramento Prickly	Dicot	7	Endangered
Poppy-mallow, Texas	Dicot	15	Endangered
Potentilla, Hickman's	Dicot	19	Endangered
Prairie-chicken, Attwater's Greater	Bird	32	Endangered
Pronghorn, Sonoran	Mammal	29	Endangered
Pseudoscorpion, Tooth Cave	Arachnid	4	Endangered
Pteris lidgatei (ncn)	Ferns	18	Endangered
Pua'ala (Brighamia rockii)	Dicot	13	Endangered
Pupfish, Ash Meadows Amargosa	Fish	6	Endangered
Pupfish, Comanche Springs	Fish	20	Endangered
Pupfish, Desert	Fish	118	Endangered
Pupfish, Devils Hole	Fish	11	Endangered
Pupfish, Leon Springs	Fish	8	Endangered
Pupfish, Owens	Fish	4	Endangered
Pupfish, Warm Springs	Fish	6	Endangered
Purple Bean	Bivalve	52	Endangered
Pu'uka'a (Cyperus trachysanthos)	Monocot	16	Endangered
Pygmy-owl, Cactus Ferruginous	Bird	64	Endangered
Quillwort, Black-spored	Ferns	25	Endangered
Quillwort, Louisiana	Ferns	65	Endangered
Quillwort, Mat-forming	Ferns	17	Endangered
Rabbit, Pygmy	Mammal	27	Endangered
Rabbit, Riparian Brush	Mammal	22	Endangered
Rabbitsfoot, Rough	Bivalve	37	Endangered
Rail, California Clapper	Bird	104	Endangered
Rail, Light-footed Clapper	Bird	59	Endangered
Rail, Yuma Clapper	Bird	94	Endangered
Rattleweed, Hairy	Dicot	11	Endangered
Reed-mustard, Barneby	Dicot	10	Endangered
Reed-mustard, Shrubby	Dicot	15	Endangered
Remya kauaiensis (ncn)	Dicot	11	Endangered
Remya montgomeryi (ncn)	Dicot	11	Endangered
Remya, Maui	Dicot	13	Endangered
Rhadine exilis (ncn)	Insect	11	Endangered
Rhadine infernalis (ncn)	Insect	11	Endangered
Rhododendron, Chapman	Dicot	7	Endangered
Ridge-cress (=Pepper-cress), Barneby	Dicot	11	Endangered
Riffleshell, Northern	Bivalve	179	Endangered
Riffleshell, Tan	Bivalve	122	Endangered
Riversnail, Anthony's	Gastropod	36	Endangered
Rock-cress, Hoffmann's	Dicot	13	Endangered
Rock-cress, Large (=Braun's)	Dicot	30	Endangered
Rock-cress, McDonald's	Dicot	11	Endangered
Rock-cress, Santa Cruz Island	Dicot	11	Endangered
Rock-cress, Shale Barren	Dicot	32	Endangered
Rock-cress, Small	Dicot	18	Endangered
Rock-pocketbook, Ouachita (=Wheeler's pm)	Bivalve	22	Endangered
Rocksnail, Plicate	Gastropod	18	Endangered
Rosemary, Etonia	Dicot	8	Endangered
Rosemary, Short-leaved	Dicot	10	Endangered
Rush-pea, Slender	Dicot	9	Endangered
Salamander, Barton Springs	Amphibian	7	Endangered

Salamander, California Tiger	Amphibian	316	Endangered
Salamander, Desert Slender	Amphibian	18	Endangered
Salamander, Santa Cruz Long-toed	Amphibian	21	Endangered
Salamander, Shenandoah	Amphibian	15	Endangered
Salamander, Sonora Tiger	Amphibian	11	Endangered
Salamander, Texas Blind	Amphibian	44	Endangered
Salmon, Atlantic	Fish	40	Endangered
Salmon, Chinook (Sacramento River Winter Run)	Fish	197	Endangered
Salmon, Chinook (Upper Columbia River Spring)	Fish	128	Endangered
Salmon, Coho (Central California Coast population)	Fish	64	Endangered
Salmon, Sockeye (Snake River population)	Fish	119	Endangered
Sandalwood, Lanai (='Iliahi)	Dicot	13	Endangered
Sandlace	Dicot	17	Endangered
Sand-verbena, Large-fruited	Dicot	14	Endangered
Sandwort, Cumberland	Dicot	14	Endangered
Sandwort, Marsh	Dicot	12	Endangered
Sanicula mariversa (ncn)	Dicot	5	Endangered
Sanicula purpurea (ncn)	Dicot	13	Endangered
Sawfish, Smalltooth	Fish	19	Endangered
Schiedea haleakalensis (ncn)	Dicot	13	Endangered
Schiedea helleri (ncn)	Dicot	11	Endangered
Schiedea hookeri (ncn)	Dicot	5	Endangered
Schiedea kaalae (ncn)	Dicot	5	Endangered
Schiedea kauaiensis (ncn)	Dicot	11	Endangered
Schiedea lydgatei (ncn)	Dicot	13	Endangered
Schiedea membranacea (ncn)	Dicot	11	Endangered
Schiedea nuttallii (ncn)	Dicot	16	Endangered
Schiedea sarmentosa (ncn)	Dicot	13	Endangered
Schiedea spergulina var. leiopoda (ncn)	Dicot	11	Endangered
Schiedea verticillata (ncn)	Dicot	5	Endangered
Schiedea, Diamond Head (Schiedea adamantis)	Dicot	5	Endangered
Sea turtle, green	Reptile	399	Endangered
Sea turtle, hawksbill	Reptile	235	Endangered
Sea turtle, Kemp's ridley	Reptile	236	Endangered
Sea turtle, leatherback	Reptile	378	Endangered
Sea-blite, California	Dicot	12	Endangered
Seal, Caribbean Monk	Marine mml	3	Endangered
Seal, Hawaiian Monk	Marine mml	39	Endangered
Sedge, Golden	Monocot	14	Endangered
Sedge, White	Monocot	20	Endangered
Sheep, Peninsular Bighorn	Mammal	43	Endangered
Sheep, Sierra Nevada Bighorn	Mammal	15	Endangered
Shiner, Cahaba	Fish	30	Endangered
Shiner, Cape Fear	Fish	51	Endangered
Shiner, Palezone	Fish	20	Endangered
Shiner, Topeka	Fish	258	Endangered
Shrew, Buena Vista Lake Ornate	Mammal	20	Endangered
Shrike, San Clemente Loggerhead	Bird	11	Endangered
Shrimp, Alabama Cave	Crustacean	9	Endangered
Shrimp, California Freshwater	Crustacean	35	Endangered
Shrimp, Kentucky Cave	Crustacean	14	Endangered
Silene alexandri (ncn)	Dicot	13	Endangered
Silene lanceolata (ncn)	Dicot	36	Endangered
Silene perlmanii (ncn)	Dicot	5	Endangered
Silversword, Ka'u (Argyroxiphium kauense)	Dicot	7	Endangered
Silversword, Mauna Kea ('Ahinahina)	Dicot	20	Endangered
Skipper, Carson Wandering	Insect	7	Endangered

Skipper, Laguna Mountain	Insect	11	Endangered
Snail, Armored	Gastropod	8	Endangered
Snail, Iowa Pleistocene	Gastropod	36	Endangered
Snail, Lioplax Cylindrical	Gastropod	5	Endangered
Snail, Morro Shoulderband	Gastropod	12	Endangered
Snail, O'ahu Tree (Achatinella abbreviata)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella apexfulva)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella bellula)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella buddii)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella bulimoides)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella byronii)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella caesia)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella casta)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella cestus)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella concavospira)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella curta)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella decipiens)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella decora)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella dimorpha)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella elegans)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella fulgens)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella fuscobasis)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella juddii)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella juncea)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella lehuiensis)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella leucorraphe)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella lila)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella livida)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella lorata)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella mustelina)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella papyracea)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella phaeozona)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella pulcherrima)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella pupukanioe)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella rosea)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella sowerbyana)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella spaldingi)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella stewartii)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella swiftii)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella taeniolata)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella thaanumi)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella turgida)	Gastropod	5	Endangered
Snail, O'ahu Tree (Achatinella valida)	Gastropod	5	Endangered
Snail, Pecos Assiminea	Gastropod	24	Endangered
Snail, Snake River Physa	Gastropod	21	Endangered
Snail, Tulotoma	Gastropod	26	Endangered
Snail, Virginia Fringed Mountain	Gastropod	3	Endangered
Snake, San Francisco Garter	Reptile	18	Endangered
Snakeroot	Dicot	11	Endangered
Snowbells, Texas	Dicot	23	Endangered
Sparrow, Cape Sable Seaside	Bird	4	Endangered
Sparrow, Florida Grasshopper	Bird	26	Endangered
Spermolepis hawaiiensis (ncn)	Dicot	36	Endangered
Spider, Government Canyon Cave	Arachnid	11	Endangered
Spider, Kauai Cave Wolf	Arachnid	11	Endangered
Spider, Madla's Cave	Arachnid	11	Endangered
Spider, Robber Baron Cave	Arachnid	11	Endangered

Spider, Spruce-fir Moss	Arachnid	48	Endangered
Spider, Tooth Cave	Arachnid	4	Endangered
Spider, Vesper Cave	Arachnid	11	Endangered
Spinedace, White River	Fish	8	Endangered
Spineflower, Ben Lomond	Dicot	10	Endangered
Spineflower, Howell's	Dicot	11	Endangered
Spineflower, Orcutt's	Dicot	22	Endangered
Spineflower, Robust	Dicot	21	Endangered
Spineflower, Scotts Valley	Dicot	10	Endangered
Spineflower, Slender-horned	Dicot	55	Endangered
Spineflower, Sonoma	Dicot	28	Endangered
Spinymussel, James River	Bivalve	85	Endangered
Spinymussel, Tar River	Bivalve	63	Endangered
Springfish, Hiko White River	Fish	4	Endangered
Springfish, White River	Fish	2	Endangered
Springsnail, Alamosa	Gastropod	5	Endangered
Springsnail, Bruneau Hot	Gastropod	6	Endangered
Springsnail, Koster's	Gastropod	9	Endangered
Springsnail, Roswell	Gastropod	9	Endangered
Springsnail, Socorro	Gastropod	5	Endangered
Spurge, Deltoid	Dicot	3	Endangered
Squawfish, Colorado	Fish	134	Endangered
Squirrel, Carolina Northern Flying	Mammal	94	Endangered
Squirrel, Delmarva Peninsula Fox	Mammal	107	Endangered
Squirrel, Mount Graham Red	Mammal	5	Endangered
Steelhead, (Southern California population)	Fish	71	Endangered
Stenogyne angustifolia (ncn)	Dicot	7	Endangered
Stenogyne bifida (ncn)	Dicot	13	Endangered
Stenogyne campanulata (ncn)	Dicot	11	Endangered
Stenogyne kanehoana (ncn)	Dicot	5	Endangered
Stickleback, Unarmored Threespine	Fish	50	Endangered
Stickseed, Showy	Dicot	5	Endangered
Stickyseed, Baker's	Dicot	20	Endangered
Stilt, Hawaiian (=Ae'o)	Bird	36	Endangered
Stirrupshell	Bivalve	15	Endangered
Stonecrop, Lake County	Dicot	69	Endangered
Stork, Wood	Bird	1092	Endangered
Sturgeon, Alabama	Fish	26	Endangered
Sturgeon, Pallid	Fish	829	Endangered
Sturgeon, Shortnose	Fish	772	Endangered
Sturgeon, White	Fish	7	Endangered
Sucker, June	Fish	10	Endangered
Sucker, Lost River	Fish	26	Endangered
Sucker, Modoc	Fish	8	Endangered
Sucker, Razorback	Fish	185	Endangered
Sucker, Shortnose	Fish	13	Endangered
Sumac, Michaux's	Dicot	226	Endangered
Sunflower, San Mateo Woolly	Dicot	8	Endangered
Sunflower, Schweinitz's	Dicot	133	Endangered
Tadpole Shrimp, Vernal Pool	Crustacean	322	Endangered
Taraxacum, California	Dicot	15	Endangered
Tarplant, Gaviota	Dicot	13	Endangered
Tectaria Estremerana	Ferns	1	Endangered
Tern, California Least	Bird	112	Endangered
Tern, Interior (population) Least	Bird	1562	Endangered
Tern, Roseate	Bird	98	Endangered
Tetramolopium arenarium (ncn)	Dicot	7	Endangered

Tetramolopium capillare (ncn)	Dicot	13	Endangered
Tetramolopium filiforme (ncn)	Dicot	5	Endangered
Tetramolopium lepidotum ssp. lepidotum (ncn)	Dicot	5	Endangered
Tetramolopium remyi (ncn)	Dicot	13	Endangered
Thistle, Chorro creek Bog	Dicot	12	Endangered
Thistle, Fountain	Dicot	32	Endangered
Thistle, La Graciosa	Dicot	25	Endangered
Thistle, Suisun	Dicot	17	Endangered
Thornmint, San Mateo	Dicot	8	Endangered
Threeridge, Fat (Mussel)	Bivalve	36	Endangered
Thrush, Large Kauai	Bird	11	Endangered
Thrush, Molokai (Oloma'o)	Bird	13	Endangered
Thrush, Small Kauai (Puaiohi)	Bird	11	Endangered
Toad, Arroyo Southwestern	Amphibian	113	Endangered
Toad, Houston	Amphibian	83	Endangered
Toad, Wyoming	Amphibian	2	Endangered
Topminnow, Gila (Yaqui)	Fish	68	Endangered
Torreya, Florida	Conf/cycds	26	Endangered
Trematolobelia singularis (ncn)	Dicot	5	Endangered
Trillium, Persistent	Monocot	27	Endangered
Trillium, Relict	Monocot	71	Endangered
Trout, Gila	Fish	19	Endangered
Tuctoria, Green's	Dicot	125	Endangered
Turtle, Alabama Red-bellied	Reptile	21	Endangered
Turtle, Plymouth Red-bellied	Reptile	7	Endangered
Uhiuhi (Caesalpinia kavaiensis)	Dicot	25	Endangered
Ulihi (Phyllostegia glabra var. lanaiensis)	Dicot	13	Endangered
Umbel, Huachuca Water	Dicot	18	Endangered
Vernonia Proctorii (ncn)	Dicot	2	Endangered
Vetch, Hawaiian (Vicia menziesii)	Dicot	7	Endangered
Vigna o-wahuensis (ncn)	Dicot	31	Endangered
Viola helenae (ncn)	Dicot	11	Endangered
Viola lanaiensis (ncn)	Dicot	13	Endangered
Viola oahuensis (ncn)	Dicot	5	Endangered
Vireo, Black-capped	Bird	382	Endangered
Vireo, Least Bell's	Bird	137	Endangered
Vole, Amargosa	Mammal	17	Endangered
Vole, Florida Salt Marsh	Mammal	9	Endangered
Vole, Hualapai Mexican	Mammal	5	Endangered
Wahane (Pritchardia aylmer-robinsonii)	Monocot	11	Endangered
Wahine Noho Kula (Isodendrion pyrifolium)	Dicot	7	Endangered
Wallflower, Ben Lomond	Dicot	10	Endangered
Wallflower, Contra Costa	Dicot	5	Endangered
Wallflower, Menzie's	Dicot	37	Endangered
Warbler (=Wood), Golden-cheeked	Bird	199	Endangered
Warbler (=Wood), Kirtland's	Bird	141	Endangered
Warbler, Bachman's	Bird	32	Endangered
Warea, Wide-leaf	Dicot	16	Endangered
Watercress, Gambel's	Dicot	62	Endangered
Water-willow, Cooley's	Dicot	10	Endangered
Wawae'iole (Phlegmariurus (=Huperzia) mannii)	Ferns	20	Endangered
Wawae'iole (Phlegmariurus (=Lycopodium) nutans)	Ferns	5	Endangered
Whale, Finback	Marine mml	63	Endangered
Whale, Humpback	Marine mml	67	Endangered
Whale, northern right	Marine mml	7	Endangered
Wild-buckwheat, Clay-loving	Dicot	17	Endangered
Wild-rice, Texas	Monocot	44	Endangered

Wire-lettuce, Malheur	Dicot	2	Endangered
Wireweed	Dicot	10	Endangered
Woodland-star, San Clemente Island	Dicot	11	Endangered
Woodpecker, Ivory-billed	Bird	17	Endangered
Woodpecker, Red-cockaded	Bird	2267	Endangered
Woodrat, Riparian	Mammal	22	Endangered
Woolly-star, Santa Ana River	Dicot	44	Endangered
Woolly-threads, San Joaquin	Dicot	113	Endangered
Woundfin	Fish	13	Endangered
Xylosma crenatum (ncn)	Dicot	11	Endangered
Yerba Santa, Lompoc	Dicot	13	Endangered
Ziziphus, Florida	Dicot	10	Endangered
Adobe Sunburst, San Joaquin	Dicot	56	Threatened
Amaranth, Seabeach	Dicot	119	Threatened
Amole, Cammatta Canyon	Monocot	12	Threatened
Amole, Purple	Monocot	23	Threatened
Amphianthus, Little	Dicot	99	Threatened
Aster, Decurrent False	Dicot	179	Threatened
Aupaka (Isodendrion longifolium)	Dicot	16	Threatened
Baccharis, Encinitas	Dicot	22	Threatened
Bankclimber, Purple	Bivalve	117	Threatened
Barbara Buttons, Mohr's	Dicot	29	Threatened
Beaked-rush, Knieskern's	Monocot	49	Threatened
Bear, Grizzly	Mammal	189	Threatened
Bear, Louisiana Black	Mammal	349	Threatened
Beetle, Delta Green Ground	Insect	17	Threatened
Beetle, Northeastern Beach Tiger	Insect	57	Threatened
Beetle, Puritan Tiger	Insect	37	Threatened
Beetle, Valley Elderberry Longhorn	Insect	269	Threatened
Birch, Virginia Round-leaf	Dicot	3	Threatened
Birds-in-a-nest, White	Dicot	4	Threatened
Bladderpod, Dudley Bluffs	Dicot	2	Threatened
Bladderpod, Lyrate	Dicot	20	Threatened
Bladderpod, Missouri	Dicot	36	Threatened
Blazing Star, Ash Meadows	Dicot	6	Threatened
Blazing Star, Heller's	Dicot	31	Threatened
Bluecurls, Hidden Lake	Dicot	15	Threatened
Boa, Mona	Reptile	1	Threatened
Bonamia, Florida	Dicot	42	Threatened
Brodiaea, Chinese Camp	Monocot	3	Threatened
Brodiaea, Thread-leaved	Monocot	66	Threatened
Buckwheat, Scrub	Dicot	31	Threatened
Buckwheat, Southern Mountain Wild	Dicot	15	Threatened
Butterfly Plant, Colorado	Dicot	36	Threatened
Butterfly, Bay Checkerspot (Wright's euphydryas)	Insect	29	Threatened
Butterfly, Oregon Silverspot	Insect	46	Threatened
Butterweed, Layne's	Dicot	13	Threatened
Butterwort, Godfrey's	Dicot	4	Threatened
Cactus, Bunched Cory	Dicot	6	Threatened
Cactus, Chisos Mountain Hedgehog	Dicot	2	Threatened
Cactus, Cochise Pincushion	Dicot	9	Threatened
Cactus, Lee Pincushion	Dicot	8	Threatened
Cactus, Lloyd's Mariposa	Dicot	4	Threatened
Cactus, Mesa Verde	Dicot	19	Threatened
Cactus, Siler Pincushion	Dicot	12	Threatened
Cactus, Uinta Basin Hookless	Dicot	51	Threatened
Cactus, Winkler	Dicot	10	Threatened

Caracara, Audubon's Crested	Bird	79	Threatened
Catchfly, Spalding's	Dicot	41	Threatened
Catfish, Yaqui	Fish	9	Threatened
Cavefish, Ozark	Fish	81	Threatened
Ceanothus, Vail Lake	Dicot	18	Threatened
Centaury, Spring-loving	Dicot	8	Threatened
Checker-mallow, Nelson's	Dicot	76	Threatened
Chub, Chihuahua	Fish	2	Threatened
Chub, Hutton Tui	Fish	6	Threatened
Chub, Slender	Fish	39	Threatened
Chub, Sonora	Fish	2	Threatened
Chub, Spotfin	Fish	120	Threatened
Chumbo, Higo	Dicot	1	Threatened
Clarkia, Springville	Dicot	17	Threatened
Clover, Fleshy Owl's	Dicot	104	Threatened
Clover, Prairie Bush	Dicot	493	Threatened
Cobana Negra	Dicot	2	Threatened
Crocodile, American	Reptile	12	Threatened
Crownbeard, Big-leaved	Dicot	22	Threatened
Cycladenia, Jones	Dicot	17	Threatened
Cypress, Gowen	Conf/cycds	11	Threatened
Dace, Blackside	Fish	33	Threatened
Dace, Desert	Fish	6	Threatened
Dace, Foskett Speckled	Fish	2	Threatened
Daisy, Lakeside	Dicot	33	Threatened
Daisy, Maguire	Dicot	10	Threatened
Daisy, Parish's	Dicot	33	Threatened
Darter, Bayou	Fish	12	Threatened
Darter, Cherokee	Fish	15	Threatened
Darter, Goldline	Fish	18	Threatened
Darter, Leopard	Fish	22	Threatened
Darter, Niangua	Fish	85	Threatened
Darter, Slackwater	Fish	42	Threatened
Darter, Snail	Fish	98	Threatened
Dudleya, Conejo	Dicot	13	Threatened
Dudleya, Marcescent	Dicot	35	Threatened
Dudleya, Santa Cruz Island	Dicot	13	Threatened
Dudleya, Santa Monica Mountains	Dicot	35	Threatened
Dudleya, Verity's	Dicot	13	Threatened
Dwarf-flax, Marin	Dicot	8	Threatened
Eagle, Bald	Bird	57	Threatened
Elimia, Lacy	Gastropod	6	Threatened
Evening-primrose, San Benito	Dicot	13	Threatened
Fairy Shrimp, Vernal Pool	Crustacean	373	Threatened
Fatmucket, Arkansas	Bivalve	17	Threatened
Fern, Alabama Streak-sorus	Ferns	3	Threatened
Fern, American hart's-tongue	Ferns	54	Threatened
Fleabane, Zuni	Dicot	8	Threatened
Four-o'clock, Macfarlane's	Dicot	6	Threatened
Frog, California Red-legged	Amphibian	247	Threatened
Frog, Chiricahua Leopard	Amphibian	66	Threatened
Fruit, Earth (=geocarpon)	Dicot	69	Threatened
Gnatcatcher, Coastal California	Bird	79	Threatened
Goldenrod, Blue Ridge	Dicot	23	Threatened
Goldenrod, Houghton's	Dicot	55	Threatened
Goldenrod, White-haired	Dicot	8	Threatened
Gooseberry, Miccosukee	Dicot	14	Threatened

Grass, Colusa	Monocot	85	Threatened
Grass, San Joaquin Valley Orcutt	Monocot	137	Threatened
Grass, Slender Orcutt	Dicot	94	Threatened
Groundsel, San Francisco Peaks	Dicot	2	Threatened
Guajon	Amphibian	1	Threatened
Gumplant, Ash Meadows	Dicot	8	Threatened
Haha (Cyanea recta)	Dicot	11	Threatened
Ha'Iwale (Cyrtandra limahuliensis)	Dicot	11	Threatened
Heartleaf, Dwarf-flowered	Dicot	75	Threatened
Heather, Mountain Golden	Dicot	12	Threatened
Howellia, Water	Dicot	46	Threatened
Iguana, Mona Ground	Reptile	1	Threatened
Iris, Dwarf Lake	Monocot	75	Threatened
Isopod, Madison Cave	Crustacean	19	Threatened
Ivesia, Ash Meadows	Dicot	8	Threatened
Joint-vetch, Sensitive	Dicot	148	Threatened
Kolea (Myrsine linearifolia)	Dicot	11	Threatened
Ladies'-tresses, Ute	Monocot	93	Threatened
Liveforever, Laguna Beach	Dicot	11	Threatened
Lizard, Coachella Valley Fringe-toed	Reptile	18	Threatened
Lizard, Island Night	Reptile	37	Threatened
Locoweed, Fassett's	Dicot	22	Threatened
Lupine, Kincaid's	Dicot	61	Threatened
Lynx, Canada	Mammal	192	Threatened
Madtom, Neosho	Fish	85	Threatened
Madtom, Yellowfin	Fish	54	Threatened
Makou (Peucedanum sandwicense)	Dicot	29	Threatened
Manaca, palma de	Monocot	3	Threatened
Manzanita, Ione	Dicot	7	Threatened
Manzanita, Morro	Dicot	12	Threatened
Manzanita, Pallid	Dicot	10	Threatened
Milk-vetch, Ash Meadows	Dicot	6	Threatened
Milk-vetch, Deseret	Dicot	10	Threatened
Milk-vetch, Fish Slough	Dicot	4	Threatened
Milk-vetch, Heliotrope	Dicot	8	Threatened
Milk-vetch, Pierson's	Dicot	10	Threatened
Milkweed, Mead's	Dicot	214	Threatened
Milkweed, Welsh's	Dicot	4	Threatened
Minnow, Devils River	Fish	5	Threatened
Minnow, Loach	Fish	61	Threatened
Monkshood, Northern Wild	Dicot	103	Threatened
Moth, Kern Primrose Sphinx	Insect	20	Threatened
Mouse, Preble's Meadow Jumping	Mammal	72	Threatened
Mouse, Southeastern Beach	Mammal	4	Threatened
Mucket, Orangenacre	Bivalve	43	Threatened
Murrelet, Marbled	Bird	336	Threatened
Mussel, Alabama Moccasinshell	Bivalve	69	Threatened
Mussel, Fine-lined Pocketbook	Bivalve	142	Threatened
Mussel, Heelsplitter Inflated	Bivalve	64	Threatened
Mustard, Penland Alpine Fen	Dicot	2	Threatened
Naucorid, Ash Meadows	Insect	6	Threatened
Navarretia, Spreading	Dicot	40	Threatened
Oak, Hinckley	Dicot	4	Threatened
Orchid, Eastern Prairie Fringed	Monocot	411	Threatened
Orchid, Western Prairie Fringed	Monocot	692	Threatened
Otter, Northern Sea	Marine mml	3	Threatened
Otter, Southern Sea	Marine mml	33	Threatened

Owl, Mexican Spotted	Bird	333	Threatened
Owl, Northern Spotted	Bird	447	Threatened
Paintbrush, Ash-grey Indian	Dicot	15	Threatened
Paintbrush, Golden	Dicot	23	Threatened
Pearlshell, Louisiana	Bivalve	16	Threatened
Pink, Swamp	Monocot	245	Threatened
Plover, Western Snowy	Bird	230	Threatened
Pogonia, Small Whorled	Monocot	496	Threatened
Potato-bean, Price's	Dicot	93	Threatened
Prairie Dog, Utah	Mammal	23	Threatened
Primrose, Maguire	Dicot	9	Threatened
Pussypaws, Mariposa	Dicot	45	Threatened
Rattlesnake, New Mexican Ridge-nosed	Reptile	14	Threatened
Reed-mustard, Clay	Dicot	4	Threatened
Rocksnail, Painted	Gastropod	22	Threatened
Rocksnail, Round	Gastropod	5	Threatened
Rosemary, Cumberland	Dicot	27	Threatened
Roseroot, Leedy's	Dicot	39	Threatened
Rush-rose, Island	Dicot	11	Threatened
Salamander, Cheat Mountain	Amphibian	13	Threatened
Salamander, Flatwoods	Amphibian	187	Threatened
Salamander, Red Hills	Amphibian	28	Threatened
Salamander, San Marcos	Amphibian	44	Threatened
Salmon, Chinook (California Coastal Run)	Fish	42	Threatened
Salmon, Chinook (Central Valley Fall Run)	Fish	42	Threatened
Salmon, Chinook (Central Valley Spring Run)	Fish	240	Threatened
Salmon, Chinook (Lower Columbia River)	Fish	71	Threatened
Salmon, Chinook (Puget Sound)	Fish	106	Threatened
Salmon, Chinook (Snake River Fall Run)	Fish	116	Threatened
Salmon, Chinook (Snake River spring/summer)	Fish	130	Threatened
Salmon, Chinook (Upper Willamette River)	Fish	129	Threatened
Salmon, Chum (Columbia River population)	Fish	56	Threatened
Salmon, Chum (Hood Canal Summer population)	Fish	34	Threatened
Salmon, Coho (Southern OR/Northern CA Coast)	Fish	105	Threatened
Salmon, Sockeye (Ozette Lake population)	Fish	7	Threatened
Sandwort, Bear Valley	Dicot	15	Threatened
Schiedea spergulina var. spergulina (ncn)	Dicot	11	Threatened
Scrub-Jay, Florida	Bird	201	Threatened
Sculpin, Pygmy	Fish	3	Threatened
Sea turtle, loggerhead	Reptile	537	Threatened
Sea turtle, olive ridley	Reptile	45	Threatened
Seagrass, Johnson's	Monocot	26	Threatened
Seal, Guadalupe Fur	Marine mml	14	Threatened
Sea-lion, Steller (eastern)	Marine mml	1	Threatened
Sedge, Navajo	Monocot	10	Threatened
Shagreen, Magazine Mountain	Gastropod	8	Threatened
Shearwater, Newell's Townsend's	Bird	23	Threatened
Shiner, Arkansas River	Fish	401	Threatened
Shiner, Beautiful	Fish	17	Threatened
Shiner, Blue	Fish	47	Threatened
Shiner, Pecos Bluntnose	Fish	24	Threatened
Shrimp, Squirrel Chimney Cave	Crustacean	13	Threatened
Silene hawaiiensis (ncn)	Dicot	7	Threatened
Silverside, Waccamaw	Fish	11	Threatened
Silversword, Haleakala ('Ahinahina)	Dicot	20	Threatened
Skink, Blue-tailed Mole	Reptile	11	Threatened
Skink, Sand	Reptile	31	Threatened

Skipper, Pawnee Montane	Insect	10	Threatened
Skullcap, Large-flowered	Dicot	36	Threatened
Slabshell, Chipola	Bivalve	19	Threatened
Smelt, Delta	Fish	82	Threatened
Snail, Bliss Rapids	Gastropod	15	Threatened
Snail, Chittenango Ovate Amber	Gastropod	9	Threatened
Snail, Flat-spired Three-toothed	Gastropod	11	Threatened
Snail, Newcomb's	Gastropod	11	Threatened
Snail, Noonday	Gastropod	4	Threatened
Snail, Painted Snake Coiled Forest	Gastropod	3	Threatened
Snake, Atlantic Salt Marsh	Reptile	12	Threatened
Snake, Concho Water	Reptile	66	Threatened
Snake, Eastern Indigo	Reptile	954	Threatened
Snake, Giant Garter	Reptile	170	Threatened
Snake, Lake Erie Water	Reptile	13	Threatened
Snake, Northern Copperbelly Water	Reptile	67	Threatened
Sneezeweed, Virginia	Dicot	28	Threatened
Sparrow, San Clemente Sage	Bird	11	Threatened
Spikedace	Fish	61	Threatened
Spinedace, Big Spring	Fish	2	Threatened
Spinedace, Little Colorado	Fish	8	Threatened
Spineflower, Monterey	Dicot	21	Threatened
Spiraea, Virginia	Dicot	182	Threatened
Springfish, Railroad Valley	Fish	8	Threatened
Spurge, Garber's	Dicot	3	Threatened
Spurge, Hoover's	Dicot	111	Threatened
Spurge, Telephus	Dicot	4	Threatened
Squirrel, Northern Idaho Ground	Mammal	4	Threatened
Steelhead, (California Central Valley population)	Fish	298	Threatened
Steelhead, (Central California Coast population)	Fish	91	Threatened
Steelhead, (Lower Columbia River population)	Fish	81	Threatened
Steelhead, (Middle Columbia River population)	Fish	127	Threatened
Steelhead, (Northern California population)	Fish	68	Threatened
Steelhead, (Snake River Basin population)	Fish	138	Threatened
Steelhead, (South-Central California population)	Fish	57	Threatened
Steelhead, (Upper Columbia River population)	Fish	130	Threatened
Steelhead, (Upper Willamette River population)	Fish	123	Threatened
Steelhead, Puget Sound	Fish	123	Threatened
Sturgeon, green	Fish	75	Threatened
Sturgeon, Gulf	Fish	466	Threatened
Sucker, Santa Ana	Fish	55	Threatened
Sucker, Warner	Fish	5	Threatened
Sunflower, Pecos	Dicot	39	Threatened
Sunray, Ash Meadows	Dicot	6	Threatened
Tarplant, Otay	Dicot	11	Threatened
Tarplant, Santa Cruz	Dicot	26	Threatened
Tetramolopium rockii (ncn)	Dicot	13	Threatened
Thelypody, Howell's Spectacular	Dicot	7	Threatened
Thistle, Pitcher's	Dicot	228	Threatened
Thistle, Sacramento Mountains	Dicot	7	Threatened
Thornmint, San Diego	Dicot	11	Threatened
Tortoise, Desert	Reptile	103	Threatened
Tortoise, Gopher	Reptile	92	Threatened
Towhee, Inyo Brown	Bird	2	Threatened
Townsendia, Last Chance	Dicot	12	Threatened
Trout, Apache	Fish	19	Threatened
Trout, Bull	Fish	454	Threatened

Trout, Bull (Columbia River population)	Fish	326	Threatened
Trout, Bull (Klamath River population)	Fish	321	Threatened
Trout, Greenback Cutthroat	Fish	37	Threatened
Trout, Lahontan Cutthroat	Fish	97	Threatened
Trout, Little Kern Golden	Fish	43	Threatened
Trout, Paiute Cutthroat	Fish	45	Threatened
Turtle, Bog (Northern population)	Reptile	351	Threatened
Turtle, Flattened Musk	Reptile	64	Threatened
Turtle, Ringed Sawback	Reptile	51	Threatened
Turtle, Yellow-blotched Map	Reptile	34	Threatened
Twinpod, Dudley Bluffs	Dicot	2	Threatened
Vervain, California	Dicot	3	Threatened
Water-plantain, Kral's	Monocot	14	Threatened
Whipsnake (=Striped Racer), Alameda	Reptile	10	Threatened
Whitlow-wort, Papery	Dicot	20	Threatened
Wild-buckwheat, Gypsum	Dicot	12	Threatened
Wings, Pigeon	Dicot	17	Threatened
Yellowhead, Desert	Dicot	6	Threatened

No species were selected for exclusion.

Dispersed species included in report.

10/26/2010 11:16:40 AM Ver. 2.10.4

EXHIBIT 30

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, DC 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

January 29, 2016

DECISION MEMORANDUM

SUBJECT: EPA Recommendation to Cancel All Currently Registered Flubendiamide Products (BELT™ SC Insecticide (EPA Reg. No. 264-1025); SYNAPSE™ WG Insecticide (EPA Reg. No. 264-1026); FLUBENDIAMIDE Technical (EPA Reg. No. 71711-26); VETICA® Insecticide (EPA Reg. No. 71711-32); and TOURISMO® Insecticide (EPA Reg. No. 71711-33))

FROM: Susan T. Lewis, Director
Registration Division (7505P)

TO: Jack E. Housenger, Director
Office of Pesticide Programs (7501P)

1. Regulatory Background

On August 1, 2008, the EPA granted a time-limited (5-year) conditional registration under section 3(c)(7) of FIFRA for flubendiamide to Bayer CropScience LP as agent for Nichino America, Inc., hereafter jointly identified as BCS/NAI. EPA issued a time-limited/conditional registration due to the Agency's initial concerns regarding flubendiamide's mobility, stability/persistence, accumulation in soils, water columns and sediments, and the extremely toxic nature of the primary degradate NNI-001-des-iodo (des-iodo) to aquatic invertebrates. Flubendiamide currently has foliar (ground & aerial) uses on over 200+ use sites with some crops having as many as 6 applications per year. Flubendiamide acts against the larvae of the target pests (Lepidoptera *spp.*) via oral ingestion of toxic residues on plants.

As a condition of registration, as established in the preliminary acceptance letter (PAL) for flubendiamide (copy attached), if the Agency makes a determination that further registration of the flubendiamide technical and end-use products will result in unreasonable adverse effects on the environment, within (1) week of this finding, BCS/NAI must submit a voluntary cancellation of the flubendiamide technical and all end use products. BCS/NAI's original release for shipment of the flubendiamide products constituted acceptance of the conditions of registration as outlined in the PAL. As stated in the notices of registration for each flubendiamide product, if the conditions of registration are not complied with, the registration for all flubendiamide products would be subject to cancellation in accordance with section 6(e) of FIFRA.
In addition, as part of these conditions of registration, BCS/NAI agreed to generate and submit a vegetative filter strip (VFS) study and, if the VFS proved to be ineffective in reducing the contamination, to conduct a farm pond water monitoring program. The VFS study was required to assess the efficacy of the BCS/NAI-proposed 15-foot VFS in field conditions. The VFS study was submitted to the Agency on August 3, 2010. Prior to the Agency's completion of the VFS study review, BCS/NAI submitted a waiver request for the farm pond water monitoring program study. This waiver request was denied by the Agency via a letter dated November 8, 2010 because the Agency had identified a major modeling error in BCS/NAI's VFS study and believed that even if the error was corrected, a VFS "would be insufficient to preclude ecological risk concerns". As a result, the second data-related condition of registration, the farm pond water monitoring program was triggered. The farm pond water monitoring program was comprised of 3 years of water monitoring from 2 VFS-protected farm ponds in Georgia and North Carolina (submitted December 22, 2014). The Agency review, provided to BCS/NAI on February 20, 2015, indicated that both flubendiamide

and des-iodo were accumulating in all of the farm ponds' overlying water, sediment, and pore water; therefore, the VFSs were ineffective at preventing flubendiamide and des-iodo from accumulating in aquatic systems downstream of the fields to which flubendiamide had been applied.

2. Time-Limited/Conditional Registration Expiration Date Extensions

The original time-limited/conditional registration expiration date for flubendiamide was July 31, 2013; however, BCS/NAI has requested several extensions to the time-limited/conditional registration expiration date, with the latest extension out to January 29, 2016. The latest extension allowed EPA to host a technical discussion between its scientists and BCS/NAI scientists on January 6, 2016, which allowed them to engage in dialogue related to the conditional data and the EPA's conclusions related to flubendiamide. This extension also allowed additional time for EPA to review 2 newly submitted data volumes (an aqueous photolysis study and a spiked sediment study) and to consider the most recent label proposal submitted by BCS/NAI on January 8, 2016.

3. Human Health Risk Assessment:

No human health concerns have been identified with the use of flubendiamide. The human health assessment for flubendiamide has not changed since the initial risk assessment in 2008. Flubendiamide has a low acute oral (LD_{50} >2,000 mg/kg body weight/day (mg/kg/day)); dermal (LD_{50} >2,000 mg/kg/day); and inhalation toxicity (LC_{50} >68.5 mg/m^3 air). Though it is a slight irritant to the eye, flubendiamide is not a skin irritant and it is not a skin sensitizer. The primary target organ is liver with thyroid and kidney effects being secondary. Ocular effects were observed in multiple studies and used for acute dietary risk assessment. Flubendiamide is considered "Not Likely to be Carcinogenic to Humans," and was not mutagenic. There is no residual uncertainty for pre- and post-natal toxicity, and flubendiamide is not neurotoxic. The FQPA safety factor was reduced to 1X. Aggregate exposure (refined food and updated estimated drinking water concentrations) are below the Agency's level of concern. EPA has not found flubendiamide to share a common mechanism of toxicity with any other substances, and flubendiamide does not appear to produce a toxic metabolite produced by other substances.

4. Ecological Fate and Effects Risk Assessments

Flubendiamide has been subject to three (3) ecological fate and effects risk assessments. The initial assessment, dated June 23, 2008, was followed by two (2) subsequent separate assessments (May 17, 2010 and December 16, 2010, respectively) to add new crops/uses in 2010. The most recent document: "*Flubendiamide: Ecological Risk Assessment Addendum Summarizing All Submissions and Discussions to Date*," dated January 28, 2016, is an addendum/compilation of all of the ecological fate and effects submissions and technical discussions with BCS/NAI to date.

The June 23, 2008 risk assessment addressed BCS/NAI's initial registration proposals for one (1) technical product and two (2) flubendiamide end-use product formulations. The 480 SC product was proposed for corn, cotton, tobacco, grapes, pome fruit, stone fruit, and tree nut crops. A second formulation, 24 WG, was proposed for use on cucurbit vegetables, fruiting vegetables, leafy vegetables, and brassica (cole) leafy vegetables.

The June 23, 2008 risk assessment's evaluation of the physical and chemical properties of flubendiamide indicated that flubendiamide is stable to hydrolysis, aerobic and anaerobic soil metabolism, and aerobic aquatic metabolism. Photolysis and anaerobic aquatic metabolism were reported to be the main routes of degradation for flubendiamide. Flubendiamide degrades to des-iodo under anaerobic aquatic conditions ($t_{1/2}$ = 364 days) and direct aqueous photolysis ($t_{1/2}$ = 11.6 days), but rather slowly by soil photolysis ($t_{1/2}$ = 70.5 days). Submitted fate data indicate flubendiamide slowly converts to its des-iodo degradate, which does not further breakdown. Flubendiamide and des-iodo were reported to have the potential for groundwater contamination in vulnerable soils with low organic carbon content after a very heavy rainfall and/or in the presence of shallow groundwater.

The June 23, 2008 risk assessment also noted that the overall stability/persistence profiles for flubendiamide and the des-iodo degradate were suggestive of accumulation in soils, water column, and sediments with each successive application. Analysis of available ecological effects data resulted in the conclusion that both flubendiamide and its des-iodo degradate were of toxicological concern. EFED modeling predicted that flubendiamide and des-iodo would accumulate in aquatic systems eventually exceeding Agency LOCs, and concluded that there is a potential for risk to benthic invertebrates[1] exposed to flubendiamide and its des-iodo degradate, and that the formulated products 480 SC and 24 WG do result in direct acute and chronic risk to freshwater invertebrates. The acute risk issue is relatively minor and refers to enhanced toxicity of the formulations compared to the technical grade active ingredient (applicable only to direct application to aquatic environments through spray drift), while the chronic risk to freshwater invertebrates is the major risk concern. Because of these chronic aquatic risk concerns, two (2) data-related conditions of registration were imposed and conveyed to BCS/NAI by the PAL:

- Vegetative Filter Strip Study – a run-off study to determine the magnitude of the parent, flubendiamide, retained in buffer strips of various widths; and
- Farm Pond Water Monitoring Program – if a risk assessment, based on the results from the small-scale run-off/vegetative filter strip study and additional available data, indicates that there are still risk concerns, monitoring of selected receiving waters will be required within watersheds where flubendiamide will be used.

According to the flubendiamide PAL, the "Agency believed that the efficacy of vegetative buffers for flubendiamide use is uncertain." Since 2008, BCS/NAI has argued that: (1) VFSs would prevent accumulation from exceeding Agency LOCs (flubendiamide labels require a 15-foot VFS around aquatic areas); and (2) the Agency overestimates aquatic exposure because the EFED modeling cannot account for the effect of VFSs. During the Agency's cursory review of the VFS study protocol, a major modeling error was identified. The Agency requested the study be corrected and re-submitted; however, BCS/NAI never re-submitted a corrected study. Therefore, the second data-related conditional registration requirement, the 'farm pond' water monitoring program, was triggered.

The May 17, 2010 environmental risk assessment addressed additional registration proposals for 480 SC formulation use on Christmas trees and legume vegetables including soybeans, and the 24 WG formulation for rotational plant-back interval use for legume vegetables. The conclusions of the May 17, 2010 risk assessment were not markedly different from the 2008 risk assessment's characterization of the environmental fate, stressors of concern, nor the risk conclusions: (1) concern for long-term accumulation of the parent flubendiamide and the des-iodo degradate; (2) flubendiamide and the des-iodo degradate as stressors of concern and; (3) risk concerns for benthic invertebrates from both flubendiamide and the des-iodo degradate as well as surface water concerns for the formulations to freshwater invertebrates. However, the risk assessment also addressed the potential for distance buffers between application sites and surface waters as a risk mitigation option. The May 17, 2010 risk assessment concluded that buffers, from a spray drift perspective, would have little impact on the risks of concern.

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[1] Some species of aquatic invertebrates inhabit the overlying water (water above the sediment in a water body), while others inhabit the benthic zone (in or on the sediment in a water body). Because exposure and effects endpoints can vary between overlying and benthic (or pore) water, it is sometimes necessary to specify overlying or benthic if referring to only one portion of the water body or one of these groups of aquatic invertebrates.

The December 16, 2010 risk assessment addressed proposed new uses of flubendiamide on alfalfa, globe artichoke, low growing berries (except cranberry), peanut, pistachio, small fruit vine climbing (except fuzzy kiwifruit), sorghum, sugarcane, sunflower, safflower, turnip greens, and a proposed increased application rate on brassica leafy vegetables. The proposed new uses and increased rate included the water dispersible granule formulation SYNAPSE™ WG (39% flubendiamide) and BELT™ SC (24% flubendiamide), a suspension concentrate formulation. Flubendiamide was proposed for ground application, aerial application (restricted for pistachio, and small fruit vine climbing group), and chemigation. Again, as in the previous risk assessments, flubendiamide and the des-iodo degradate were identified as the stressors of concern. Environmental fate and transport data indicated that flubendiamide is stable to hydrolysis, aerobic and anaerobic soil metabolism, and aerobic aquatic metabolism. Photolysis and anaerobic aquatic metabolism appeared to be the main routes of degradation for flubendiamide.

Flubendiamide degrades to des-iodo under anaerobic aquatic conditions ($t_{1/2}$ = 364 days), direct aqueous photolysis ($t_{1/2}$ = 11.6 days), and by soil photolysis ($t_{1/2}$ = 35.3 days). Flubendiamide was expected to be slightly to hardly mobile in the environment. The des-iodo degradate was concluded to be persistent (stable in an aerobic soil environment) and expected to be moderately mobile. As in the previous risk assessments, concern was indicated for chronic risk to benthic invertebrates from exposures in the water column and pore water from the total residues of flubendiamide and des-iodo. The December 16, 2010 risk assessment mentions that a field study of the efficacy of vegetative filter strips to reduce pesticide loading to surface waters was under review at the time of writing. However, the results of that study were not incorporated into the December 16, 2010 risk assessment.

5. Label Proposal, Additional Data and Interactions with BCS/NAI

The 3-year report on the farm pond water monitoring study of water column, sediments, and pore water in 3 ponds (2 in Georgia and 1 in North Carolina) was submitted by BCS/NAI in December of 2014. The Agency's review has identified several issues with this monitoring data. Despite these issues, EPA believes the monitoring data shows clear evidence that both flubendiamide and des-iodo accumulate in the ponds monitored. The accumulation measured in the first 3 years of the pond data largely matches the initial predictions. Because the Agency's modeling does not account for the effect of VFSs, but still largely matches the monitoring data, we believe the effect of VFSs is not large enough to mitigate the ecological risks posed by flubendiamide applications. Our conclusion is the original and subsequent ecological risk assessments performed by the Agency adequately reflect the risks posed by flubendiamide applications and rejects BCS/NAI's argument that the label-required 15-foot VFSs around aquatic areas would prevent accumulation from exceeding Agency LOCs. Accumulation was consistent with the Agency's 2008 model predictions for a pond without grassed waterways. Since both flubendiamide and des-iodo were found to be accumulating in surface water, sediment, and pore water in all three of the VFS-protected ponds monitored, the VFSs were deemed ineffective in preventing accumulation of flubendiamide and des-iodo in water bodies.

In late October 2015 through January 2016, numerous re-review and validation refinements of the ecological and fate data evaluation records and new model scenarios occurred in critical documents. BCS/NAI also asked the Agency to consider various label mitigation options of reducing crops and application rates and frequency, deleting aerial use and considering an increase in the buffer size so that the chemical might retain its active registration status. The Agency performed numerous series of "bracketing scenarios" of label applications and rates. Also during this time, the water values were reassessed by using a time-weighted average (TWA) approach instead of a single measured value. This recalculation of TWA values reduces the LOAEC for parent flubendiamide in overlying water by a factor greater than two and pore water by a factor slightly greater than one. The TWA values factor in the variability of measured concentrations rather than relying on a single measured value at onset of test consistent with current guidance in EFED. Recalculation of TWA values for the des-iodo degradate produced no change in the NOAEC values for overlying and pore water. These latest proposed label mitigation scenarios exceed Agency

LOCs based on TWA endpoints.

6. Comparison of EPA Use of Flubendiamide and Des-iodo Toxicity Endpoints in Previous Risk Assessments

A comparison of the use of the flubendiamide toxicity endpoints in the previous risk assessments shows that TWA concentrations were not reported in the previous risk assessments for the NOAEC in overlying and pore waters, and shows that they reported the LOAEC as a single post-application measured dose of 69 µg/L in overlying water and 3 µg/l in pore water. In addition, a comparison of the use of the des-iodo degradate toxicity endpoints in the previous risk assessments shows that TWA concentrations are the same as those in previous risk assessments for the NOAEC in overlying and pore waters, and that the previous risk assessments did not report a TWA for the LOAEC. A detailed summary of the toxicity endpoints used in previous risk assessments for flubendiamide and des-iodo is shown within Tables 3 and 4, on pages 7 to 8, of the EFED document entitled "*Flubendiamide: Ecological Risk Assessment Addendum Summarizing All Submissions and Discussions to Date*," dated January 28, 2016.

7. Final Suite of Available Effects Toxicity Endpoints

Table 1 lists the final suite of flubendiamide and des-iodo chronic toxicity endpoints for *Chironomus riparius* (an aquatic invertebrate of the benthos) in spiked water and spiked sediment tests. Consistent with other studies with this species and sediment, emergence of the organisms proved to be the most sensitive endpoint. These endpoints are all based on emergence inhibition. (For example, 80% emergence inhibition indicates that 80% of the test organisms were unable to emerge as the adult, reproductive life-stage from the sediment where the juveniles reside, while 20% were able to emerge and potentially complete their life-cycle.)

Table 1. Current Flubendiamide and Des-iodo Toxicity Endpoints for *Chironomus riparius* in Spiked Water and Spiked Sediment Tests.

Overlying Water TWA (µg/L)	Pore Water TWA (µg/L)	Endpoint Label
Flubendiamide Endpoints in Chironomus Spiked Water 28-Day (MRID 46817022)		
15.5	1.51	NOAEC Percent emergence
29.9	2.50	LOAEC 22% inhibition
62.0	6.05	100% inhibition
Flubendiamide Endpoints in Chironomus Spiked Sediment (MRID 49661801) (in review)		
5.23	1.53	NOAEC Percent emergence
12.3	4.32	LOAEC Percent emergence
Des-iodo Endpoints in Chironomus Spiked Water 28-Day (MRID 46817023)		
1.90	0.278	NOAEC Percent emergence
4.14	0.737	LOAEC 17% inhibition
8.27	1.47	33% inhibition
16.0	3.91	80% inhibition
Des-iodo Endpoints in Chironomus Spiked Sediment (MRID 48175605)		
7.18	19.5	NOAEC (Highest dose tested)
>7.18	>19.5	LOAEC

8. Discussion of Ecological Fate and Effects Data Submitted after the Last Risk Assessment Dated December 16, 2010

Several ecological fate and effects studies have been submitted since the December 16, 2010 risk assessment for flubendiamide. In 2015, while the evaluation of all lines of evidence was underway with respect to the efficacy of vegetative filter strips, model assumptions, and surface water monitoring, the RD risk managers requested that exposure modelling results be compared to the full suite of effects endpoints from the two spiked water prolonged sediment toxicity tests with *Chironomus riparius* (MRIDs 46817022 (flubendiamide) and 46817023 (des-iodo degradate)). As a result, EPA scientists issued a memorandum that summarized the approach for evaluation of the two studies, and the findings of that effort. A detailed summary of the resulting toxicological endpoints for flubendiamide and des-iodo, expressed as TWA, is shown within Tables 1 and 2, on page 7, of the EFED document entitled "*Flubendiamide: Ecological Risk Assessment Addendum Summarizing All Submissions and Discussions to Date*," dated January 28, 2016.

9. Ecological Fate Data

The flubendiamide fate data interpretation has not changed since the new chemical assessment in December 16, 2008. Additional laboratory fate data was requested and submitted for the des-iodo degradate after the new chemical assessment. All of this additional des-iodo fate data indicated that the des-iodo degradate does not degrade in the environment with the exception of the des-iodo aquatic photolysis study that was recently submitted on January 5, 2016.

10. New Des-iodo Aquatic Photolysis Study (MRID 49661701)

BCS/NAI submitted a 10-day aqueous photolysis study on January 5, 2016, that estimates a 79-day half-life for the des-iodo degradate when expressed as an environmentally relevant half-life for June in Phoenix, AZ. While this study is in review, the following is a preliminary analysis:

"At the end of the 10-day aqueous photolysis study, 77% of the des-iodo remained as untransformed des-iodo. The other 23% had transformed into 14 degradates and CO_2. Because so many degradates together make up so little mass, no degradate exceeded 6% and only two degradates could be identified. None of the degradates have toxicity data, so none can be ruled out as degradates of concern other than CO_2. Assuming that all of the degradates, other than CO_2, are degradates of concern would produce a total toxic residue (TTR) half-life exceeding 1,000 years."

11. Tree Nut Use Modeling

At the most recent technical meetings between EPA scientists and BCS/NAI scientists on January 6, 2016, BCS/NAI inquired about the possibility of submitting a new label mitigation proposal where BCS/NAI would retain only one use – tree nuts on their label, and stated that it would not exceed any of the Agency's LOCs. On January 8, 2016, BCS/NAI submitted a new revised label to the Agency that: (1) eliminated aerial applications; (2) limited use to tree nuts in California only; and (3) further limited application rates for tree nut uses below that on the current label for EPA Reg. No. 264-1025 (BELT™ SC Insecticide).

Modeling of this proposed remaining use allowed the Agency to perform an assessment of not only the reduced application rates, but also allowed EPA to incorporate the 79-day aqueous photolysis half-life data for des-iodo into this assessment. Previous analyses were unable to use this half-life estimate since it was only just submitted to the Agency on January 5, 2016. Flubendiamide air blast applications to tree nuts were modeled using the California almond scenario, based on an application rate of 0.125 pound of active ingredient per acre with a 7-day application interval and up to 3 applications per year. The scenario modeled assumes that flubendiamide has not previously been used in the fields to which it is to be applied, and includes a 30-ft spray drift buffer zone around aquatic areas based on the new proposed label (previous modeling had only included a 15-ft spray drift buffer zone which was correct based on the spray drift language of the previous labels).

To provide an estimate of the ecological effects to be anticipated at different RQ levels, the NOAEC and any additional treatment levels that showed a significant effect above the NOAEC were included. Analyzed endpoints include both the Agency endpoints based on TWAs and the BCS/NAI-suggested endpoints that are not supported by the Agency guidance.

A detailed summary of the comparison of EFED's most sensitive endpoints based on TWA concentrations and BCS/NAI-suggested most sensitive endpoints for flubendiamide and its des-iodo degradate, is shown within Table 6, on page 10, of the EFED document entitled "*Flubendiamide: Ecological Risk Assessment Addendum Summarizing All Submissions and Discussions to Date*," dated January 28, 2016. All of the existing uses for the time-limited/conditional flubendiamide registrations as well as the latest proposed use scenarios exceed the Agency LOCs for aquatic system invertebrates based on the TWA effect endpoints from *C. riparius* testing compared with estimated toxicant concentrations for sediment pore- and overlying-water.

12. Integration of New Ecological Fate and Effects Information into the Amended EFED Risk Assessment

Results from the Farm Pond Water Monitoring Study: At the end of three (3) years of water monitoring, BCS/NAI submitted the final farm pond water monitoring reports. In its review, EFED identified several issues with this monitoring data. Despite these issues, EFED believed the monitoring data showed clear evidence that both flubendiamide and des-iodo accumulated in the ponds monitored. The accumulation measured in the first 3 years of the pond data least impacted by the identified issues largely matched the initial 3 years of concentration predictions of EFED's aquatic exposure modeling. Because EPA's modeling does not account for the effect of VFSs, but still largely matched the monitoring data, EPA believes the effect of VFSs is not large enough to mitigate the ecological risks posed by flubendiamide applications. EPA concluded the original and subsequent ecological risk assessments performed by the Agency adequately reflect the risks posed by flubendiamide applications and rejects BCS/NAI's argument that the label-required 15-foot VFSs would prevent accumulation from exceeding Agency LOCs.

Analysis of Results from Four Regulatory Scenarios for Multiple Crops: The Agency compared four regulatory scenarios for multiple crops based on standard EPA aquatic modeling procedures. The crops selected were those with the largest number of acres treated according to proprietary pesticide usage data available to the Agency. The regulatory scenarios assumed maximum use rates from 2009 (the year after flubendiamide was registered) to 2015, and then changed according to the regulatory scenario modeled, which included 'no change from current label,' 'change to one ground application forever,' 'change to one ground application, then cancel in 2018,' and 'cancel uses after the 2015 application.' When considering the TWA endpoints, all four (4) of the regulatory scenarios exceed Agency LOCs for all of the simulated crops. Consistently, the greatest exceedances occur for des-iodo in pore water, and many of the scenarios achieve exposure levels that resulted in 80% emergence inhibition in the des-iodo chronic laboratory toxicity study, which indicates at this exposure level that 80% of the test organisms were unable to emerge as the adult (reproductive life-stage) from the sediment (where the juveniles reside), while 20% were able to emerge and potentially complete their life-cycle.

Flubendiamide and its des-iodo degradate pose a long-term risk long after a regulatory action may take place (*i.e.*, there is a time-lag between mitigation and the maximum risk). For example, under the "cancel now" regulatory scenario, flubendiamide applications to the watershed above the modeled pond stop after 2015; however, risk from des-iodo in pore water does not level-off (stop increasing) for more than a decade after. This time-lag is due to the time required to transport the flubendiamide from the field to the pond and subsequent conversion of flubendiamide in the pond into des-iodo.

The TWA endpoint exceedances tend to occur quite early in the temporal trends. For example, all of the des-iodo pore water TWA endpoints exceed Agency LOCs within two years. Considering that flubendiamide applications could have started in 2009 for these crops, these projected exceedances could have occurred as early as five years ago. Even if risk were judged by the less sensitive endpoints suggested by BCS/NAI, all but two of the regulatory scenarios exceed Agency LOCs. These two regulatory scenarios are the "Change to one ground application then cancel after the studies are submitted" and "Cancel now" scenarios for the leafy vegetables (based on the CA lettuce scenario, with ground applications initially in the first time period).

Analysis Results from High and Low Exposure Analysis for 13 Crop Uses: BCS/NCI requested the Agency also consider another label mitigation option where only 13 crops remained on the labels. This analysis provided additional characterization of ecological risk through consideration of a subset of crops proposed as posing limited ecological risk to aquatic invertebrates. The crop scenarios were selected based on the 13 crops (or crop groups; i.e., alfalfa, brassica leafy vegetables, cotton (AZ and CA only), cucurbit vegetables, fruiting vegetables, grape, leafy vegetables, legume vegetables, pome fruit, stone fruit, strawberry, tobacco, and tree nuts) that BCS/NAI proposed to retain on flubendiamide labels. Only two crop scenarios (high and low exposure) were investigated for this second memo to capture the range of flubendiamide risk from the BCS/NAI-proposed crops to be retained. This analysis assumed no prior use of flubendiamide and modeled different numbers of applications from the maximum allowed on the label down to one at the maximum single application rate. Both the high and low exposure/risk crop scenarios exceed Agency LOCs (based on the TWA endpoints). There is risk for all application numbers modeled for both high and low scenarios. The low exposure scenario exceeds Agency LOCs in: 3 years at six, five, or four applications per year; 4 years at three applications per year; 6 years at two applications per year; and 9 years with only one application per year. The high exposure scenario applying two applications per year (the most allowed by the BCS/NAI proposal) exceeds Agency LOCs in 2 years, while the first exceedance occurs in 3 years with only one application per year.

Although the Agency does not agree with the use of the nominal-based endpoints that were suggested by BCS/NAI, the low exposure scenario exceeds Agency LOCs in 11 years at six applications per year, 13 years at five applications per year, 16 years at four applications per year, and 21 years at three applications per year using the BCS/NAI-suggested endpoints. The low exposure scenario based on either one or two applications per year does not exceed LOCs within the 30 years simulated based on the BCS/NAI-suggested endpoints. However, both application patterns of either one or two applications per year would be expected to eventually exceed if applications continued long enough. The high exposure scenario applying two applications per year exceeds LOCs based on the BCS/NAI-suggested endpoints in eight years, while the first exceedance occurs in 11 years with only one application per year. Therefore, when considering BCS/NAI's less conservative proposed endpoints, use of flubendiamide still results in risk concerns for aquatic system invertebrates.

Tree Nut Assessment Results: The Agency received a new proposed label for flubendiamide on January 8, 2016 that limits the label only to tree nuts in California, and further limits application rates. Modeling this proposed use allowed the Agency to perform an assessment of not only the reduced application rates, but also incorporate the 79-day aqueous photolysis half-life for des-iodo into this assessment (previous analyses had not used this half-life estimate since it was submitted to the Agency on January 5, 2016). This analysis also assumed no prior use of flubendiamide and modeled different numbers of applications from the maximum allowed on the label down to one at the maximum single application rate. Based on the TWA endpoints, the currently proposed flubendiamide tree nut use results in risk that exceeds Agency LOCs for all numbers of applications modeled. The tree nut scenario proposed by the BCS/NAI exceeds Agency LOCs in 2 years at three applications per year and 3 years at two or one application(s) per year. Although the Agency does not agree with the use of the nominal-based endpoints that were suggested by BCS/NAI, the proposed tree nut scenario exceeds Agency LOCs using these endpoints in 10 years at three applications per year, 11 years at two applications per year, and 21 years at one application per year. Therefore, when considering BCS/NAI's less conservative proposed endpoints, the continued use of flubendiamide still results in risk concerns for aquatic system invertebrates. Based on the California almond scenario presented above, as well as the other recent modeling, significant chronic risk effects to aquatic organisms due to the use of flubendiamide could potentially occur in as little as 2 years.

While BCS/NAI has raised many issues as discussed in detail within the amended ecological risk assessment, none have persuaded the Agency that the original and subsequent ecological risk assessment conclusions were inaccurate nor have they diminished confidence in those conclusions.

13. USGS Monitoring Information

Additional information from U.S. Geological Survey (USGS) stream and river monitoring data (2012 to 2014) indicate that flubendiamide and des-iodo was detected at 26 sites in 14 states. California, Georgia, North Carolina, Mississippi, and Louisiana had multiple sites with frequent detections. These detections were filtered water samples only. The Agency fully expects higher concentrations in unfiltered water or sediment samples.

14. Other Persistent Chemicals

In terms of the Agency's history in mitigating the ecological risks posed by other persistent and toxic insecticides, EPA has limited similar insecticide products to greenhouses, perimeter structural treatments, or indoor uses. Since flubendiamide only has outdoor above-ground foliar crop uses, this type of mitigation is not a regulatory option for the compound.

15. Mitigation and Labeling Requirements

A series of meetings between EPA scientists and BCS/NAI scientists has occurred since March 2015, where the Agency has continued to engage in dialogue about the referenced conditional data and the environmental risk conclusions. After review of all the BCS/NAI data submissions and previous risk assessments, EPA's conclusions on the environmental risks posed by flubendiamide and des-iodo today are consistent with those identified in 2008. EPA originally concluded that "Flubendiamide and the des-iodo degradate's overall stability/persistence suggests that they will accumulate in soils, water column, and sediments with each successive application."

EPA's analysis of BCS/NAI's farm pond water monitoring study concludes that there is: (1) accumulation of both flubendiamide and des-iodo in the water column, sediment, and pore water for all ponds monitored; and (2) definitive evidence that VFSs do not sufficiently control off-site transport of these chemicals to downstream waterbodies. In addition, stream and river monitoring conducted by BCS/NAI and the USGS over much of the United States indicates: (1) the failure of VFSs to contain these chemicals is a widespread occurrence; and (2) the potential for water quality impacts is also widespread.

16. Benefits and Alternatives

EPA evaluated the benefits and alternatives for flubendiamide in a memo dated July 24, 2015 (copy attached). The Agency reviewed benefit information submitted by BCS/NAI, which included a combination of private pesticide surveys of growers, trade journals, articles, state extension Integrated Pest Management websites, Arthropod Management Tests, and expert opinions to support claims of benefits. The benefits of flubendiamide are that it plays a role in integrated pest management and insecticide resistance management based upon the following characteristics: (1) specificity to Lepidopteran larvae; (2) non-systemic but translaminar properties; and (3) no to low impacts on beneficial arthropods. If flubendiamide is unavailable, pyrethroids would most likely be the alternative chemistry used by growers.

Other alternatives are insect growth regulators (*e.g.*, diflubenzuron, methoxyfenozide), other diamides (*e.g.*, chlorantraniliprole, cyantraniliprole), and spinosyns (*e.g.*, spinetoram). Overall, EPA concludes that there are efficacious alternatives for flubendiamide.

17. EPA Risk Management Decision and Regulatory Determination

The initial environmental risk concerns from 2008 to the present have continued to center around flubendiamide being a mobile, persistent, and extremely toxic insecticide and because the parent degrades only through aquatic photolysis and anaerobic aquatic metabolism to des-iodo, which does not further degrade except slowly through photolysis. EPA has identified chronic concerns for Flubendiamide to aquatic system invertebrates for both parent and its des-iodo degradate. These risks concerns are based on comparisons of overlying and sediment pore water concentrations of the two compounds to effects endpoints established using the emergent aquatic insect *C. riparius*, a commonly tested species with juvenile life stages that exist in the benthic sediment and are exposed to both sediment pore- and overlying-water. However, because des-iodo is 10X more toxic to aquatic invertebrates than the parent flubendiamide, it is des-iodo that causes the greatest risk concern. Therefore, with each successive flubendiamide application, more flubendiamide is transported to aquatic environments via runoff and spray drift where it accumulates and slowly degrades to des-iodo, which in turn accumulates, causing unreasonable adverse effects to aquatic environments.

EPA has assessed the risks and benefits associated with the continued use of flubendiamide as currently registered (and the modifications proposed by BCS/NAI), and determined that the risks of allowing the continued use of flubendiamide outweigh the benefits, and will result in unreasonable adverse effects to the environment. In conclusion, all of the existing uses for the time-limited/conditional flubendiamide registrations as well as the latest proposed use scenarios exceed the Agency's LOCs for aquatic system invertebrates based on the TWA effect endpoints from *C. riparius* testing compared with estimated toxicant concentrations for sediment pore- and overlying- water. The modelling scenarios based on the latest label submitted by BCS/NAI and the TWA endpoints exceed Agency LOCs within 2 years. Considering that flubendiamide applications most likely started in 2009 (7 years ago), these exceedances could have occurred as early as 5 years ago. Such adverse impacts would directly impact aquatic invertebrates in ponds, lakes, reservoirs, estuaries, areas of sediment accumulation in flowing waterbodies and any non-flowing waterbodies where des-iodo would accumulate-downstream of lands where flubendiamide is used as well as indirect impacts to fish and wildlife for which aquatic invertebrates serve as the basis for their food chain.

Within the parameters of the time limited/conditional registration agreement signed by both the Agency and BCS/NAI, the companies (BCS/NAI) agreed to voluntarily cancel all flubendiamide products if the Agency makes the determination that there are unreasonable adverse effects to the environment. If the companies (BCS/NAI) fail to voluntarily cancel all registrations by the close of business on Friday, February 5, 2016, I recommend the Agency move forward with cancellation under section 6(e) of FIFRA.

EPA RECOMMENDATION: I recommend that you concur with the cancellation of all flubendiamide products in accordance with the BCS/NAI and the Agency's time limited/conditional registration agreement that was signed and dated, July 31, 2008.

	1-29-16
CONCUR	DATE
DO NOT CONCUR	DATE

EXHIBIT 31

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

January 28, 2016

PC Code: 027602
DP Barcode: 431037

MEMORANDUM

SUBJECT: **Flubendiamide:** Ecological Risk Assessment Addendum Summarizing all Submissions and Discussions to Date

FROM: Stephen Wente, Ph.D., Biologist 1/28/16
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SUJATHA SANKULA

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TO: Carmen Rodia, Risk Manager Reviewer
Richard Gebken, Risk Manager, PM Team 10
Debbie McCall, Branch Chief
Invertebrate-Vertebrate Branch 2
Registration Division (7505P)

1. Introduction

Flubendiamide, an insecticide, received a time-limited/conditional registration in 2008 for aerial and/or ground application to corn, cotton, tobacco, pome fruit, stone fruit, tree nuts, grapes, cucurbit vegetables, fruiting vegetables, leafy vegetables, and brassica leafy vegetables. Subsequent registration actions have expanded the list of crops to which flubendiamide may be applied to more than 200 crops. Registrant (Bayer Crops Science, BCS) submitted effects studies indicate that both the parent compound (flubendiamide) and its degradate (des-iodo) exhibit chronic toxicity to aquatic invertebrates[1]. Submitted fate data indicate flubendiamide slowly converts to its des-iodo degradate, which does not appreciably breakdown and is 10 times more

[1] Flubendiamide's mode of action is taxa-specific to an unknown degree (targets lepidopteran ryanodine receptors). EFED does not have endpoints specific to lepidopterans. There are numerous species of aquatic lepidopterans of which four are listed species. The agency policy is to use the most sensitive species endpoints from studies that meet scientific quality criteria. There are no aquatic lepidopteran toxicity studies available to address this uncertainty in quantifiable terms.

toxic to aquatic invertebrates than the parent compound. EFED modeling (DP 329613+) predicts that flubendiamide and its des-iodo degradate will accumulate in aquatic systems eventually exceeding Agency levels of concern (LOCs).

The purpose of this analysis is to: 1) briefly summarize the previous risk assessments and more recent risk analyses performed for flubendiamide; 2) evaluate recent data submissions from the registrant; 3) assess ecological risk for a proposed tree nut use amendment the registrant has proposed to retain as the sole use on future flubendiamide labels; and 4) determine if any of the recent submissions and/or analyses have changed the Agency's understanding of the risks posed by current and proposed uses of flubendiamide.

2. Description of Past Risk Assessment Conclusions

Flubendiamide has been subject to three ecological risk assessments prior to this document:

- June 23, 2008: DP Barcodes: 329594, 329613, 329606, and 329599
- May 17, 2010: DP Barcodes: 368029, 368036, 368040, and 368055
- December 16, 2010: DP Barcodes: 376460, 376101, and 376102

The June 23, 2008 risk assessment addressed registration proposals for two flubendiamide formulations. Flubendiamide formulation 480 SC was proposed for corn, cotton, tobacco, grapes, pome fruit, stone fruit, and tree nut crops. A second formulation, 24 WG, was proposed for use on cucurbit vegetables, fruiting vegetables, leafy vegetables, and brassica (cole) leafy vegetables. The maximum application rate was 0.156 lbs a.i./A for pome fruit. Evaluation of the physical and chemical properties indicated that flubendiamide is stable to hydrolysis, aerobic and anaerobic soil metabolism, and aerobic aquatic metabolism. Photolysis and anaerobic aquatic metabolism were reported to be the main routes of degradation for flubendiamide. Flubendiamide degrades to NNI-0001-des-iodo (hereafter referred to as des-iodo) under anaerobic aquatic conditions ($t_{½}$ = 364 days) and direct aqueous photolysis ($t_{½}$ = 11.6 days), but rather slowly by soil photolysis ($t_{½}$ = 70.5 days). Flubendiamide and des-iodo were reported to have the potential for groundwater contamination in vulnerable soils with low organic carbon content, after very heavy rainfall, and/or in the presence of shallow groundwater. The risk assessment noted that flubendiamide and the des-iodo degradate overall stability/persistence profiles were suggestive of accumulation in soils, water column, and sediments with each successive application. Analysis of available ecological effects data resulted in the conclusion that both flubendiamide and the des-iodo degradate were of toxicological concern. The risk assessment concluded that there are risk concerns for to benthic invertebrates[2] exposed to flubendiamide and its des-iodo degradate. Furthermore, the risk assessment concluded that the formulated products 480 SC and 24 WG were also of concern for acute and chronic risks to freshwater invertebrates from direct introduction to surface waters by spray drift deposition.

The May 17, 2010 risk assessment addressed additional registration proposals for 480 SC formulation use on Christmas trees and legume vegetables including soybeans, and the 24 WG formulation for rotational plant-back interval use for legume vegetables. The conclusions of the

[2] Some species of aquatic invertebrates inhabit the overlying water (water above the sediment in a water body), while others inhabit the benthic zone (in or on the sediment in a water body). Because exposure and effects endpoints can vary between overlying and benthic (or pore) water, it is sometimes necessary to specify overlying or benthic if referring to only one portion of the water body or one of these groups of aquatic invertebrates.

risk assessment were not markedly different from the 2008 risk assessment's characterization of the environmental fate, stressors of concern, nor the risk conclusions: 1) concern for long-term accumulation of the parent flubendiamide and the des-iodo degradate; 2) both flubendiamide and the des-iodo degradate as stressors of concern; and 3) risk concerns for benthic invertebrates from both flubendiamide and the des-iodo degradate to freshwater invertebrates. However, the risk assessment also addressed the potential for distance buffers between application sites and surface waters as a risk mitigation option. The risk assessment concluded that buffers, from a spray drift perspective, would have little impact on the risks of concern.

The December 16, 2010 risk assessment addressed proposed new uses of flubendiamide on alfalfa, globe artichoke, low growing berries (except cranberry), peanut, pistachio, small fruit vine climbing (except fuzzy kiwifruit), sorghum, sugarcane, sunflower, safflower, turnip greens and a proposed increased application rate on brassica leafy vegetables. The proposed new uses and increased rate pertained to the formulations SYNAPSE™ WG (39%), a water dispersible granule formulation, and BELT™ SC (24% ai), a suspension concentrate formulation. Flubendiamide was proposed for ground application, aerial application (restricted for pistachio, and small fruit vine climbing group), and chemigation. Again as in the previous risk assessments, flubendiamide and the des-iodo degradate were identified as the stressors of concern. Environmental fate and transport data indicated that flubendiamide is stable to hydrolysis, aerobic and anaerobic soil metabolism, and aerobic aquatic metabolism. Photolysis and anaerobic aquatic metabolism appeared to be the main routes of degradation for flubendiamide. Flubendiamide was expected to be slightly to hardly mobile in the environment. Des-iodo was concluded to be persistent (stable in an aerobic soil environment), and expected to be moderately mobile. As in the other risk assessments, concern was indicated for chronic risk to freshwater invertebrates from exposures in the water column and pore water from the total residues of flubendiamide and des-iodo. The December 16, 2010 risk assessment mentions that a field study on the efficacy of vegetative filter strips to reduce pesticide loading to surface waters was under review at the time of writing. However, the results of that study were not incorporated into the risk assessment.

3. Time-limited/Conditional Registration Requirements

Sections 3 through 6 describe a series of less formal risk assessments that were undertaken by the Agency in response to data submissions, alternative modeling submitted by Bayer CropScience, proposed label revisions, and Agency/OPP Risk Manager requests. The results of these individual analyses are described and integrated into an overall risk assessment in Section 7.

Issues surrounding the use of vegetative filter strips

After the initial (June 23, 2008) risk assessment, the registrant argued that the 15-ft. vegetative filter strip (VFS) included on all flubendiamide labels would largely prevent transfer of flubendiamide from the field of application to downslope waterbodies, thereby limiting the accumulation of flubendiamide and des-iodo in these waterbodies and preventing exceedances of Agency LOCs. According to this argument, the Agency's modeling over-estimated exposure and therefore risk, because it could not account for the mitigation provided by the VFS.

The Environmental Fate and Effects Division (EFED) counter-argued that VFSs can be beneficial for pesticides that would degrade in the VFSs, but flubendiamide would not be expected to degrade in the VFSs due to its persistent nature. Therefore, EFED believed flubendiamide movement would only be “temporarily delayed” by the VFS (*i.e.*, flubendiamide washed into the VFS by a runoff event would likely be transported to a downstream waterbody by a subsequent runoff event).

However, neither the registrant nor EFED had data to support either side’s argument. This uncertainty is reflected in the preliminary acceptance letter dated 7/31/2008 (a document notifying the registrant of the conditions of registration) which required the following:

1. Small-Scale Run-off/Vegetative Filter Strip Study – a run-off study to determine the magnitude of the parent, flubendiamide, retained in filter strips of various widths; and
2. Farm Pond Monitoring Program – if risk assessment, based on the results from the small-scale run-off/vegetative filter strip study and additional available data indicates that there are still risk concerns, monitoring of selected receiving waters will be required within watersheds where flubendiamide will be used.

Flubendiamide was granted a time-limited/conditional registration while the registrant generated the data necessary to address the uncertainties identified at the time of registration.

A major modeling error was identified in a cursory review (DP 382010) of the small-scale run-off/vegetative filter strip study (MRIDs 48175602, 48175604, and 48175606) submitted by the registrant in response to the first condition of registration. The Agency requested that the study be corrected and resubmitted to the Agency, but the study was never re-submitted. Therefore, the second requirement, the ‘farm pond’ monitoring program, was triggered.

Requirements for Environmental Monitoring

The registrant submitted a monitoring protocol for flubendiamide and its metabolite, des-iodo flubendiamide, in sediment and surface water (MRID 48010201). EFED recommended (DP 375361) three modifications of the proposed study. First, the submitted protocol should include water bodies that will likely represent worst case scenarios in terms of flubendiamide accumulation in sediment (*e.g.*, ponds for which the entire upstream drainage area is treated with flubendiamide). Second, the time period monitored should be extended to allow accurate accumulation rates in sediment for flubendiamide and its des-iodo degradate to be determined. Third, the registrant needs to make available sufficient quantities of the technical grade active ingredient and des-iodo degradate for analytical standards, so that the U.S. Geological Survey (USGS) can include these chemicals in their pesticide surveys.

After site selection studies in Georgia (MRID 48644901) and North Carolina (MRID 48535201), the registrant and EFED agreed to monitoring a total of three ponds (two adjacent ponds in Georgia (DP 398132) and one pond in North Carolina (DP 394006)). Both sites were selected from regions of the United States with high initial (2009) flubendiamide sales data.

In addition to the registrant’s monitoring effort, the USGS was able to add flubendiamide and des-iodo to their pesticide monitoring programs from 2012 onward (water sampling only, no sediment monitoring).

Registrant-suggested Modeling Efforts

The registrant asked the Agency to consider modeling pond overflow in MRID 49532601. The registrant documented overflow events at the ponds monitored in the farm pond study (MRIDs 49415303, 49415302, and 49415301), but did not measure overflow volumes or concentrations in overflow for any of the ponds. In response to the registrant's request, the Agency modeled several scenarios (Appendix 1) using the "varying volume and flowthrough" option in the Surface Water Concentration Calculator (SWCC version 1.106; PRZM version 5.0; VVWM version 1.0).

Modeling overflow dramatically decreases the pond estimated environmental concentrations (EECs) in the Eastern/Southeastern United States scenarios modeled relative to the EECs based on standard EFED modeling (which uses the "constant volume, no flowthrough" option). This change in EECs is due to greater precipitation in the Eastern/Southeastern United States, which keeps the pond near full capacity and causes overflow with most runoff events (*i.e.*, little change in EECs due to changing pond volume, but does include a significant pesticide mass loss through overflow). However, EECs are higher in the Western United States using the "varying volume and flowthrough" option relative to standard EFED modeling that does not account for overflow. In the Western United States, the farm pond is often below full capacity and refills rather than overflows with most runoff events (*i.e.*, concentration increases as pond volume diminishes, while pesticide mass loss through overflow is rare).

Additionally, it is important to note that any flubendiamide or des-iodo "lost" with overflow is expected to accumulate in a different aquatic environment (*e.g.*, lakes, reservoirs, and/or estuaries) further downstream due to the persistence of these chemicals. Therefore, modeling overflow doesn't diminish the overall environmental consequences of flubendiamide applications in the Eastern/Southeastern United States and results in higher EECs in the Western United States (DP 426940).

Responses to Registrant Email Inquiries

The registrant asked the Agency to consider several topics through emails submitted 6/22/2015 and 6/30/2015. The 6/22/2015 email concerned USGS stream monitoring data, the proximity of farm ponds to crop areas with flubendiamide use, and aquatic photolysis as an explanation for the 66-day mesocosm study half-life. A response provided on 7/8/2015 (DP 427901) concluded that "the information contained in this submission would not change the conclusions of previous EFED responses subsequent to the pond studies or previous EFED risk assessments".

The 6/30/2015 email contained an attachment entitled "White Paper: Flubendiamide Benefits, Aquatic Risk Assessment Summary and Proposed Path Forward" (no MRID number) with comments on several topics: 1) pond monitoring data; 2) USGS stream monitoring; 3) the low extent of des-iodo formation in aerobic and semi-aerobic environments; 4) limited numbers of ponds adjacent to high use areas; 5) lower toxicity compared to main competitor products; 6) fate of flubendiamide and des-iodo in streams under real world conditions; 7) interpretation of 3.5-year monitoring data – farm pond accumulation; and 8) a proposed path forward. The Agency responded (DP 427973) to the 2nd email on 7/15/2015 with the same response as for the first email because the information provided did not change the conclusions of previous EFED responses subsequent to the pond studies or previous EFED risk assessments.

Responses to Registrant Requests to Review Flubendiamide Analyses Prepared for Agency Managers

In the fall of 2015, a series of presentations were made to the Office of Pesticide Programs (OPP) Risk Managers regarding flubendiamide (10/28/2015 – 12/3/2015). As part of these presentations, two series of analyses were produced at the request of the Risk Managers from the

Registration Division of OPP. Because the registrant asked to see these analyses, two memos were subsequently produced to provide a written context to analyses so that the registrant could better interpret these analyses. The first memo (DP 430747) compared four regulatory scenarios for multiple crops based on the standard EFED aquatic modeling procedures. The crops selected were those with the largest number of acres treated according to proprietary pesticide usage data available to the Agency. The regulatory scenarios assumed maximum use rates from 2009 (the year after flubendiamide was registered) to 2015 and then changed according to the regulatory scenario modeled, which included 'no change from current label', 'change to one ground application forever', 'change to one ground application, then cancel in 2018', and 'cancel uses after the 2015 application'. This analysis showed that all four of the regulatory scenarios exceed Agency LOCs for all of the simulated crops because too much flubendiamide had already been applied to these simulated fields through 2015 based on the maximum application rates on current labels. Any additional applications beyond 2015 simply causes further deterioration of the aquatic environment modeled (*i.e.*, des-iodo would continue to accumulate adversely affecting greater proportions of aquatic invertebrates with similar sensitivities to the organisms from which the endpoints were derived as well as adversely affecting greater numbers of less sensitive aquatic invertebrate species as those species' tolerances are exceeded).

The second memo (DP 430972) provided additional characterization of ecological risk through consideration of a subset of crops proposed as posing limited ecological risk to aquatic invertebrates. The crop scenarios were selected based on the 13 crops (or crop groups; *i.e.*, alfalfa, brassica leafy vegetables, cotton (AZ and CA only), cucurbit vegetables, fruiting vegetables, grape, leafy vegetables, legume vegetables, pome fruit, stone fruit, strawberry, tobacco, and tree nuts) that the registrant proposed to retain on flubendiamide labels (email from Charlotte Sanson of Bayer CropScience to Susan Lewis of USEPA on 12/15/15). The application rates, number of applications per year and annual maximum application rates were based on an email from Nancy Delaney of Bayer CropScience to Deborah McCall of USEPA on 8/12/15. Only two application scenarios (high and low exposure) were investigated for this second memo. This analysis assumed no prior use of flubendiamide and modeled different numbers of applications per year from the maximum allowed on the label down to one at the maximum single application rate.

Additional analysis of all these crops was performed prior to a meeting with the registrant and provided to the registrant at that meeting on 1/6/2016. This analysis used the same methods as described in the second memo and is attached to this memo as Appendix 3. These results confirm the range of results in the second memo (DP 430972) and provides additional results for the entire set of uses described by the BCS emails.

4. Discussion of Fate and Effects Data Submitted after the Last Risk Assessment

Several fate and effects studies have been submitted since the last comprehensive risk assessment conducted in 2010.

Toxicological Data

Subsequent to the risk assessments in 2010 additional sediment effects data were made available to the Agency. In addition, over the course of several months OPP Risk Managers requested additional perspective on the suite of effects observed in available sediment effects data at doses beyond the no adverse effect concentration (NOAEC) for the available data.

Submissions of Sediment Toxicity Data After 2010

The registrant submitted a des-iodo degradate prolonged sediment toxicity test with *Chironomus riparius* using spiked sediment (MRID 48175605). The Agency completed a data evaluation record (DER) for this study in July of 2011. The study was classified supplemental and returned a NOAEC at the highest dose tested: time weighted average (TWA) of 52.6 µg of total recoverable residue (TRR)/kg-dw sediment; TWA 7.18 µg TRR/L overlying water; TWA 19.5 µg TRR/L pore water.

In January of 2016 the registrant submitted a flubendiamide prolonged sediment toxicity test with *C. riparius* using spiked sediment (MRID 49661801). The Agency has conducted an evaluation of the study (DP 431040) and concludes that the study is scientifically sound and suitable for use quantitatively in risk assessment. Consistent with other studies with this species and sediment, emergence of the organisms proved to be the most sensitive endpoint. The Agency's Data Evaluation Record concludes that the NOAEC is TWA 12.3 µg/L in overlying water and TWA 4.32 µg/L in pore water. The LOAEC is TWA 23.7 µg/L in overlying water and TWA 8.09 µg/L in pore water.

Confirmation of Existing Studies

In 2015, while the evaluation of all lines of evidence was underway with respect to the efficacy of vegetative filter strips, model assumptions and surface water monitoring, the Risk Managers from the Registration Division of OPP requested that exposure modelling results be compared to the full suite of effects endpoints from the two spiked water prolonged sediment toxicity tests with *C. riparius* (MRIDs 46817022 (flubendiamide) and 46817023 (des-iodo degradate)).

EFED issued a memorandum (DP 430746) that summarized the approach for evaluation of the two studies and the findings of that effort. The resulting endpoints, expressed as TWA, follow in Tables 1 and 2.

Table 1. Flubendiamide Effects Endpoints (mg/L) from MRID 46817022

Concentration Based on Nominal Treatment	Concentration Based on Time Weighted Average (TWA)	Effect Observation
Overlying Water		
0.04	0.015504356*	NOEC Percent emergence
0.08	0.029875**	LOEC 22% inhibition
0.16	0.062017426*	100% inhibition
Pore Water		
0.04	0.001513025*	NOEC Percent emergence
0.08	0.0025**	LOEC 22% inhibition
0.16	0.006052101*	100% inhibition

* based on nominal treatment and average ratio of nominal:TWA
** based on measured TWA

Table 2. Des-iodo Effects Endpoints (mg/L) from MRID 46817023

Concentration Based on Nominal Treatment	Concentration Based on Time Weighted Average (TWA)	Effect Observation
Overlying Water		
0.004	0.00189775*	NOEC Percent emergence
0.008	0.004135578**	LOEC 17% inhibition
0.016	0.008271157**	33% inhibition
0.032	0.015995*	80% inhibition
Pore Water		
0.004	0.00027825*	NOEC Percent emergence
0.008	0.000737285**	LOEC 17% inhibition
0.016	0.00147457**	33% inhibition
0.032	0.00391375*	80% inhibition

* based on nominal treatment and average ratio of nominal:TWA
** based on measured TWA

A comparison of the past risk assessment use of the flubendiamide endpoints from MRID 46817022 is presented below (Table 3), and shows that TWA concentrations were not reported in previous risk assessments for the NOAEC in overlying and pore waters and that previous risk assessments reported the LOAEC as a single post application measured dose of 69 µg/L in overlying water and 3 µg/l in pore water.

Table 3. Current Flubendiamide Endpoints from the Spiked Water 28-day *Chironomus riparius* (MRID 46817022) Compared with Previous Assessments (µg/L)

Risk Assessment	Overlying Water Concentrations Based on Time Weighted Average		Pore Water Concentrations Based on Time Weighted Average	
	NOAEC	LOAEC	NOAEC	LOAEC
June 2008	Not Calculated	69 (single measured value)	Not Calculated	3 (single measured value)
May 2010	Not Calculated	69 (single measured value)	Not Calculated	3 (single measured value)
December 2010	Not Calculated	69 (single measured value)	Not Calculated	3 (single measured value)
Current	15	29.8	1.5	2.5

A comparison of the past risk assessment use of the des-iodo degradate endpoints from MRID 46817023 is presented below in Table 4, and shows that TWA concentrations are the same as previous risk assessments for the NOAEC in overlying and pore waters and that previous risk assessments did not report a TWA for the LOAEC.

Table 4. Current Des-iodo Endpoints from the Spiked Water 28-day *Chironomus riparius* (MRID 46817023) Des-iodo Compared with Previous Assessments (µg/L)

Risk Assessment	Overlying Time Weighted Average		Pore Time Weighted Average	
	NOAEC	LOAEC	NOAEC	LOAEC
June 2008	1.9	Not Calculated	0.28	Not Calculated
May 2010	1.9	Not Calculated	0.28	Not Calculated
December 2010	1.9	Not Calculated	0.28	Not Calculated
Current	1.90	4.14	0.28	7.4

Final Suite of Available Effects Endpoints

The following is the final suite of flubendiamide and des-iodo endpoints for *C. riparius* in spiked water and spiked sediment tests. Flubendiamide's mode of action is purported to be taxa-specific, principally targeting the lepidopteran ryanodine receptor. The extent to which the receptor affinity for the compound and its degradate changes across invertebrate taxa is not well understood for all aquatic invertebrates and so there remains uncertainty as to the representation of any given species to all species within a taxonomic group. However, effects endpoints based on the test organism *C. riparius* (not a lepidopteran) remain the most sensitive available and, consistent with EPA policy, are the basis for the risk assessment.

Table 5. Current Flubendiamide and Des-iodo Endpoints for *Chironomus riparius* in Spiked Water and Spiked Sediment Tests

Overlying Water TWA (µg/L)	Pore Water TWA (µg/L)	Endpoint Label
Flubendiamide – Spiked Water 28-Day (MRID 46817022)		
15.5	1.51	NOAEC Percent emergence
29.9	2.50	LOAEC 22% inhibition
62.0	6.05	100% inhibition
Flubendiamide – Spiked Sediment (MRID 49661801) (in review)		
12.3	4.32	NOAEC Percent emergence
23.7	8.09	LOAEC Percent emergence
Des-iodo – Spiked Water 28-Day (MRID 46817023)		
1.90	0.278	NOAEC Percent emergence
4.14	0.737	LOAEC 17% inhibition
8.27	1.47	33% inhibition
16.0	3.91	80% inhibition
Des-iodo – Spiked Sediment (MRID 48175605)		
7.18	19.5	NOAEC (Highest dose tested)
>7.18	>19.5	LOEC

Registrant Endpoint Selection

In December 2014 the registrant submitted a document containing their perspective on flubendiamide and des-iodo degradate sediment toxicity endpoints (MRID 49415302). The following is a summary of the registrant's endpoint selection:

- Flubendiamide Sediment Toxicity Study, Spiked Water (MRID 46817022) – results based on nominal initial overlying water
    - EC_{50} 59 µg a.i./L
    - EC_{15} 45 µg a.i./L
    - NOAEC 40 µg a.i./L
- Flubendiamide Sediment Toxicity Study, Spiked Sediment (MRID 49661801)
    - NOAEC 156 µg/kg sediment (dry weight)
    - NOAEC 2.56 µg a.i./L (pore water)
- Des-iodo Degradate Sediment Toxicity Study, Spiked Water (MRID 46817023) – results based on nominal initial overlying water
    - EC_{50} 18.6 µg/L
    - EC_{15} 9 µg/L
    - NOAEC 4.0 µg/L

- Des-Iodo Degradate Sediment Toxicity Study, Spiked Sediment (MRID 48178605)
    - NOAEC 55 µg/kg sediment (dry weight)
    - NOAEC peak pore water 31.3 µg des-iodo/L
    - NOAEC mean measure pore water 22 µg des-iodo/L
- Flubendiamide *Daphnia magna* Reproduction Study, Spiked Water (MRID 46816944)
    - NOAEC 33 µg/L

Fate Data

The flubendiamide fate data interpretation has not changed since the 2008 and 2010 risk assessment. Additional laboratory fate data was requested and submitted for des-iodo after the time-limited/conditional registration. All of this des-iodo data indicated that des-iodo does not degrade in the environment with the exception of the recently (1/5/2016) submitted des-iodo aquatic photolysis study, described below.

<u>Des-iodo Aquatic Photolysis Study</u>

The registrant submitted a 10-day, aqueous photolysis study (MRID 49661701) that estimates a 79-day half-life for des-iodo when expressed as an environmentally relevant half-life for June in Phoenix, AZ. At the end of the 10-day study, 77% of the des-iodo remained as untransformed des-iodo. The other 23% had transformed into 14 degradates and CO_2. Because so many degradates together make up so little mass, no degradate exceeded 6% and only two degradates could be identified. None of the degradates have toxicity data, so none can be ruled out as toxic degradates of concern other than CO_2. Potentially, these degradates may be: more toxic than des-iodo; as toxic as des-iodo; or less toxic than des-iodo. Assuming that all of the degradates other than CO_2 are as toxic as des-iodo would produce a half-life for the entire mass of toxic metabolites (total toxic residue half-life) exceeding 1000 years. Therefore the 79-day aquatic photolysis half-life for des-iodo estimated in MRID 49661701 should be considered an optimistic estimate. Other caveats in using this half-life are discussed in Section 5.

5. Modeling Based on Tree Nut Use in California

The Agency received a new proposed label for flubendiamide on 1/8/2016 that limits use to tree nuts in California only and further limits application rates for tree nut uses below that on the current label. Up to three applications can be made to tree nuts, therefore modeling was conducted for one to three applications per year. Modeling this proposed use in this memo allows the Agency to perform an assessment of not only the reduced application rates, but also incorporate the 79-day aqueous photolysis half-life for des-iodo into this assessment (previous analyses had not used this half-life estimate since it was only submitted to the Agency on 1/5/2016).

Risk, based on the time-weighted average concentration endpoints (DP 430746) and on the registrant-suggested endpoints, is displayed over time in the graphs of Figure 1 of Appendix 3. It should be noted that EFED does not believe that the registrant-submitted toxicity endpoints are appropriate because they appear to be based on the nominal concentrations to which the test organisms were intended to be exposed rather than the measured, time-varying concentrations to which the organisms were actually exposed.

Flubendiamide airblast applications to tree nuts were modeled using the California almond scenario based on an application rate of 0.125 lbs ai/A with a 7-day application interval and up to three applications per year. The scenario modeled assumes that flubendiamide has not previously been used in the fields to which it is to be applied and includes a 30-ft spray drift buffer zone around aquatic areas based on the new proposed label (previous modeling had only included a 15-ft spray drift buffer zone which was correct based on the spray drift language of the previous labels).

Because flubendiamide and its des-iodo degradate are expected to persist and accumulate in the environment, the ecological risk posed by these chemicals in aquatic environments is expected to increase over time. Therefore, the number of applications per year EECs are compared in a set of graphs for each number of applications per year simulation depicting how ecological exposure changes over time for flubendiamide in pore water, des-iodo in overlying water, and des-iodo in pore water (flubendiamide in overlying water didn't exceed Agency LOCs and therefore, is not presented).

Predicted changes in aquatic exposure over time are displayed in Figure 1 of Appendix 3[3]. To provide an estimate of the ecological effects to be anticipated at different risk quotient levels, the no observed adverse effect concentration (NOAEC) and any additional treatment levels that showed a significant effect above the NOAEC (MRIDs 46817022, 46817023, 46816944 and 49661801) were included in the graphs of Figure 1 of Appendix 3. Analyzed endpoints include both the Agency endpoints based on time-weighted averages (Table 5 and DP 430746) and the registrant-suggested endpoints (MRID 49415302) that are not supported by the Agency guidance (DP 430746). Appendix 4 reports the input parameters used in this analysis. Results are discussed in Section 7.

6. Confirmation of Risk from Lowest Exposure Scenario

The Risk Managers from the Registration Division of OPP requested that exposure modeling be conducted with the lowest possible exposure scenario in conjunction with the half-life from the recently submitted des-iodo photolysis study (MRID 49661701; discussed in Section 4). In the document that evaluated ecological risk for 13 crops proposed as posing limited ecological risk to aquatic invertebrates (DP 430972) there was at least one crop use with more limited exposure than the tree nut use from the latest proposed label (Section 5). However, DP 430972 was prepared before the des-iodo photolysis study was submitted to the Agency. Including the photolysis half-life with the lowest exposure scenario from DP 430972 (ground application to cucurbit vegetables) would produce a lower exposure than had been modeled. Therefore to ensure that the Agency considered the lowest exposure (the scenario most favorable to the registrant and least likely to exceed Agency LOCs), the lowest exposure scenario from DP 430972 was modeled with the des-iodo photolysis half-life using the modeling assumptions from the tree nut use in Section 5 (a 30-ft spray drift buffer and applied assuming that flubendiamide had not been previously applied to the modeled field under the higher application rates of the current labels). The same assessment methods described for assessment of tree nuts (Section 5) were used also used in this analysis. Graphical results are provided in Appendix 3 Figure 2. Discussion of results occurs in Section 7.

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[3] Note that these graphs are presented in concentration units (µg/L) rather than risk units as in previous analyses (DP 430747 and 430972) and Appendix 2.

7. Integration of New Information into the Risk Assessment

Results from the Farm Pond Monitoring Study (DP 412791+)

At the end of three years of monitoring, the registrant submitted the farm pond monitoring reports (MRIDs 49415303, 49415302, and 49415301). EFED identified several issues (variability in crops grown, variability in the date of application(s), variability in the application rates, magnitude of the study application rates compared to the maximum annual label application rates, installation of grass waterways in the GA ponds' watershed, dilution of pore water and sediment samples with underlying uncontaminated material) with this monitoring data (DP 412791+). Despite these issues, EFED believed the monitoring data showed clear evidence that both flubendiamide and des-iodo accumulated in the ponds monitored[4]. The accumulation measured in the first three years of the pond data least impacted by the identified issues largely matched the initial 3 years of concentration predictions of EFED's aquatic exposure modeling. Because EFED's modeling does not account for the effect of VFSs, but still largely matched the monitoring data, EFED believes the effect of VFSs is not large enough to mitigate the ecological risks posed by flubendiamide applications. EFED concluded the original and subsequent ecological risk assessments performed by the Agency (DP 329594+, 368029+, and 376460+) adequately reflect the risks posed by flubendiamide applications and rejects the registrant's argument that the label-required 15-ft VFSs would prevent accumulation from exceeding Agency LOCs (DP 412791+).

Analysis of Results from Four Regulatory Scenarios for Multiple Crops (DP 430747)

When considering the time-weighted average endpoints (upper set of graphs on each page in Appendix 1 Figure 1), all four of the regulatory scenarios exceed Agency LOCs for all of the simulated crops. Consistently, the greatest exceedances occur for des-iodo in pore water. Note that many of these scenarios achieve exposure levels that resulted in 80% emergence inhibition in the des-iodo chronic laboratory toxicity study (MRID 46817023). (80% emergence inhibition indicates that 80% of the test organisms were unable to emerge as the adult, reproductive life-stage from the sediment where the juveniles reside, while only 20% were able to emerge and potentially complete their life-cycle.) Such adverse impacts would directly impact aquatic invertebrates in ponds, lakes, reservoirs, estuaries, areas of sediment accumulation in flowing waterbodies and any non-flowing waterbodies where des-iodo would accumulate downstream of lands where flubendiamide is used as well as result in indirect impacts to fish and wildlife for which aquatic invertebrates serve as the basis for their food chain.

Flubendiamide and its des-iodo degradate pose a risk long after a regulatory action may take place (*i.e.*, there is a time-lag between mitigation and the maximum risk). For example, under the "cancel now" regulatory scenario (light blue dots in Figure 1), flubendiamide applications to the watershed above the modeled pond stop after 2015. However, risk from des-iodo in pore water does not level-off (stop increasing) for more than a decade after. This time-lag is due to the time required to transport the flubendiamide from the field to the pond and for flubendiamide in the pond to convert into des-iodo.

[4] The fitted trends increase with time (accumulate) in all of the 18 time-series data sets collected from these ponds [3 ponds × 3 media (water column, sediments, and pore water) × 2 chemicals = 18 time series data sets]. Fitting these trends as exponential trends (*i.e.*, fitting a linear trend to the natural log of the concentration observations) indicated that 13 of these 18 trends were statistically significant at the $p = 0.05$ level of confidence. Continued monitoring after the three year study period ended produced statistically significant trends in all 18 time series.

As a final note concerning the graphs based on time-weighted average endpoints, exceedances tend to occur quite early in the temporal trends. For example, all of the des-iodo pore water graphs based on the time-weighted average endpoints exceed Agency LOCs within 2 years. Considering that flubendiamide applications could have started in 2009 for these crops, these projected exceedances could have occurred as early as five years ago.

Even if risk were judged by the less sensitive endpoints suggested by the registrant (lower set of graphs on each page in Appendix 1 Figure 1), all but two of the regulatory scenarios exceed Agency LOCs. These two regulatory scenarios are the “Change to one ground application then cancel after 2018” and “Cancel now” scenarios for the leafy vegetables (based on the CA lettuce scenario, with ground applications initially in the first time period).

Analysis Results from High and Low Exposure Analysis for 13 Crop Uses (DP 430972)

Based on the two crops modeled to capture the range of flubendiamide risk from the registrant-proposed crops to be retained, both the high and low exposure/risk crop scenarios exceed Agency LOCs (based on the time-weighted average endpoints). There is risk for all of the numbers of applications modeled for both high and low scenarios even though the scenarios assumed that flubendiamide was applied to fields to which flubendiamide had never before been applied. The low exposure scenario exceeds Agency LOCs in: three years at six, five, or four applications per year; four years at three applications per year; six years at two applications per year; and nine years with only one application per year. The high exposure scenario applying two applications per year (the most allowed by the registrant proposal) exceeds Agency LOCs in two years, while the first exceedance occurs in three years with only one application per year.

Based on the TWA endpoints, all of the crop scenarios exceed exposure levels that resulted in 80% emergence inhibition in the des-iodo chronic laboratory toxicity study (MRID 46817023) within the 30 years simulated except: ground application to cucurbit vegetables at two applications per year (would exceed 80% emergence inhibition after 30 years) and one application per year (exceeds 33% emergence inhibition); airblast application to grapes at one application per year (would exceed 80% emergence inhibition after 30 years); and airblast application to stone fruit at one application per year (would exceed 80% emergence inhibition after 30 years). Again such adverse impacts would directly impact aquatic invertebrates in ponds, lakes, reservoirs, estuaries, areas of sediment accumulation in flowing waterbodies and any non-flowing waterbodies where des-iodo would accumulate downstream of lands where flubendiamide is used as well as indirectly impact fish and wildlife for which aquatic invertebrates serve as the basis for their food chain.

Although the Agency does not agree with the use of the nominal-based endpoints that were suggested by the registrant, with respect to the registrant-suggested endpoints, the low exposure scenario exceeds Agency LOCs in 11 years at six applications per year, 13 years at five applications per year, 16 years at four applications per year, and 21 years at three applications per year. The low exposure scenario based on either one or two applications per year does not exceed LOCs within the 30 years simulated based on the registrant-suggested endpoints. However, both application patterns of one or two applications per year would be expected to eventually exceed if applications continued long enough. The high exposure scenario based on two applications per year exceeds LOCs based on the registrant-suggested endpoints in eight years, while the first exceedance occurs in 11 years with only one application per year.

Therefore, when considering the registrant's less conservative proposed endpoints, use of flubendiamide still results in risk concerns for aquatic invertebrates.

Tree Nut Assessment Results

Based on the time-weighted average endpoints, the currently proposed flubendiamide tree nut use results in risk that exceeds Agency LOCs for all numbers of applications modeled. The tree nut scenario exceeds Agency LOCs in two years at three applications per year and three years at two or one application(s) per year. All of the numbers of applications per year modeled exceed exposure levels that resulted in 80% emergence inhibition in the des-iodo chronic laboratory toxicity study (MRID 46817023) within the 30 years simulated even though these scenarios also assumed that flubendiamide was applied to fields to which flubendiamide had never before been applied.

Although the Agency does not agree with the use of the nominal-based endpoints that were suggested by the registrant, the proposed tree nut scenario exceeds Agency LOCs using these endpoints in 10 years at three applications per year, 11 years at two applications per year, and 21 years at one application per year. Therefore, when considering the registrant's less conservative proposed endpoints, use of flubendiamide still results in risk concerns for aquatic invertebrates.

Recall that the tree nut use is based on the newly proposed label that includes an expanded spray drift buffer and uses the maximum photolysis estimate (*i.e.*, most degradation due to photolysis and therefore, most favorable to the registrant's position). Comparing the results of this analysis for tree nuts to a model run assuming no photolysis (but, retains the 30-ft spray drift buffer) decreases the 21-day average des-iodo overlying water EEC at year 30 by 24.1% (17.0 μg/L *vs*. 12.9 μg/L). The reason for the 24% decrease in exposure is that des-iodo has a low K_{OC} and therefore, tends to spend more time in the water column where photolysis could occur than chemicals with higher K_{OC}s.

However, there are several reasons to suspect that such a large photolysis effect would not occur in the environment. First, the SWCC does not account for the change of light intensity as the sun changes position throughout the year. In pure water (no interference due to suspended sediment, algae, *etc*.), the light intensity is greatest when the sun is directly overhead (typically near the summer solstice in the United States) and least during the winter solstice, when the sun's daily maximum elevation in the sky is at its lowest. The 79-day aquatic photolysis half-life estimate is for June in Phoenix, AZ and likely represents an over-estimate for the rest of the year in Phoenix. For parts of the United States further north, this half-life is likely an over-estimate throughout the year.

Second, waters draining, or downstream of, agricultural land tend to have high concentrations of dissolved or suspended sediment and nutrients compared to the pure water in which aquatic photolysis is measured. These impurities can block light penetration. Therefore after individual storm events and/or throughout the rainy season, aquatic photolysis is likely greatly over-estimated. Nutrients promote the growth of aquatic plants and algae which can block or limit light penetration for much of the time of the year when sunlight is most intense in the Northern United States or the entire year in the Southern United States (Note that in Figure 1 of DP 412791+, the Georgia ponds are a deep shade of green in images taken from September of 2010 and 2013.)

Thirdly, there is a mass transfer issue of des-iodo from the benthic sediment (where the des-iodo would form and the majority of it would remain) to the water column (where aqueous photolysis could occur). In the SWCC, equilibrium is re-established between the benthic and overlying water on a daily basis. Therefore any des-iodo degraded in the upper portion of the water column where photolysis is greatest is replaced with des-iodo from the bottom sediment within 1 day. In the actual environment, this transfer would likely be much slower as the des-iodo has to desorb from the sediment and is impeded by thermal stratification in waterbodies throughout much of the year, especially during the summer when aqueous photolysis would potentially be at its maximum.

Additionally as discussed previously, the degradates produced through aqueous photolysis may more be more or less toxic than des-iodo. Most of these degradates are unidentified and none have toxicity data. Therefore, toxicity may not diminish as des-iodo degrades through aqueous photolysis.

Note that EFED believes the SWCC performs quite well under more typical situations where pesticides degrade in shorter amounts of time (*e.g.*, wintertime photolysis is not an issue if most of the chemical has degraded within 60 days of a spring/summer application). It is specifically due to the persistence of flubendiamide and des-iodo that the assumptions of the SWCC have to be examined in such great detail. Further note that the farm pond monitoring results agreed quite well with modelling predictions (Figure 6 in DP 412791+) using modeling parameters that did not include the photolysis half-life. This provides further support that the 79-day half-life over-estimates the actual aqueous photolysis rate under environmental conditions.

Comparing the results of this analysis for tree nuts to a model run assuming no photolysis with a *30-ft spray drift buffer* to a model run assuming no photolysis with a *15-ft spray drift buffer* decreases the 21-day average des-iodo overlying water EEC at year 30 by 3.5% (17.6 μg/L *vs*. 17.0 μg/L). Therefore the combined effect of including the new des-iodo photolysis half-life and extended spray drift buffer decreases the 21-day average des-iodo overlying water EEC at year 30 by 26.7% (17.6 μg/L *vs*. 12.9 μg/L).

Cucurbit Vegetable Assessment Results (Lowest Exposure Scenario Combined with the Recent Des-iodo Photolysis Half-life Estimate)

Based on the time-weighted average endpoints, the optimistic des-iodo aqueous photolysis half-life, and a proposed 30-ft spray drift buffer, the cucurbit vegetable use (which results in the lowest exposure) results in risk that exceeds Agency LOCs for all numbers of applications per year modeled. The cucurbit vegetable scenario exceeds Agency LOCs in three years at six, five, and four applications per year, four years at three applications per year, six years at two applications per year, and nine years at one application per year. Number of applications per year scenarios exceed exposure levels that resulted in 80% emergence inhibition in the des-iodo chronic laboratory toxicity study (MRID 46817023) within the 30 years simulated for six, five, four, or three applications per year. Two applications per year exceeds the 33% emergence inhibition within the 30 years simulated, while one application per year would exceed the 33% emergence inhibition sometime after the 30 years simulated. Again such adverse impacts would directly impact aquatic invertebrates in ponds, lakes, reservoirs, estuaries, areas of sediment accumulation in flowing waterbodies and any non-flowing waterbodies where des-iodo would accumulate downstream of lands where flubendiamide is used as well as indirectly impact fish and wildlife for which aquatic invertebrates serve as the basis for their food chain.

Although the Agency does not agree with the use of the nominal-based endpoints that were suggested by the registrant, the cucurbit vegetable scenario using the optimistic des-iodo aqueous photolysis half-life and proposed 30-ft spray drift buffer, exceeds Agency LOCs in 12 years at six applications per year, 14 years at five applications per year, 18 years at four applications per year, and 25 years at three applications per year. The lowest exposure scenario based on either one or two applications per year does not exceed LOCs within the 30 years simulated based on the registrant-suggested endpoints. However, the two applications per year scenario would be expected to eventually exceed if applications continued long enough, while the one application per year scenario probably would not. Additionally note that all the caveats concerning the des-iodo photolysis half-life discussed for tree nuts apply equally well to the cucurbit vegetable assessment. Therefore, when considering the registrant's less conservative proposed endpoints, use of flubendiamide still results in risk concerns for aquatic invertebrates for all numbers of applications per year except a single application per year, and only under the most optimistic of assumptions.

8. Results from USGS Monitoring

USGS data (2012 – early 2014) showed detection of flubendiamide and/or des-iodo in filtered samples at 26 sites in 14 states (river and stream sites only, no ponds). California, Georgia, North Carolina, Mississippi, and Louisiana had multiple sites with frequent detections (Figure 1). The USGS monitoring effort complimented the targeted monitoring of the registrant by providing a nationwide (though non-targeted) scale in which to interpret the registrant's monitoring results. These widespread, non-targeted, filtered USGS detections are comparable to concentrations collected downstream from the monitored ponds, which indicates that there may be depositional zones similar to the monitored ponds upgradient from the widespread detections that have concentrations similar to those in the monitored ponds (which are well estimated by EPA modeling that assumes the des-iodo degradate is stable to aqueous photolysis).

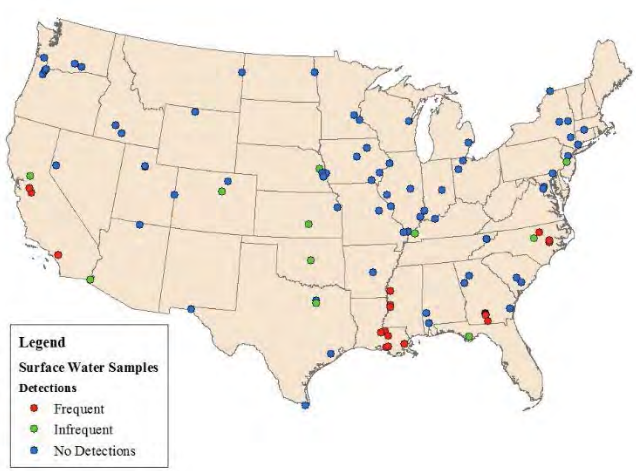


Figure 1. Flubendiamide detections in surface water samples collected by the USGS and registrant.

9. Conclusions

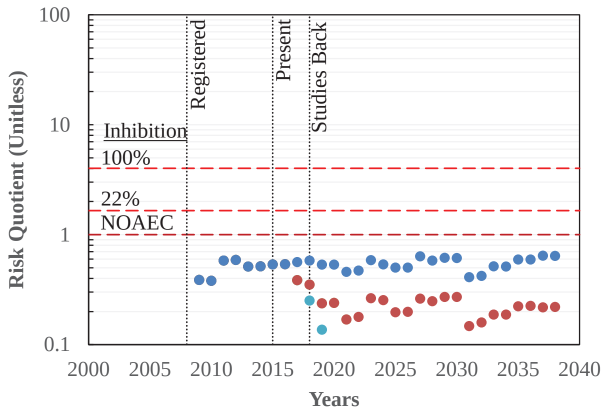
After review of the all of the data submissions and previous risk assessments, EFED's conclusions on the environmental risks posed by flubendiamide at the time of writing are consistent with those identified in 2008. EFED originally concluded that "Flubendiamide and its degradate's overall stability/persistence suggests that they will accumulate in soils, water column, and sediments with each successive application" (DP 329613+). EFED's analysis of the registrant's field monitoring (farm pond) study concludes that there is 1) accumulation of both flubendiamide and des-iodo in the water column, sediment, and pore water for all ponds monitored; and 2) definitive evidence that VFSs do not sufficiently control off-site transport of these chemicals to downstream waterbodies. In addition, stream and river monitoring conducted by the registrant and the U.S. Geological Survey over much of the United States indicates: 1) the failure of VFSs to contain these chemicals is a widespread occurrence; and 2) the potential for water quality impacts is also widespread. Based on the California almond scenario presented above as well as the other recent modeling (DP 430747, 430972, and Appendix 2), significant effects to aquatic organisms due to the use of flubendiamide could potentially occur in as little as 2 years. While the registrant has raised many issues as discussed in detail above and in the referenced documents, none have been persuasive that the original and subsequent risk assessment conclusions were inaccurate nor have they diminished confidence in those conclusions. Considering all the evolving lines of evidence, there is increased confidence in the conclusions contained in EFED's past risk assessments for flubendiamide.

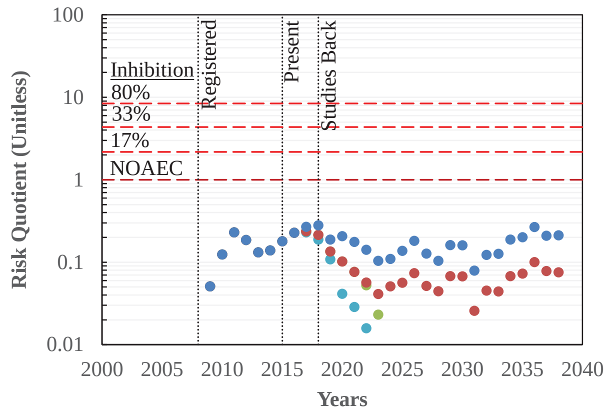
Appendix 1. Comparison of Four Regulatory Scenarios for Multiple Crops based on the Registrant-suggested Aquatic Modeling Procedures Including Pond Overflow

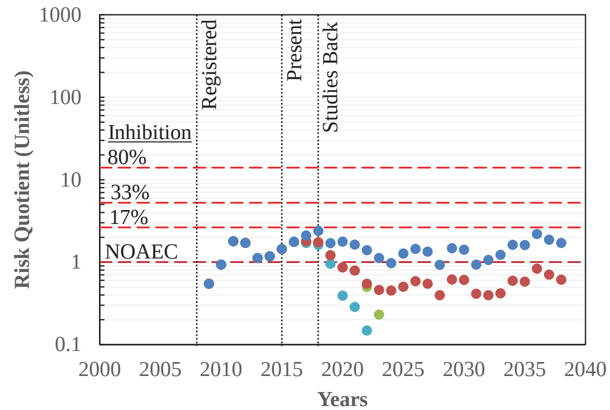
Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Soybeans based on MS Soybean Scenario (Initially as Aerial Application; Applied Every Other Year)

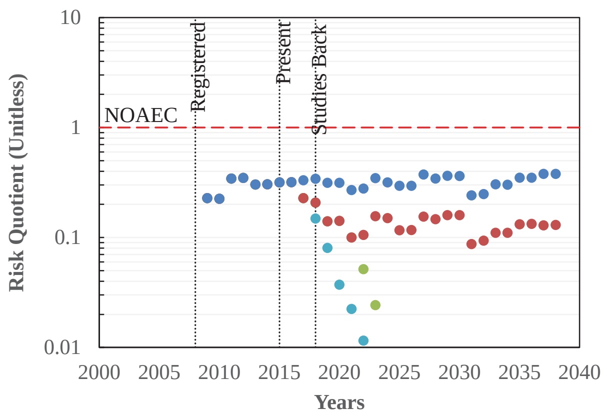
Time-weighted Average Endpoints

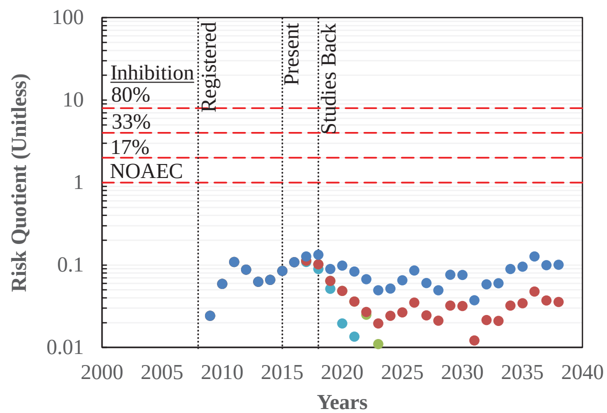


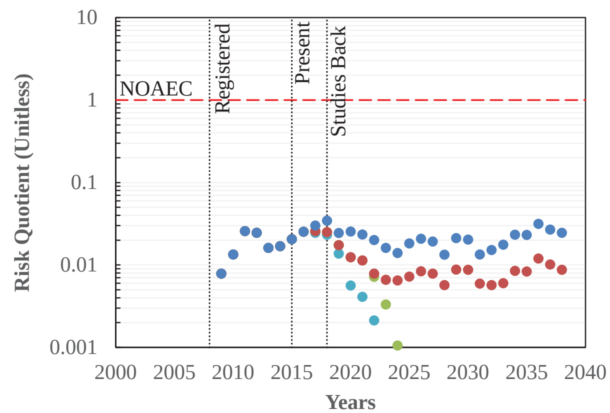




Registrant-suggested Endpoints







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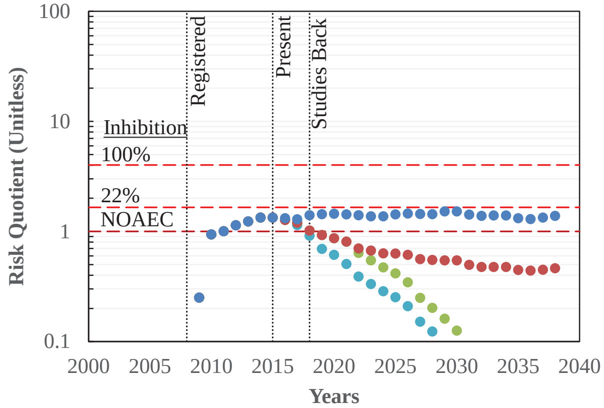
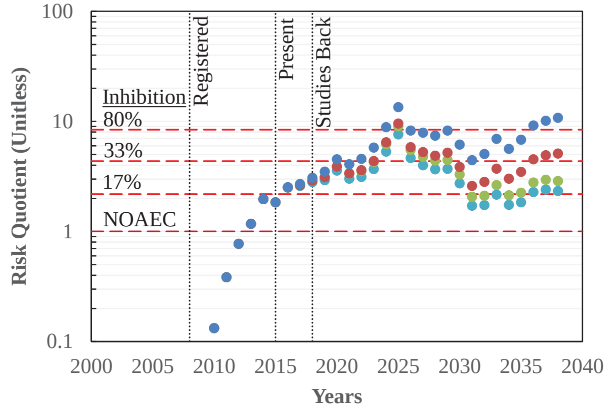
- Change to 1 App. and Cancel (7 years ground or aerial @ 4 apps/year, then 3 years ground @ 1 app/year, then cancel)
- Cancel Now (7 years aerial @ 4 apps/year, then Cancel)

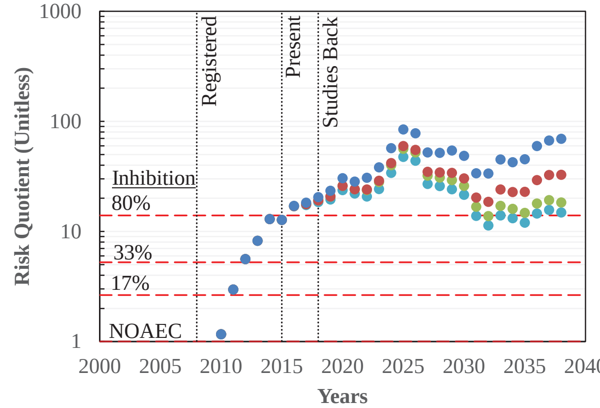
Appendix 1 Figure 1. Comparison of Four Regulatory Scenarios for Nine Crops Using both Time-weighted and Registrant-suggested Endpoints

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water
Tree Nuts based on CA Almond Scenario (Air Blast Application)		

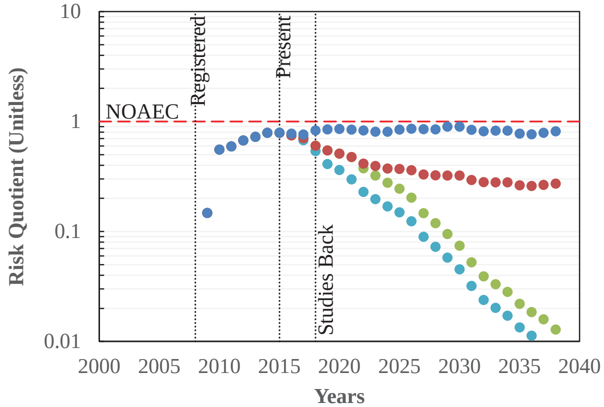
Time-weighted Average Endpoints

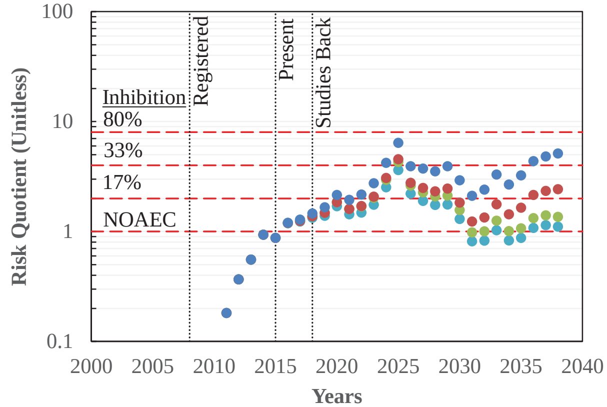


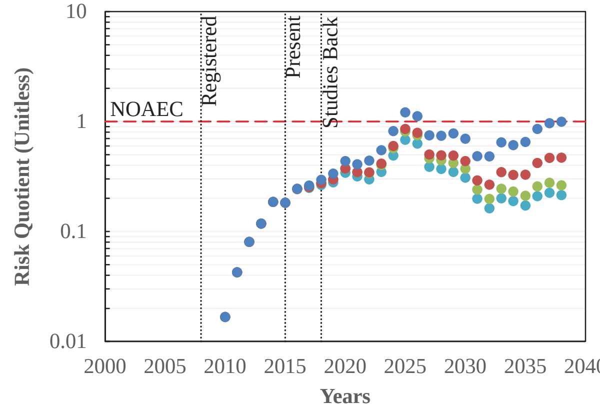




Registrant-suggested Endpoints







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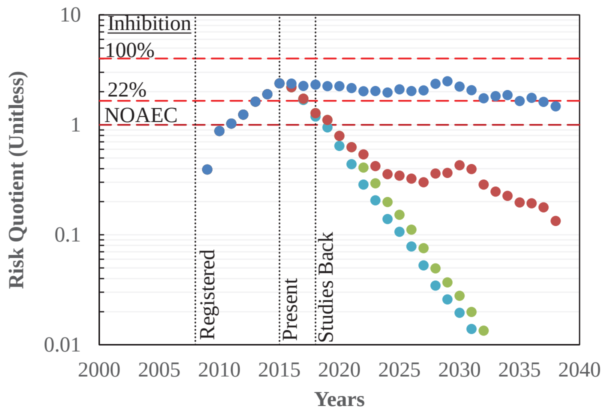
- Cancel Now (7 years aerial @ 4 apps/year, then Cancel)

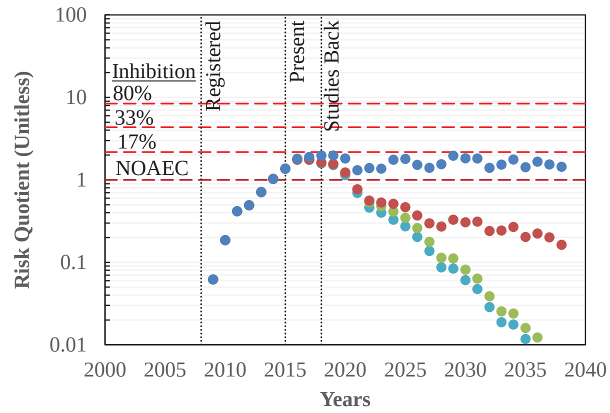
Appendix 1 Figure 1. Continued

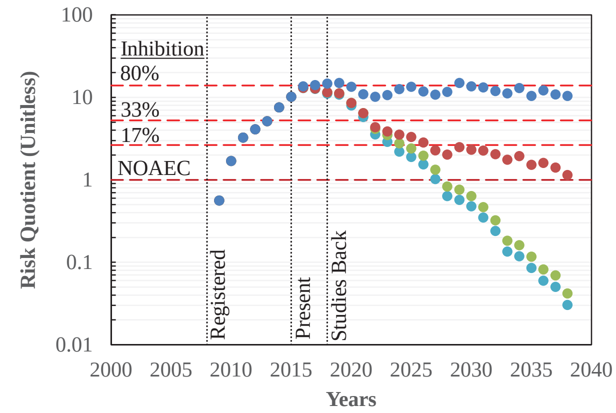
Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Tobacco based on NC Tobacco Scenario (Initially as an Aerial Application)

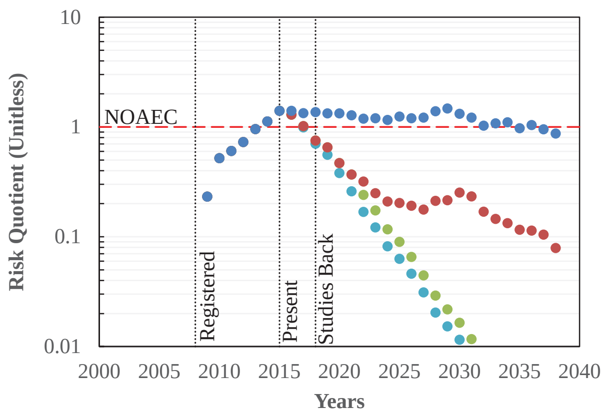
Time-weighted Average Endpoints

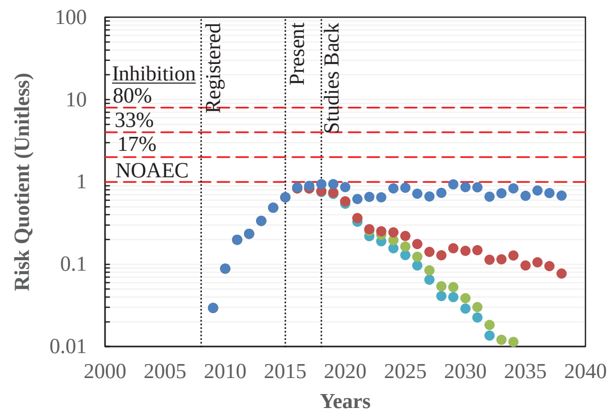


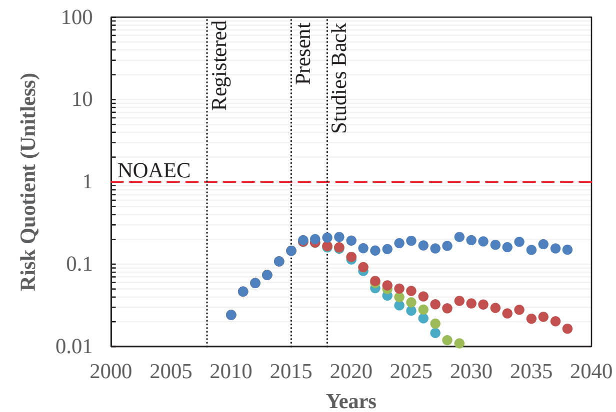




Registrant-suggested Endpoints







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Appendix 1 Figure 1. Continued

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<tr><th>Benthic Pore Water</th><th>Overlying Water</th><th>Benthic Pore Water</th></tr>
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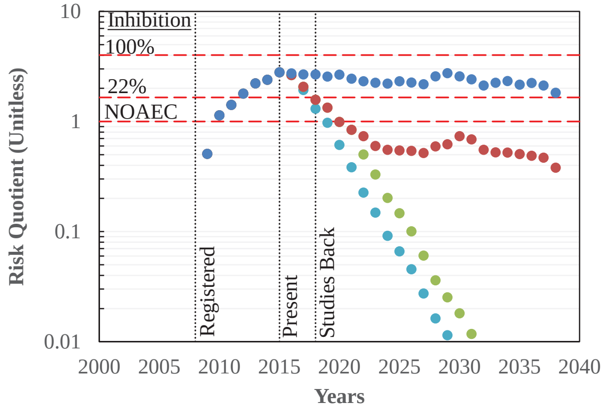
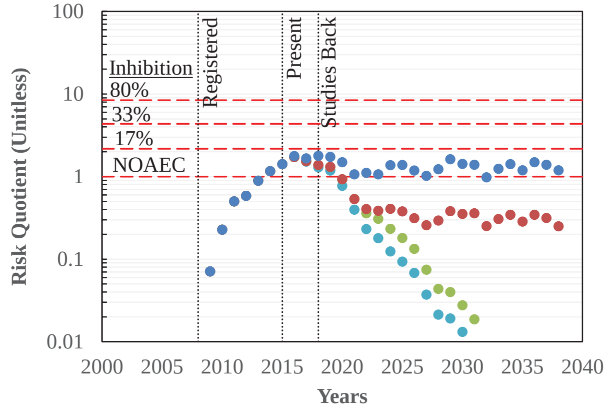
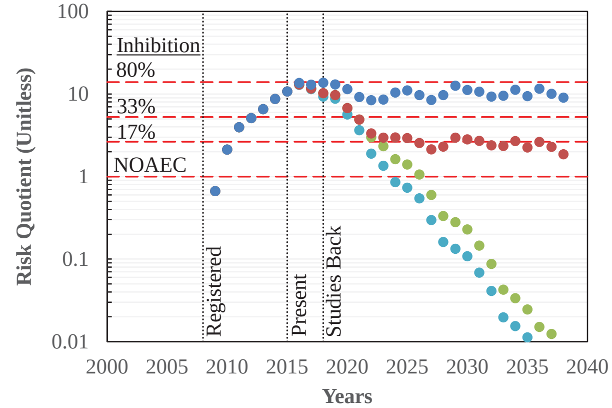
<tr><td>
</td><td>
</td><td>
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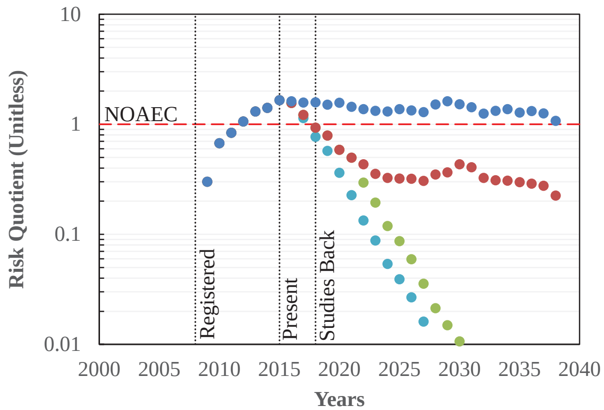
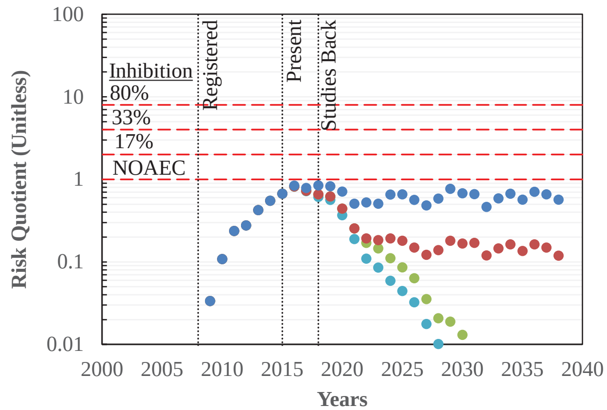
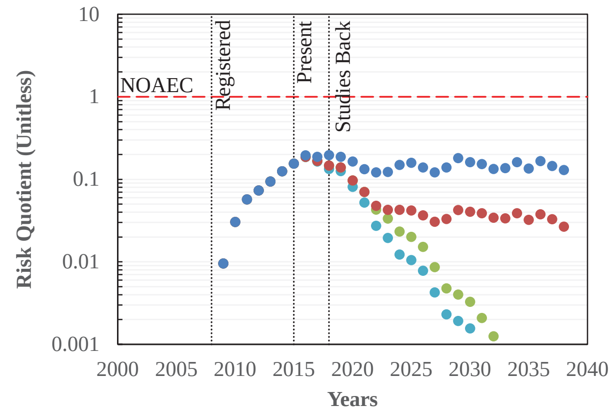
<tr><td>
</td><td>
</td><td>
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● Cancel Now (7 years aerial @ 4 apps/year, then Cancel)</td></tr>
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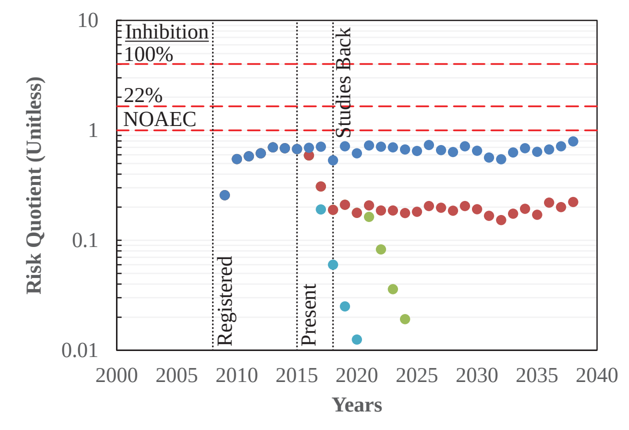
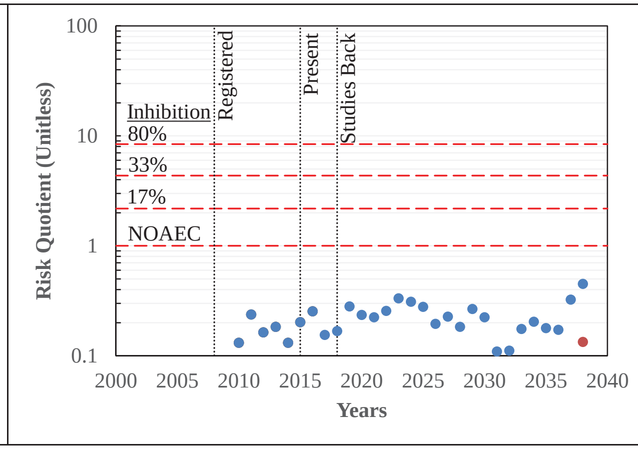
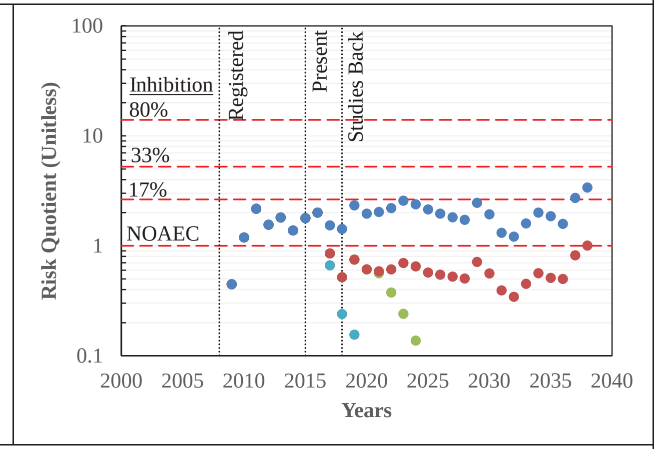
Appendix 1 Figure 1. Continued

Flubendiamide	Des-iodo	
Benthic Pore Water	**Overlying Water**	**Benthic Pore Water**
Cucurbits based on FL Cucumber Scenario (Initially as an Aerial Application)		

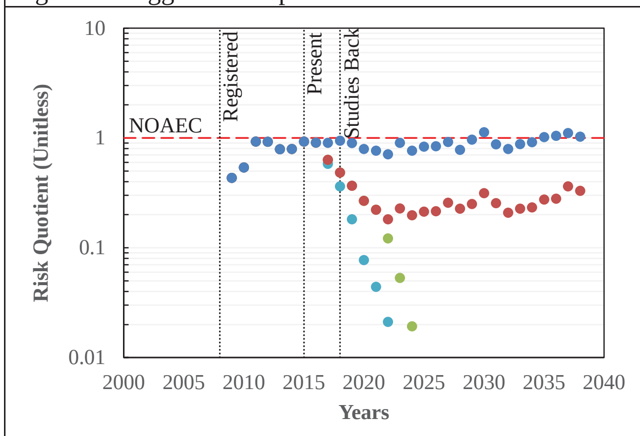
Time-weighted Average Endpoints

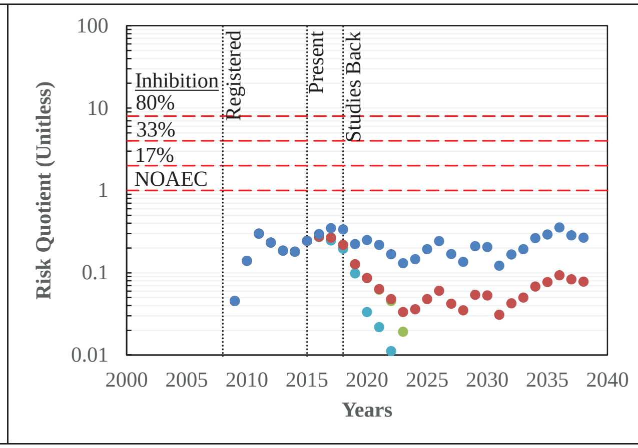


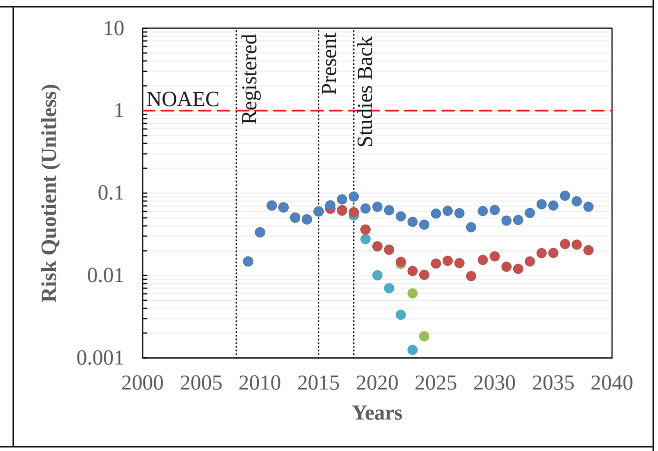




Registrant-suggested Endpoints







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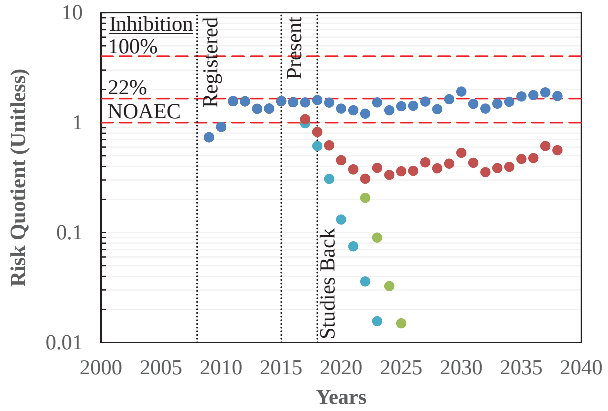
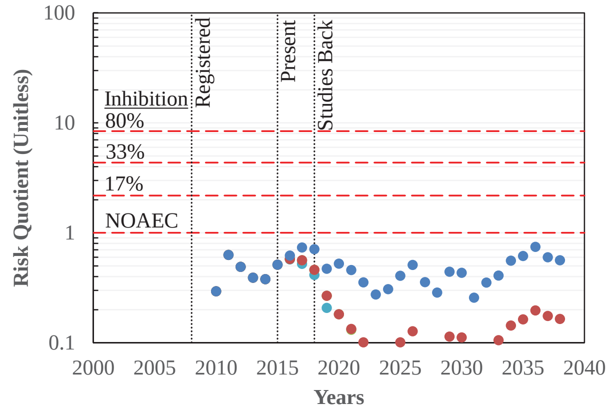
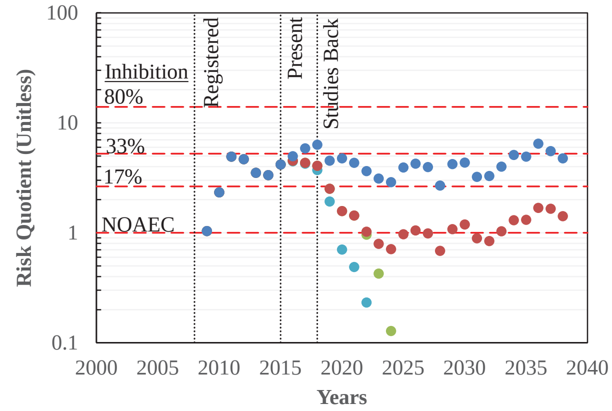
Appendix 1 Figure 1. Continued

Flubendiamide	Des-iodo	
Benthic Pore Water	**Overlying Water**	**Benthic Pore Water**
Cotton based on MS Cotton Scenaio (Initially as an Air Application)		

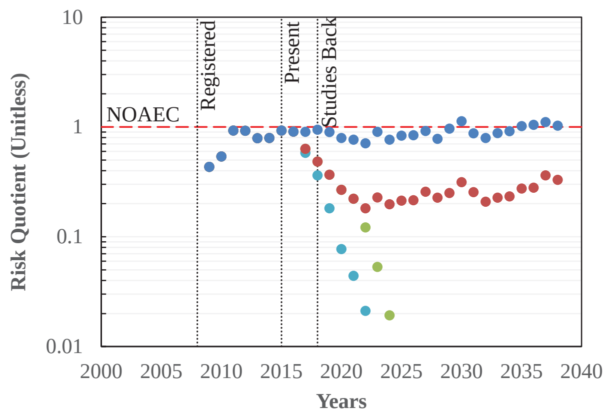
Time-weighted Average Endpoints

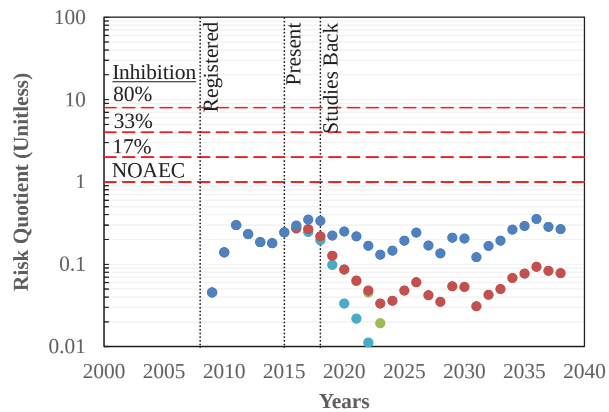


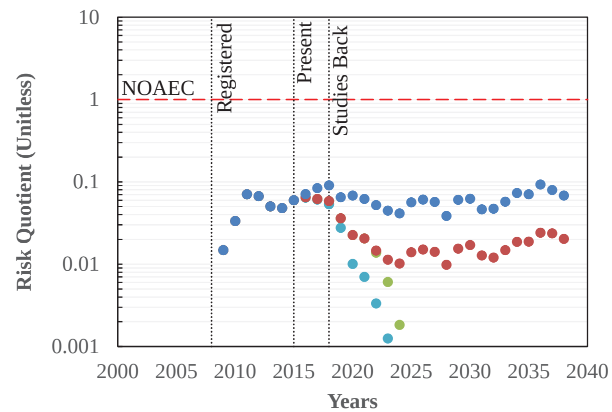




Registrant-suggested Endpoints







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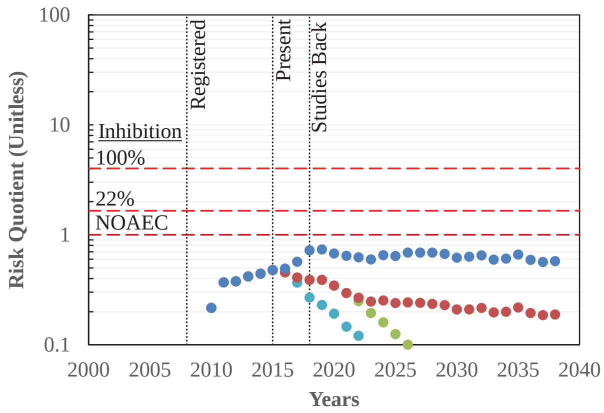
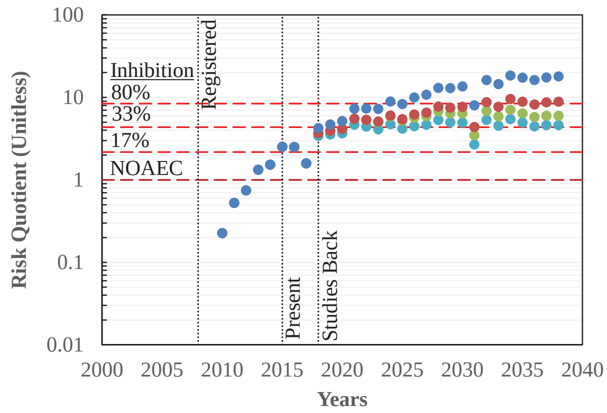
Appendix 1 Figure 1. Continued

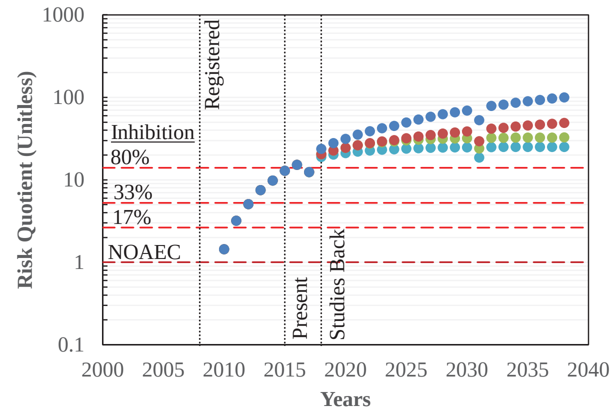
Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Fruiting based on CA Tomato Scenaio (Initially as a Ground Application)

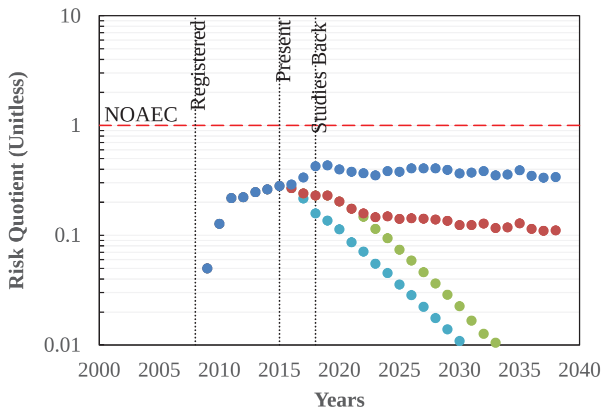
Time-weighted Average Endpoints

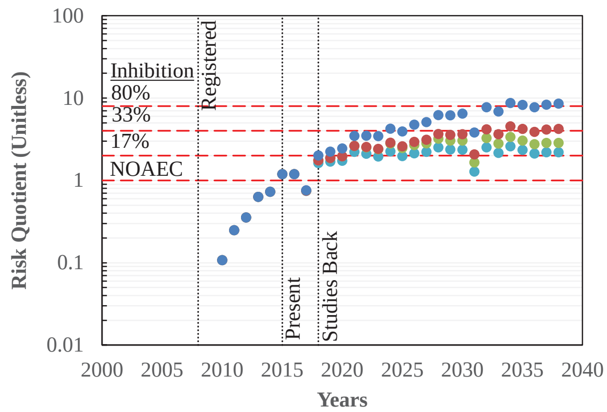


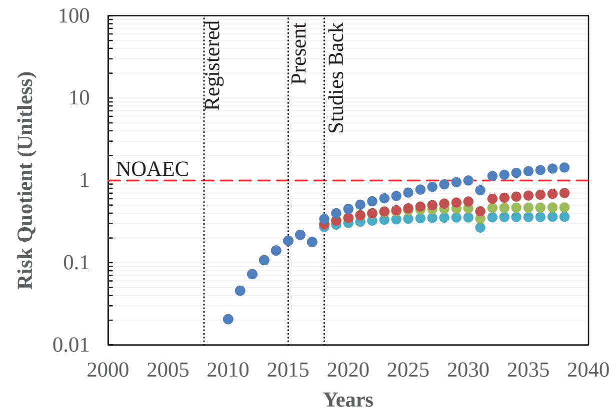




Registrant-suggested Endpoints







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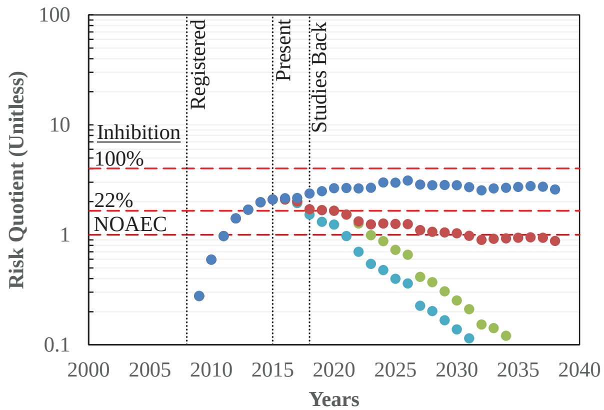
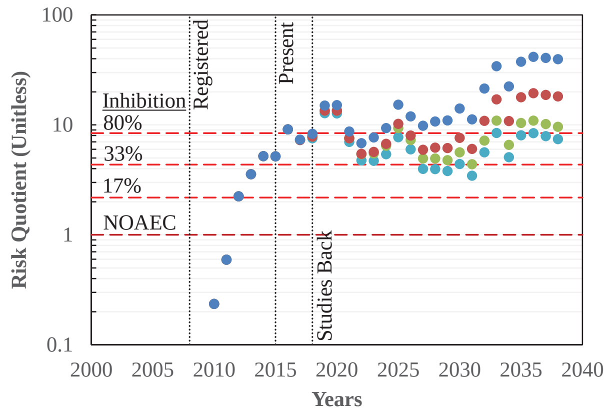
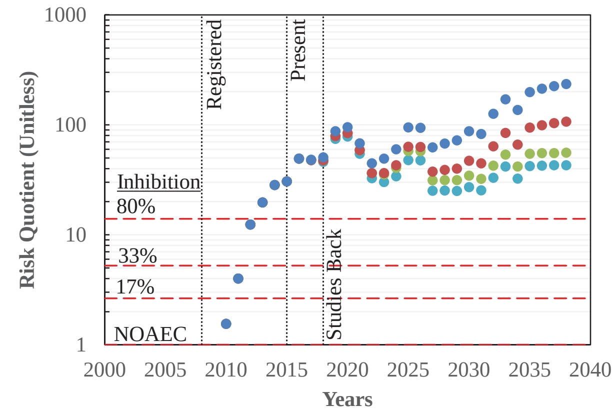
Appendix 1 Figure 1. Continued

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water
Leafy Vegetables based on CA Lettuce Scenario (Initially as a Ground Application)		

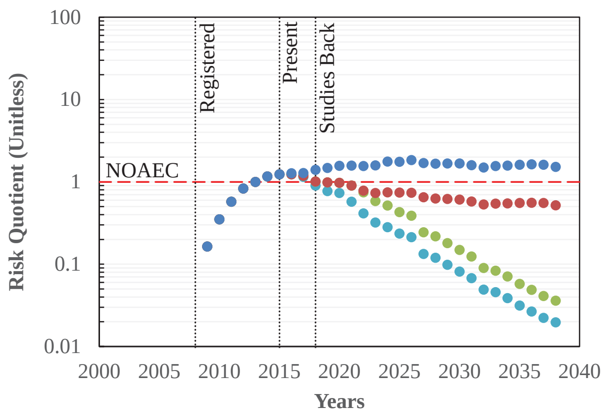
Time-weighted Average Endpoints

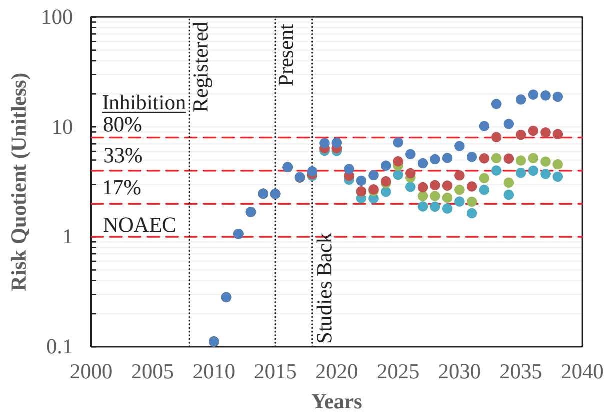


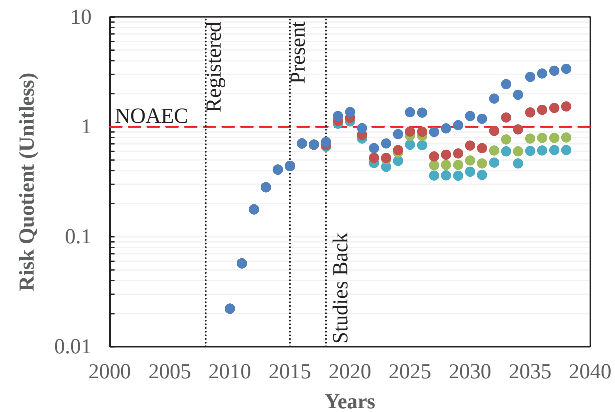




Registrant-suggested Endpoints







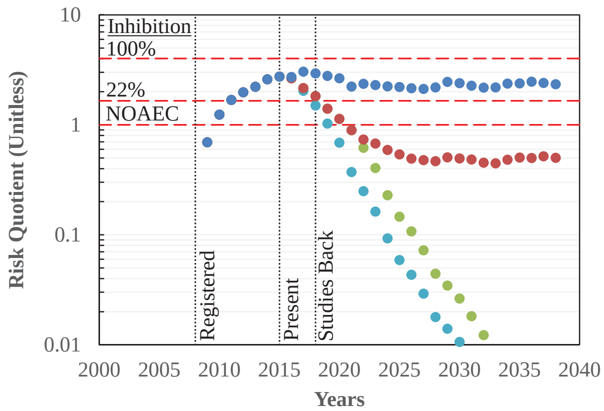
- Current Label (30 years aerial @ 4 apps/year)
- Change to 1 App. Forever (7 years aerial @ 4 apps/year, then 23 years ground @ 1 app/year)
- Change to 1 App. and Cancel (7 years ground or aerial @ 4 apps/year, then 3 years ground @ 1 app/year, then cancel)
- Cancel Now (7 years aerial @ 4 apps/year, then Cancel)

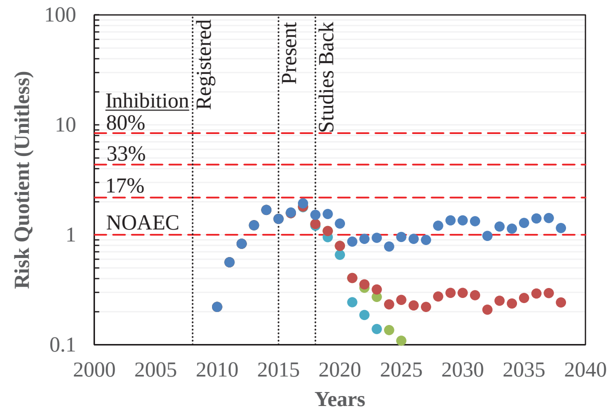
Appendix 1 Figure 1. Continued

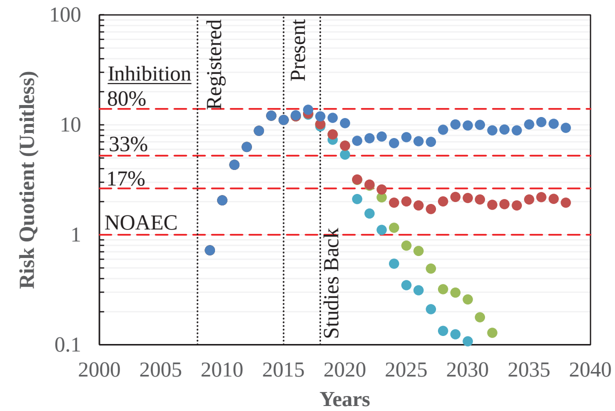
Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Alfalfa based on PA Alfalfa Scenario (Initially as a Aerial Application)

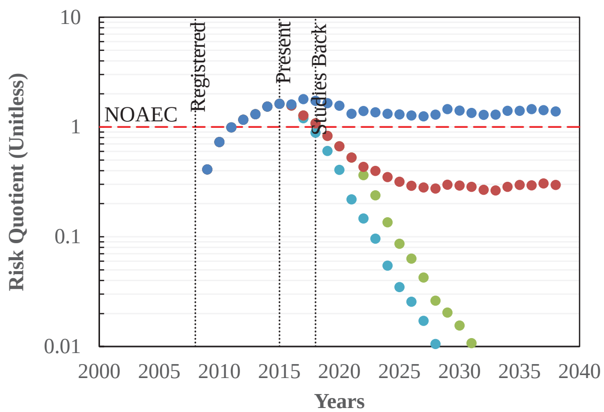
Time-weighted Average Endpoints

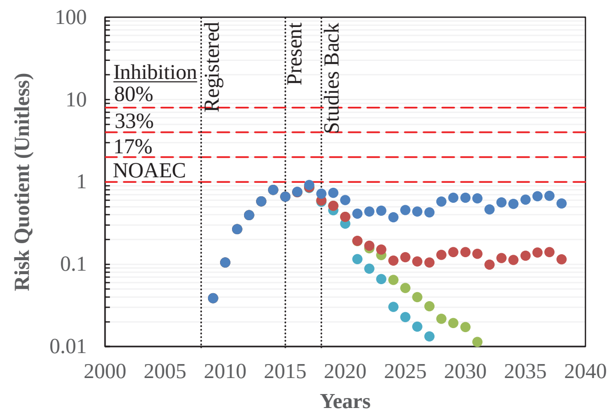


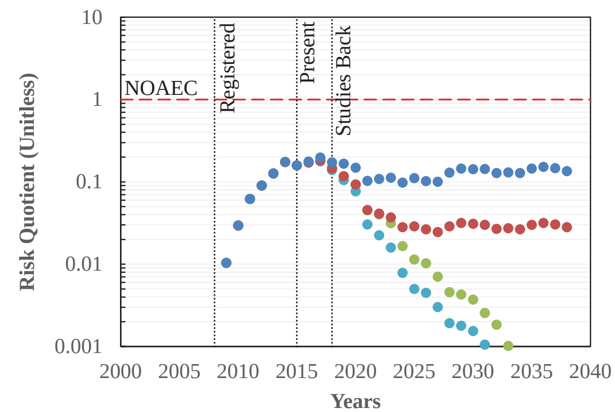




Registrant-suggested Endpoints







- Current Label (30 years aerial @ 4 apps/year)
- Change to 1 App. Forever (7 years aerial @ 4 apps/year, then 23 years ground @ 1 app/year)
- Change to 1 App. and Cancel (7 years ground or aerial @ 4 apps/year, then 3 years ground @ 1 app/year, then cancel)
- Cancel Now (7 years aerial @ 4 apps/year, then Cancel)

Appendix 1 Figure 1. Continued

Appendix 2. Regulatory Scenario Comparisons Using Time-weighted Average Concentration Endpoints and Registrant-suggested Endpoints

Appendix 2 Table 1. Comparison of Time to Exceed Agency Levels of Concern in Years using both the Time-weighted Average Endpoints and the Registrant-suggested Endpoints for the Crops Retained in Bayer CropScience's Proposal.

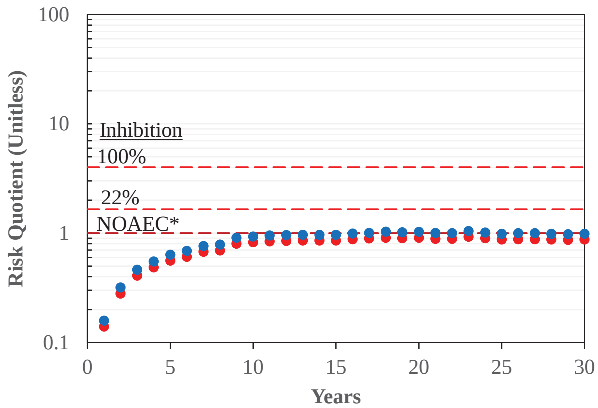
BELT Label Uses	Application Type: A = Aerial AB = Airblast G = Ground	Time to Exceed Agency Levels of Concern (Years) based on the Number of Applications (App.)[1]												Application Characteristics		
		Time-weighted Average Endpoints						Registrant-suggested Endpoints						Maximum Single Application Rate (lbs ai/A)	Maximum # of Applications (Minimum Reapplication Interval)	Maximum Annual Application Rate (lbs ai/A)
		1 App.	2 App.	3 App.	4 App.	5 App.	6 App.	1 App.	2 App.	3 App.	4 App.	5 App.	6 App.			
Alfalfa	A	3	3	NA				12	11	NA				0.125	2 (21)	0.141
	G	4	4	NA				21	19	NA						
Brassica Leafy Vegetables	A	3	2	2	2	NA		10	7	6	5	NA		0.075	4 (5)	0.282
	G	3	3	2	2	NA		12	8	7	6	NA				
Cotton (AZ and CA only)	A	3	3	NA				15	11	NA				0.094	2 (5)	0.141
	G	5	4	NA				26	18	NA						
Cucurbit Vegetables	A	5	3	3	2	2	2	28	16	12	10	8	7	0.047	6 (7)	0.282
	G	9	5	4	3	3	3	>30	>30	21	16	13	11			
Fruiting Vegetables	A	4	3	3	2	2	2	21	13	10	8	7	7	0.047	6 (3)	0.282
	G	5	4	3	3	3	3	29	18	13	11	9	8			
Grapes	G	7	5	4	NA			>30	22	20	NA			0.125	3 (5)	0.282
Leafy Vegetables	A	3	2	2	2	2	2	14	9	7	6	6	5	0.047	6 (3)	0.282
	G	4	3	2	2	2	2	15	10	8	7	6	6			
Legume Vegetables	A	3	2	2	NA			13	8	5	NA			0.094	3 (5)	0.282
	G	4	3	2	NA			18	11	6	NA					
Pome Fruit	AB	5	4	NA				27	17	NA				0.156	2 (7)	0.282
Stone Fruit	AB	6	4	4	NA			>30	19	18	NA			0.125	3 (7)	0.282
Strawberry	A	3	2	2	2	NA		10	7	5	5	NA		0.075	4 (3)	0.282
	G	3	2	2	2	NA		11	7	6	5	NA				
Tobacco	A	3	2	NA				13	11	NA				0.094	2 (5)	0.141
	G	4	3	NA				19	15	NA						
Tree Nuts	AB	3	3	2	NA			18	10	9	NA			0.125	4 (7)	0.282

[1] It may seem that stopping flubendiamide applications just before the Agency Levels of Concern (LOCs) are exceeded based on the information provided in Appendix 2 Table 1 might be a reasonable mitigation option. For example based on the time-weighted average endpoints, applying one application per year by ground application methods to cucurbit vegetables first exceeds Agency LOCs in year nine; therefore limiting similar flubendiamide applications to eight years might seem to prevent Agency LOC exceedances. However, there is a multi-year time-lag between application and attaining the maximum risk level from prior applications. Under the aforementioned cucurbit application scenario: stopping applications after year eight or seven still results in an exceedance later in year 9; stopping after year six only delays LOC exceedance to year 10; stopping after year five delays LOC exceedance to year 13; stopping after year four delays LOC exceedance to year 24; stopping after year three or less delays LOC exceedance beyond the 30 years simulated.

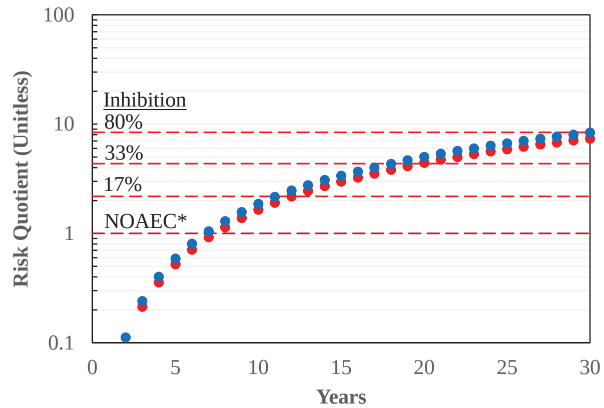
Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Alfalfa based on CAalfalfa_WirrigOP Scenario (Aerial Application)

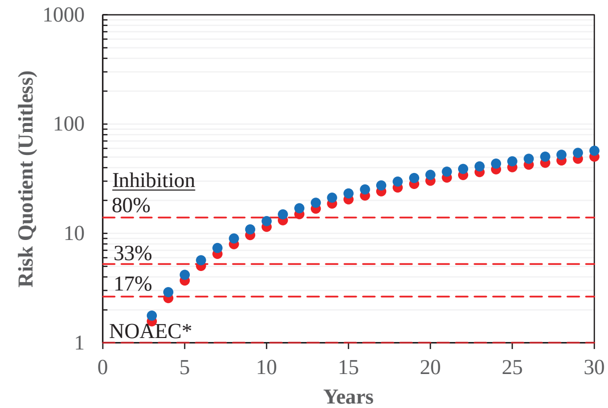
Agency Endpoints based on Time-weighted Average Concentrations



*Based on a NOAEC of 1.51 µg/L

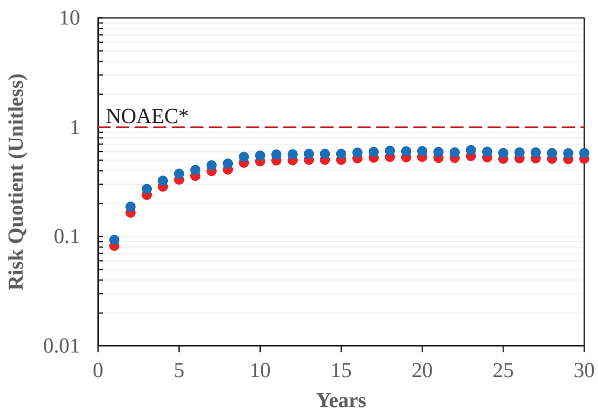


*Based on a NOAEC of 1.89 µg/L

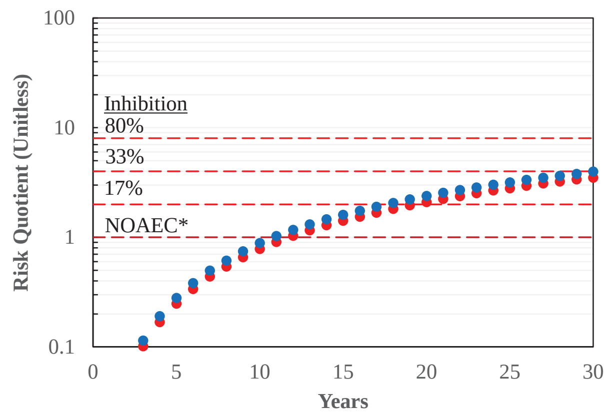


*Based on a NOAEC of 0.28 µg/L

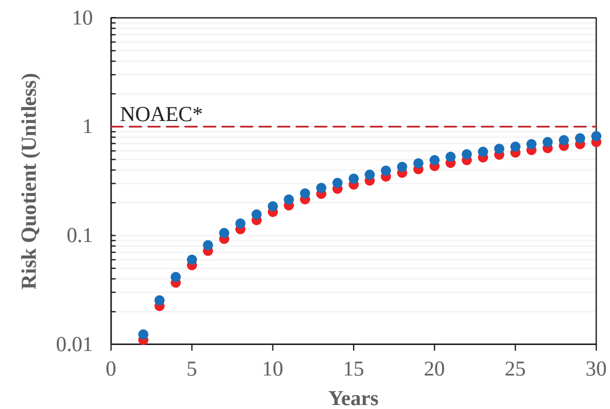
Registrant-suggested Endpoints



*Based on a NOAEC of 2.56 µg/L



*Based on a NOAEC of 4.0 µg/L

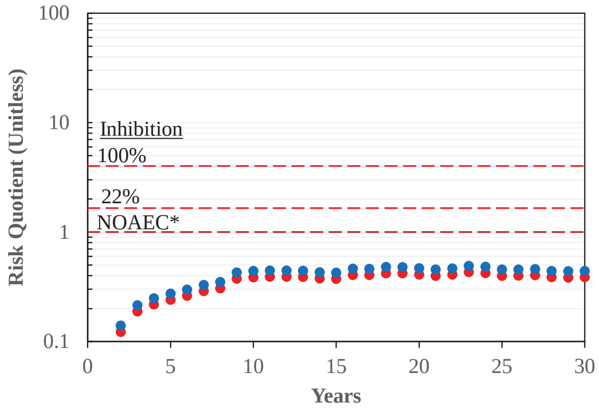


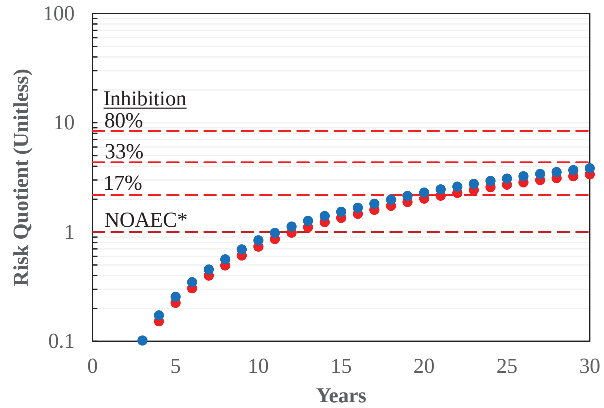
*Based on a NOAEC of 19.5 µg/L

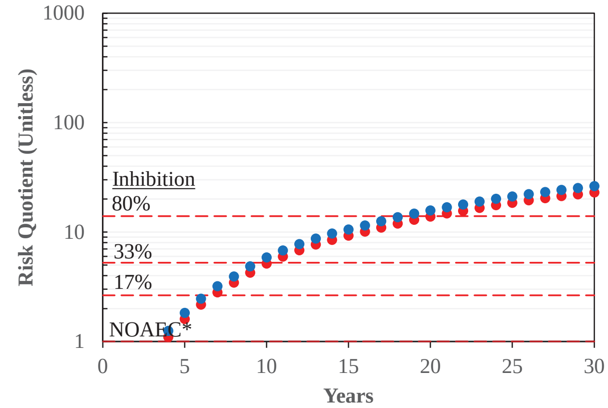
● Two applications per year for 30 years

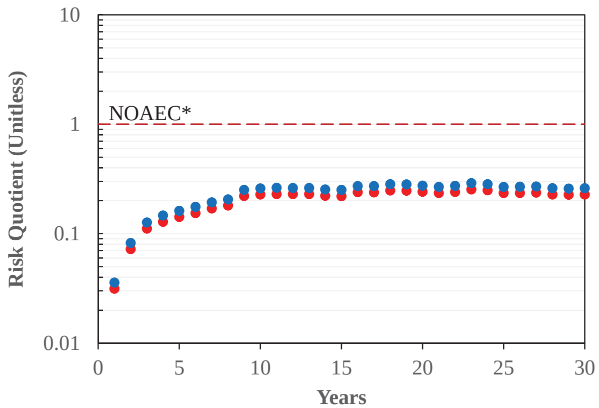
● One application per year for 30 years

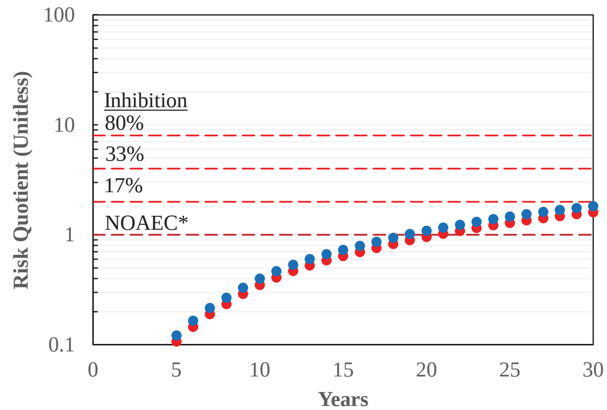
Appendix 2 Figure 1. Comparison of Potential Regulatory Scenarios Using Time-weighted Average Concentration Endpoints and Registrant-suggested Endpoints.

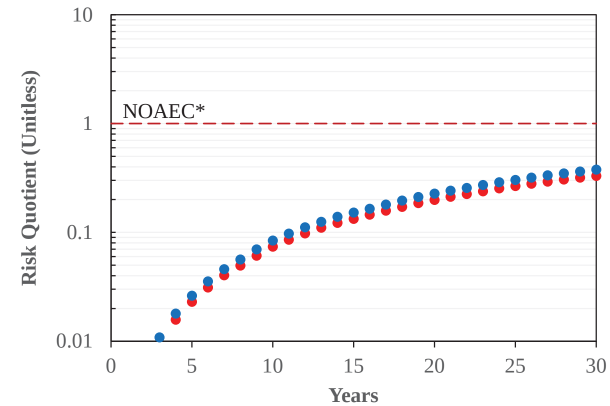
<table>
<tr><th>Flubendiamide</th><th colspan="2">Des-iodo</th></tr>
<tr><th>Benthic Pore Water</th><th>Overlying Water</th><th>Benthic Pore Water</th></tr>
<tr><td colspan="3">Alfalfa based on CAalfalfa_WirrigOP Scenario (Ground Application)</td></tr>
<tr><td colspan="3">Agency Endpoints based on Time-weighted Average Concentrations</td></tr>
<tr><td>

*Based on a NOAEC of 1.51 µg/L</td><td>

*Based on a NOAEC of 1.89 µg/L</td><td>

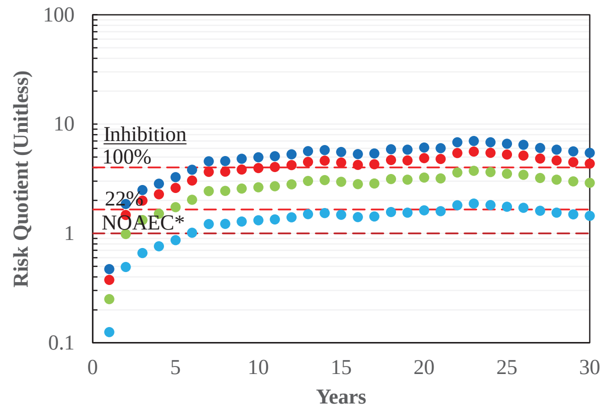
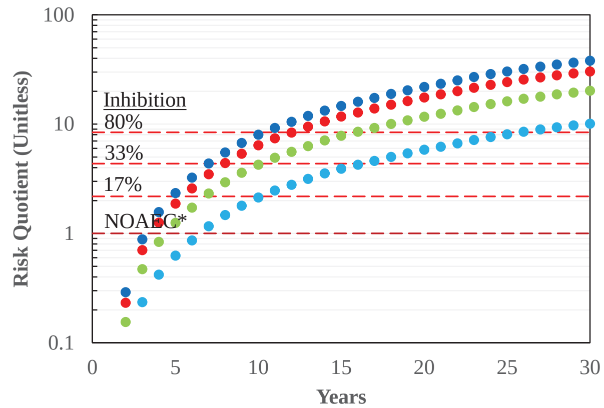
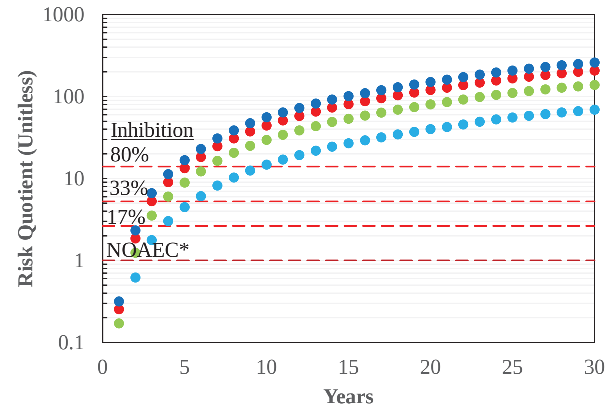
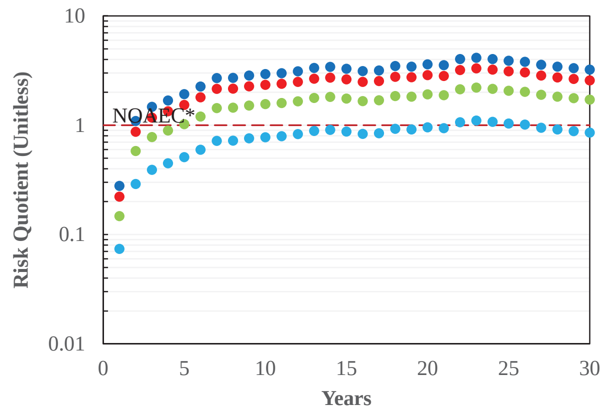
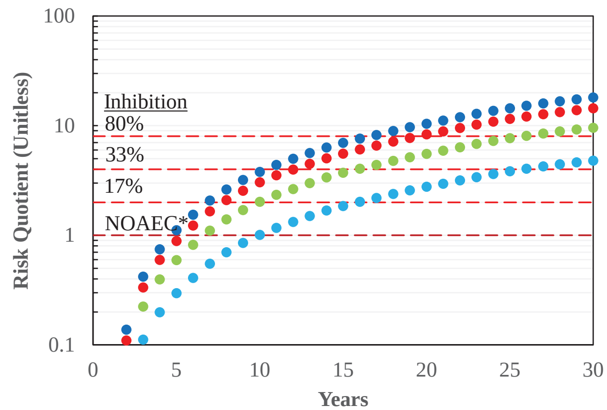
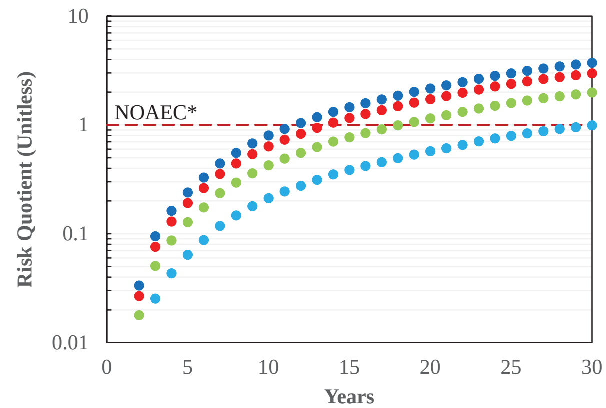
*Based on a NOAEC of 0.28 µg/L</td></tr>
<tr><td colspan="3">Registrant-suggested Endpoints</td></tr>
<tr><td>

*Based on a NOAEC of 2.56 µg/L</td><td>

*Based on a NOAEC of 4.0 µg/L</td><td>

*Based on a NOAEC of 19.5 µg/L</td></tr>
<tr><td colspan="3">Two applications per year for 30 years
One application per year for 30 years</td></tr>
</table>

Appendix 2 Figure 1. Continued.

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water
Brassica Leafy Vegetables based CAColeCropRLF_V2 Scenario (Aerial Application)		
Agency Endpoints based on Time-weighted Average Concentrations		
		
*Based on a NOAEC of 1.51 µg/L	*Based on a NOAEC of 1.89 µg/L	*Based on a NOAEC of 0.28 µg/L
Registrant-suggested Endpoints		
		
*Based on a NOAEC of 2.56 µg/L	*Based on a NOAEC of 4.0 µg/L	*Based on a NOAEC of 19.5 µg/L

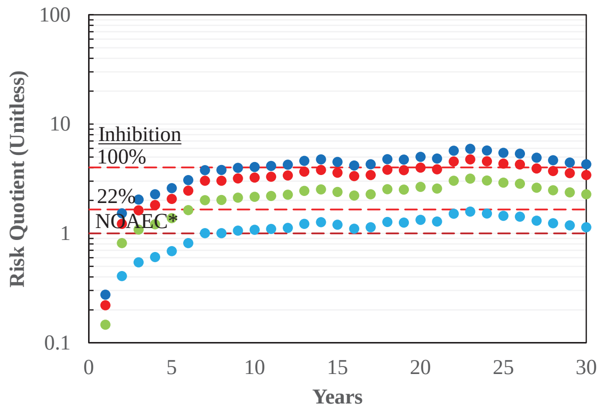
- Four applications per year for 30 years
- Three applications per year for 30 years
- Two applications per year for 30 years
- One application per year for 30 years

Appendix 2 Figure 1. Continued.

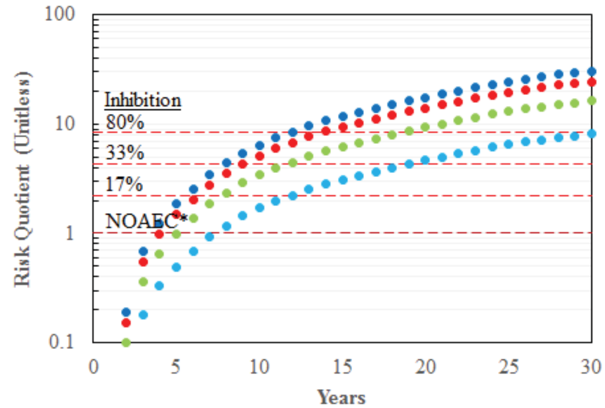
Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Brassica Leafy Vegetables based CAColeCropRLF_V2 Scenario (Ground Application)

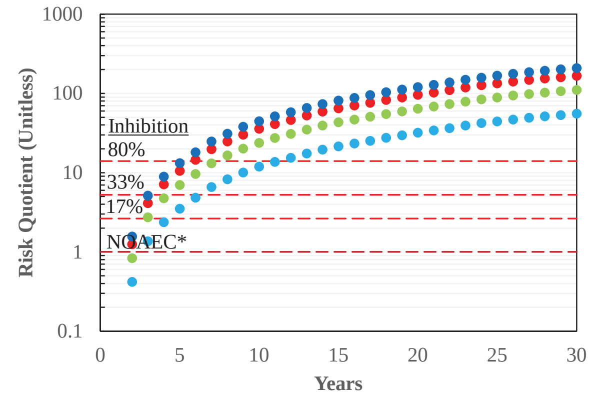
Agency Endpoints based on Time-weighted Average Concentrations



*Based on a NOAEC of 1.51 μg/L

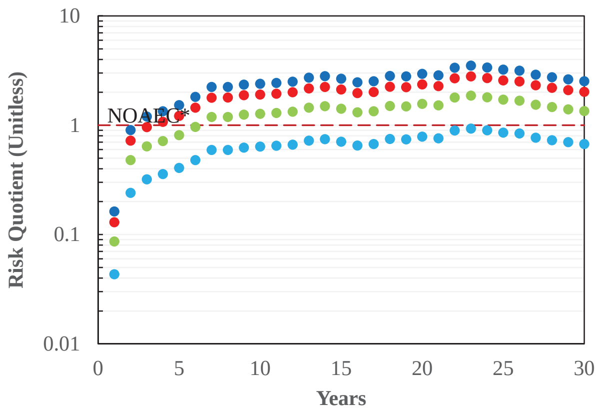


*Based on a NOAEC of 1.89 μg/L

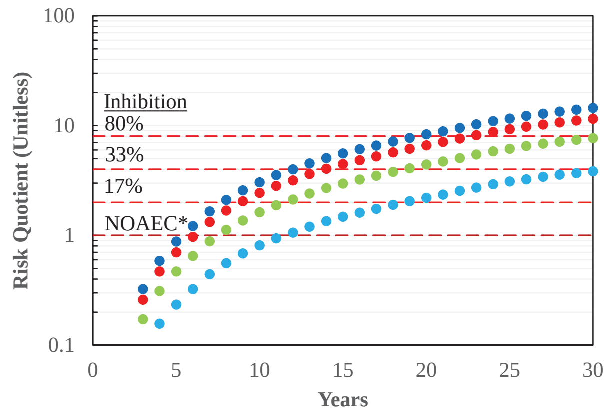


*Based on a NOAEC of 0.28 μg/L

Registrant-suggested Endpoints



*Based on a NOAEC of 2.56 μg/L



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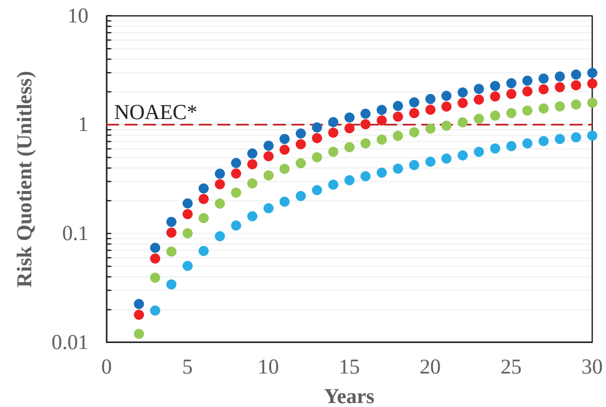


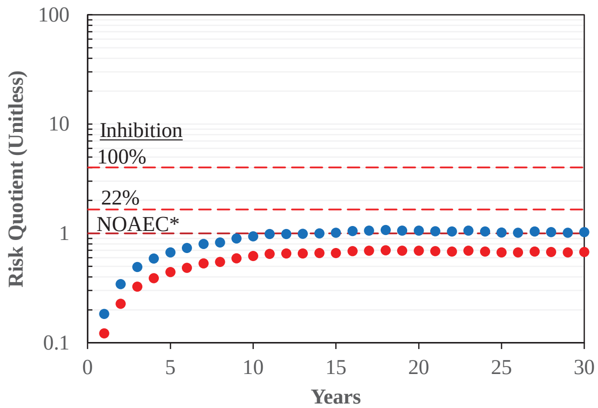
*Based on a NOAEC of 19.5 μg/L

- Four applications per year for 30 years
- Three applications per year for 30 years
- Two applications per year for 30 years
- One application per year for 30 years

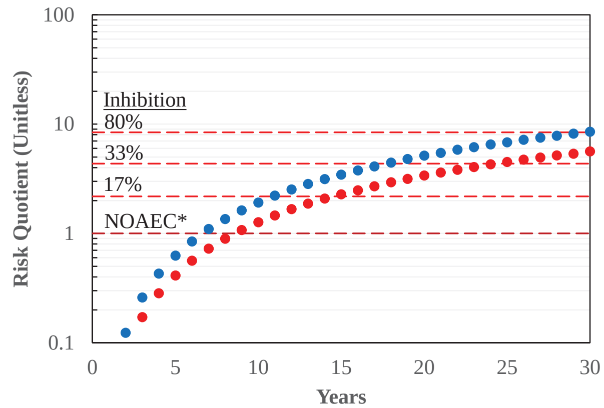
Appendix 2 Figure 1. Continued.

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water
Cotton (AZ and CA only) based CAcotton_WirrigSTD Scenario (Aerial Application)		

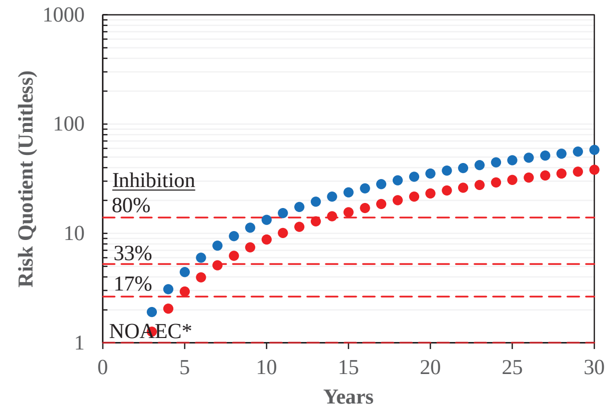
Agency Endpoints based on Time-weighted Average Concentrations



*Based on a NOAEC of 1.51 µg/L

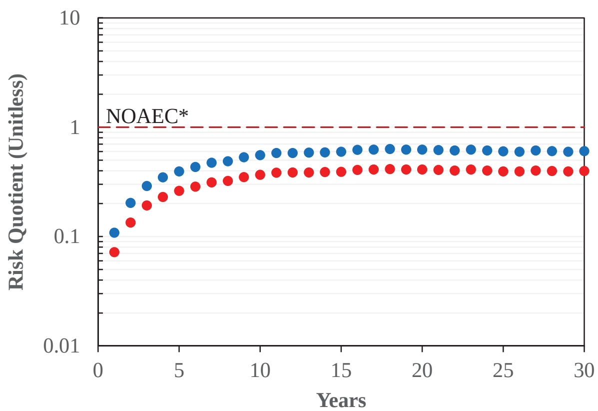


*Based on a NOAEC of 1.89 µg/L

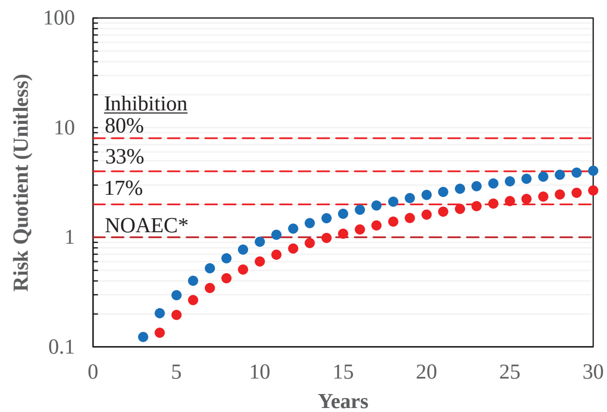


*Based on a NOAEC of 0.28 µg/L

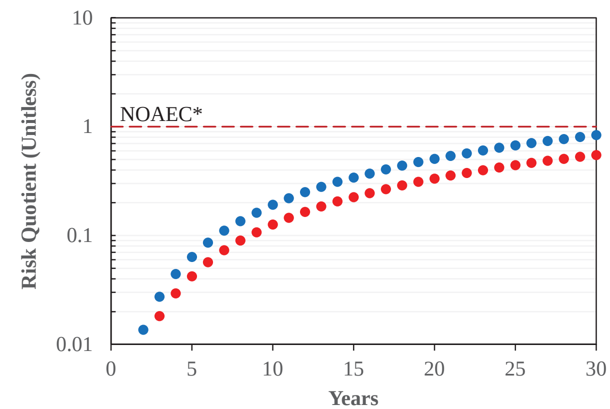
Registrant-suggested Endpoints



*Based on a NOAEC of 2.56 µg/L



*Based on a NOAEC of 4.0 µg/L



*Based on a NOAEC of 19.5 µg/L

● Two applications per year for 30 years

● One application per year for 30 years

Appendix 2 Figure 1. Continued.

<table>
<tr><th>Flubendiamide</th><th colspan="2">Des-iodo</th></tr>
<tr><th>Benthic Pore Water</th><th>Overlying Water</th><th>Benthic Pore Water</th></tr>
<tr><td colspan="3">Cotton (AZ and CA only) based CAcotton_WirrigSTD Scenario (Ground Application)</td></tr>
<tr><td colspan="3">Agency Endpoints based on Time-weighted Average Concentrations</td></tr>
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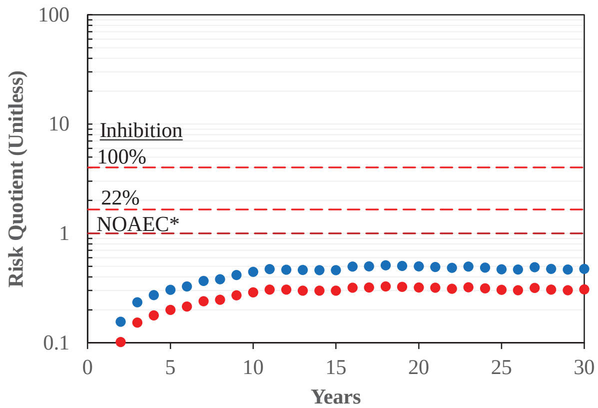
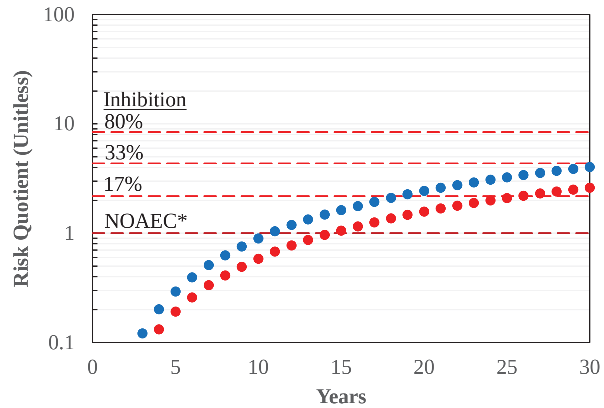
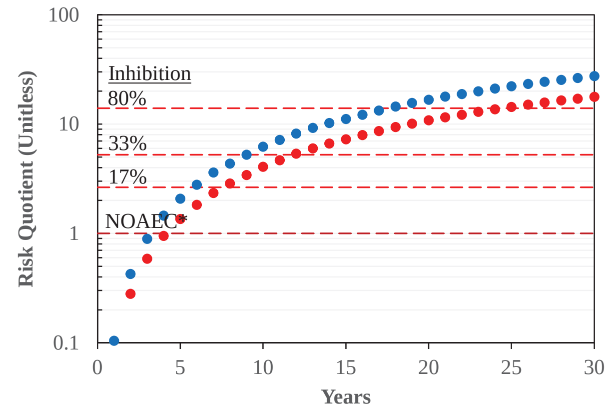
<td>

*Based on a NOAEC of 1.51 µg/L</td>
<td>

*Based on a NOAEC of 1.89 µg/L</td>
<td>

*Based on a NOAEC of 0.28 µg/L</td>
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<tr><td colspan="3">Registrant-suggested Endpoints</td></tr>
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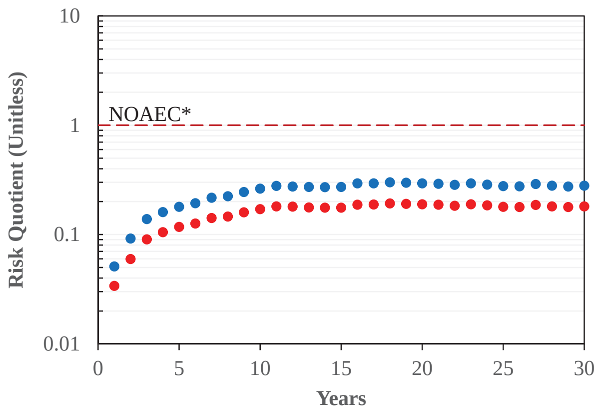
<td>

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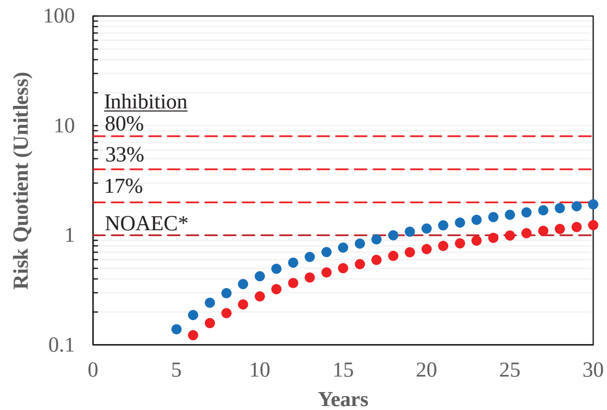
<td>

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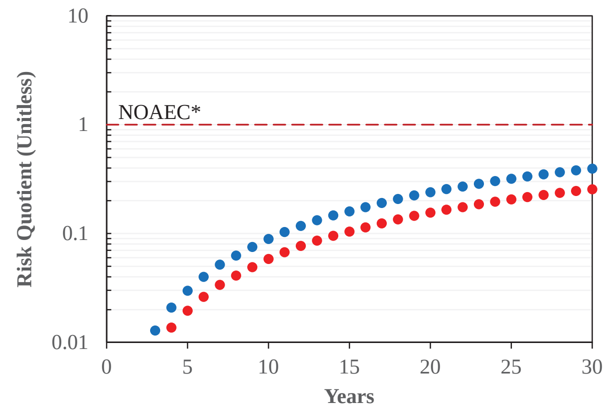
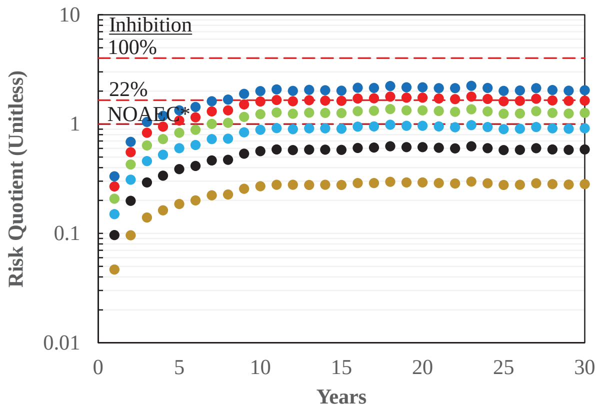
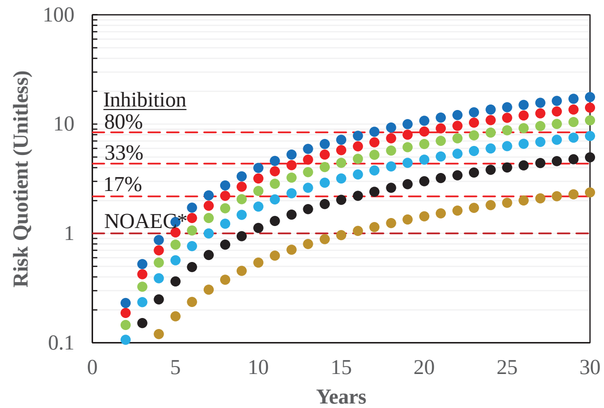
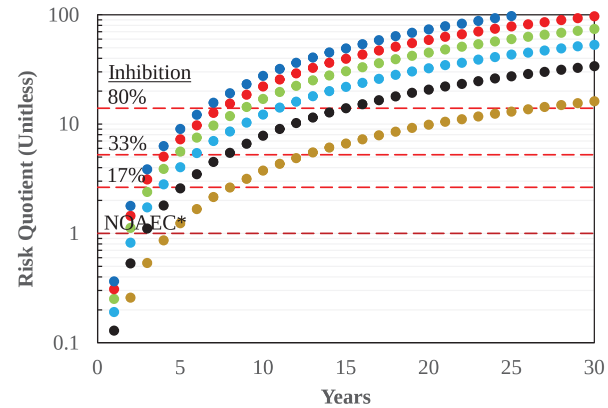
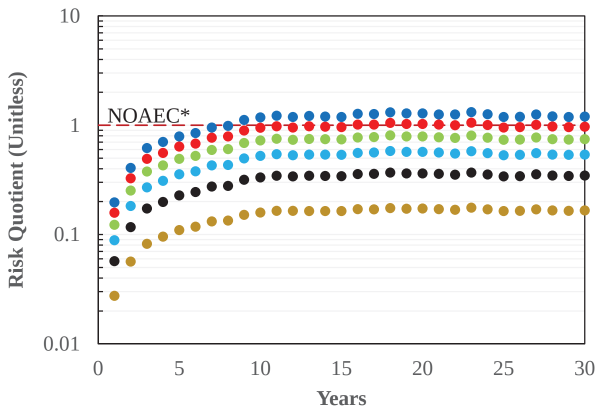
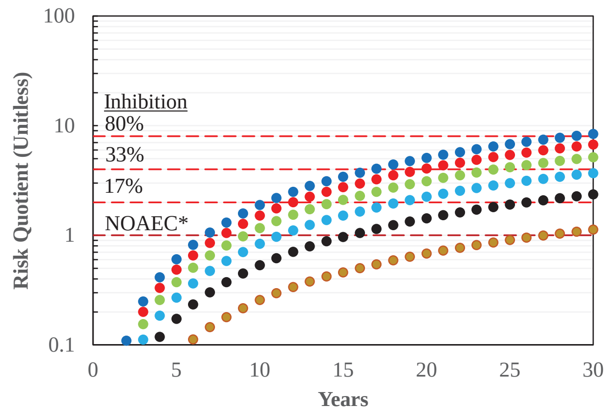
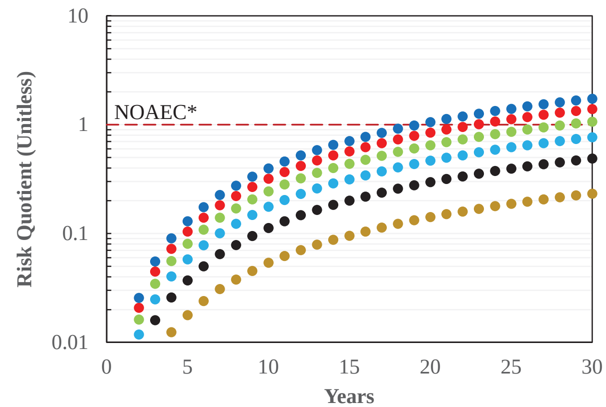
<td>

*Based on a NOAEC of 19.5 µg/L</td>
</tr>
<tr><td colspan="3">● Two applications per year for 30 years
● One application per year for 30 years</td></tr>
</table>

Appendix 2 Figure 1. Continued.

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water
Aerial Low Exposure Scenario: Cucurbit Vegetable based on CAMelonsRLF_V2 Scenario (Aerial Application)		
Agency Endpoints based on Time-weighted Average Concentrations		
 *Based on a NOAEC of 1.51 µg/L	 *Based on a NOAEC of 1.89 µg/L	 *Based on a NOAEC of 0.28 µg/L
Registrant-suggested Endpoints		
 *Based on a NOAEC of 2.56 µg/L	 *Based on a NOAEC of 4.0 µg/L	 *Based on a NOAEC of 19.5 µg/L

- Six applications per year for 30 years
- Five applications per year for 30 years
- Four applications per year for 30 years
- Three applications per year for 30 years
- Two applications per year for 30 years
- One application per year for 30 years

Appendix 2 Figure 1. Continued.

<table>
<tr><th>Flubendiamide</th><th colspan="2">Des-iodo</th></tr>
<tr><th>Benthic Pore Water</th><th>Overlying Water</th><th>Benthic Pore Water</th></tr>
<tr><th colspan="3">Ground Low Exposure Scenario: Cucurbit Vegetable based on CAMelonsRLF_V2 Scenario (Ground Application)</th></tr>
<tr><td colspan="3">Agency Endpoints based on Time-weighted Average Concentrations</td></tr>
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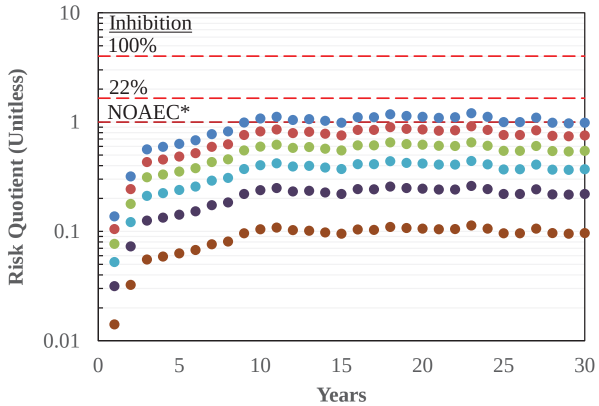
<td>

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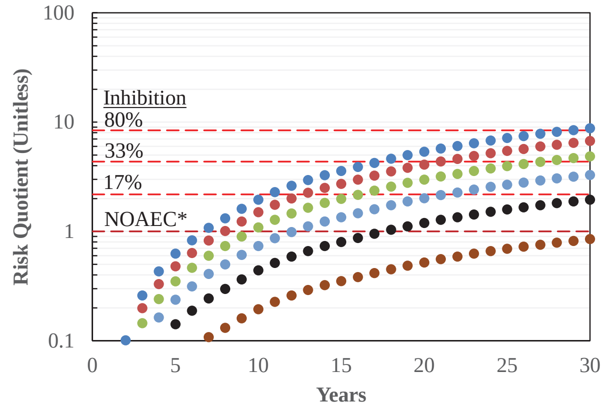
<td>

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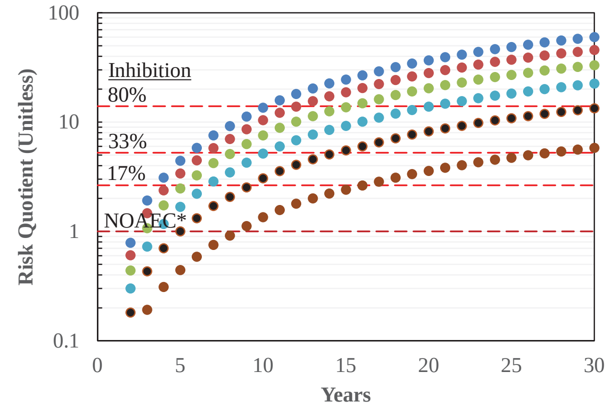
<td>

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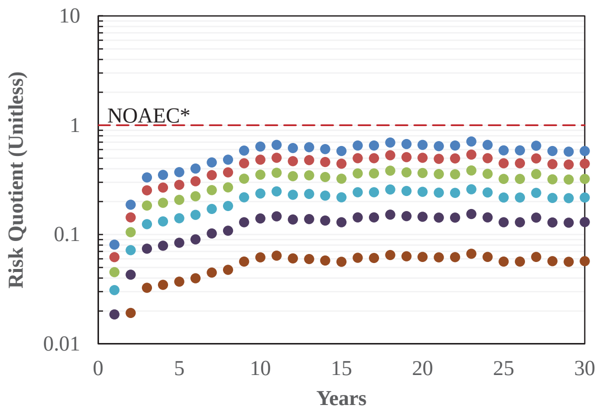
<td>

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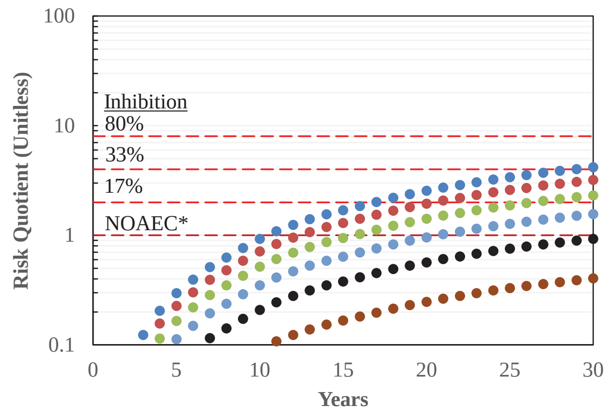
<td>

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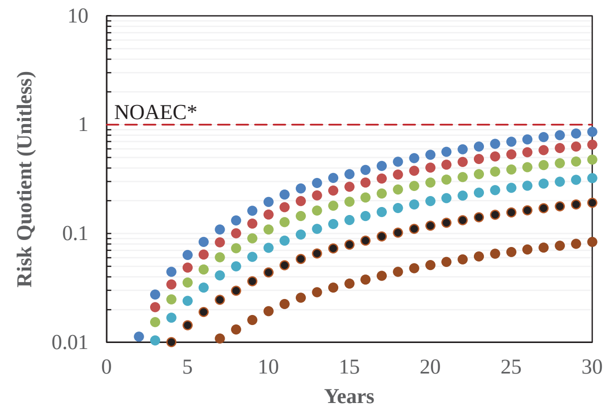
<td>

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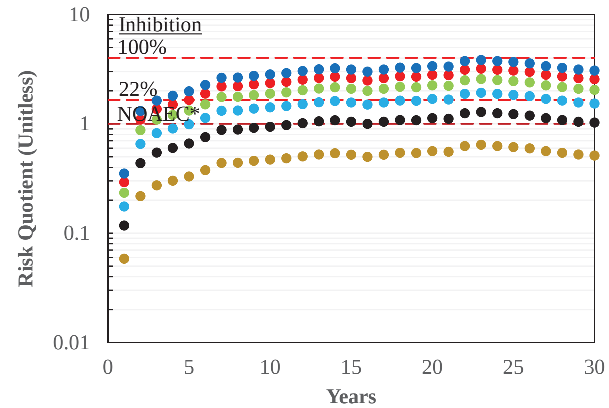
<tr><td colspan="3">Six applications per year for 30 years
Five applications per year for 30 years
Four applications per year for 30 years
Three applications per year for 30 years
Two applications per year for 30 years
One application per year for 30 years</td></tr>
</table>

Appendix 2 Figure 1. Continued.

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Fruiting Vegetables based on CARowCropRLF_V2 Scenario (Aerial Application)

Agency Endpoints based on Time-weighted Average Concentrations



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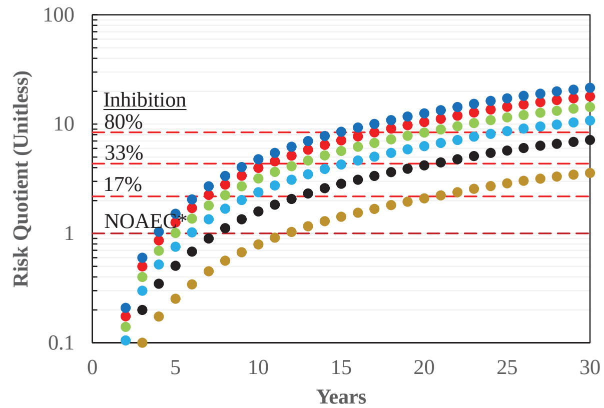

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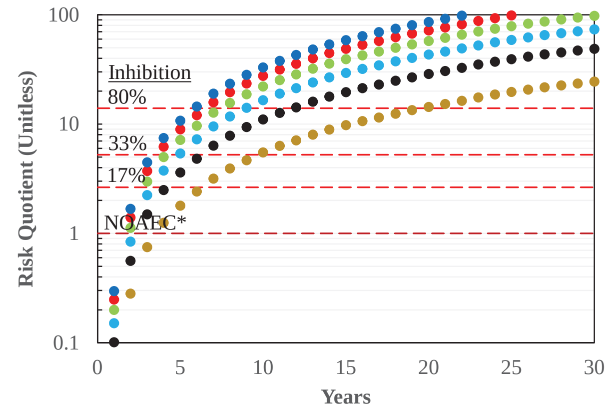
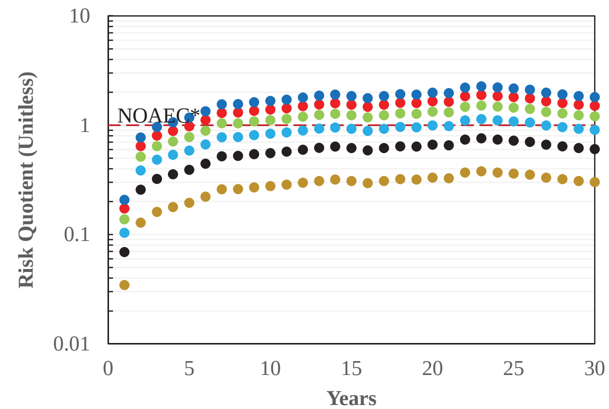


*Based on a NOAEC of 0.28 µg/L

Registrant-suggested Endpoints



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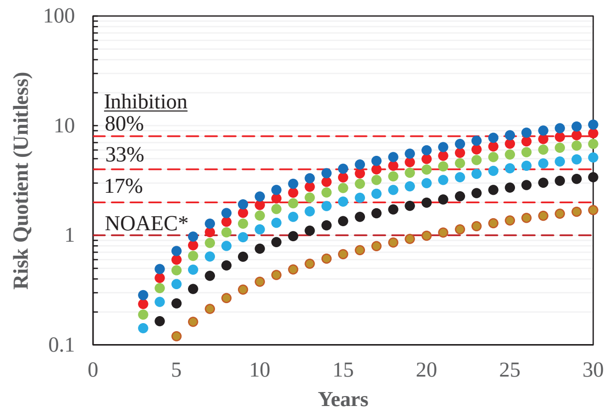

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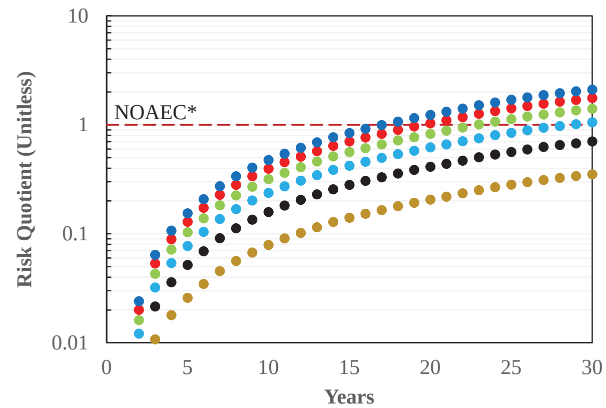
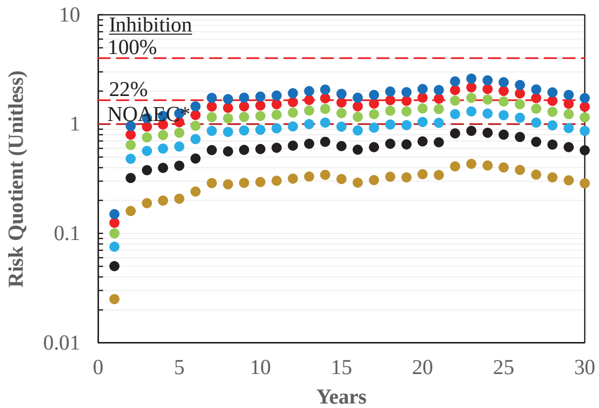
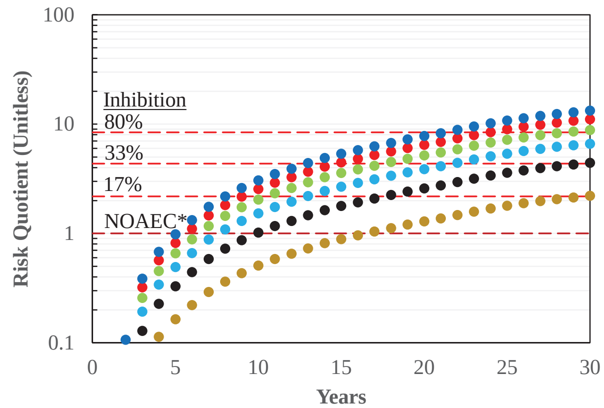
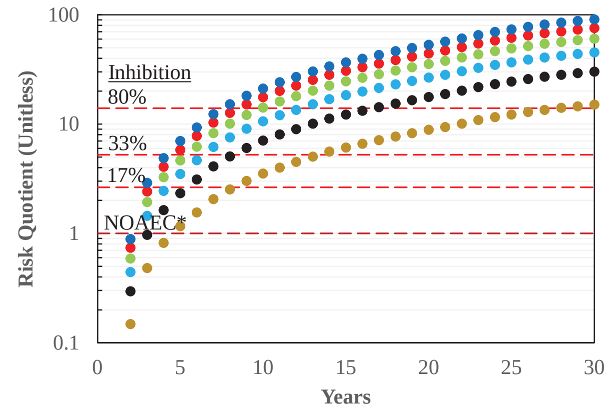
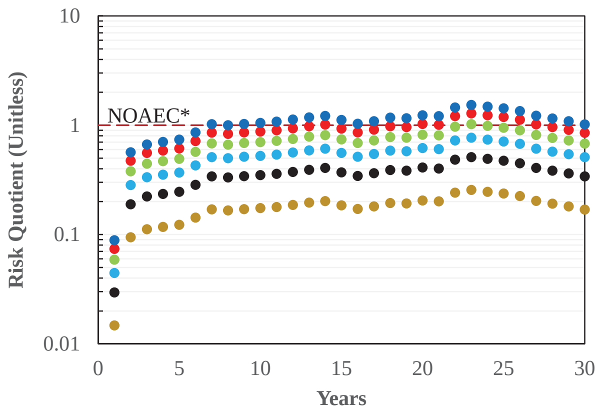
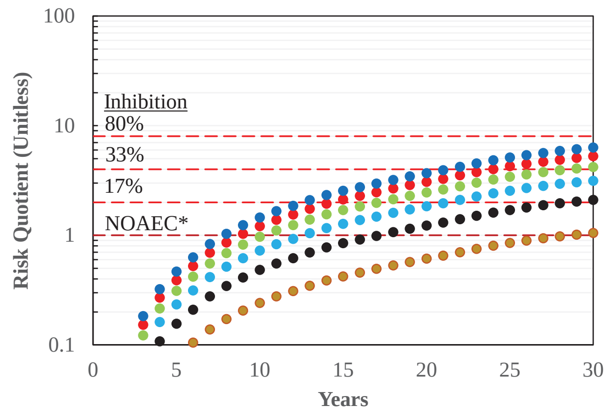
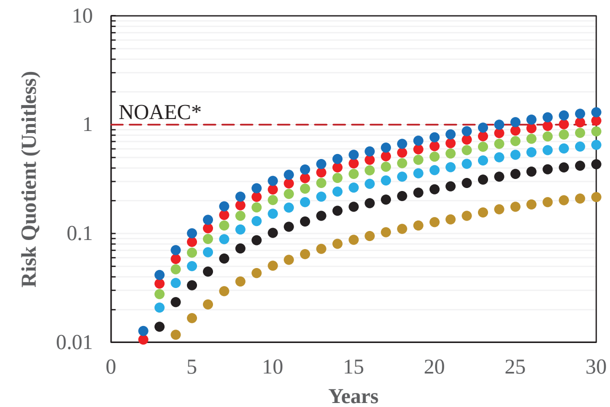


*Based on a NOAEC of 19.5 µg/L

- Six applications per year for 30 years
- Five applications per year for 30 years
- Four applications per year for 30 years
- Three applications per year for 30 years
- Two applications per year for 30 years
- One application per year for 30 years

Appendix 2 Figure 1. Continued.

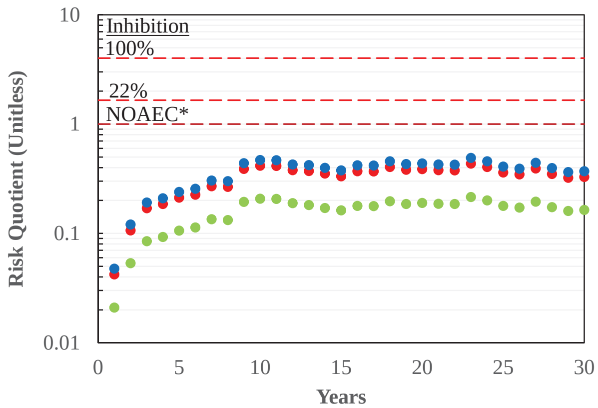
Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water
Fruiting Vegetables based on CARowCropRLF_V2 Scenario (Ground Application)		
Agency Endpoints based on Time-weighted Average Concentrations		
		
*Based on a NOAEC of 1.51 µg/L	*Based on a NOAEC of 1.89 µg/L	*Based on a NOAEC of 0.28 µg/L
Registrant-suggested Endpoints		
		
*Based on a NOAEC of 2.56 µg/L	*Based on a NOAEC of 4.0 µg/L	*Based on a NOAEC of 19.5 µg/L

- Six applications per year for 30 years
- Five applications per year for 30 years
- Four applications per year for 30 years
- Three applications per year for 30 years
- Two applications per year for 30 years
- One application per year for 30 years

Appendix 2 Figure 1. Continued.

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water
Grapes based on CAgrapes_WirrigSTD Scenario (Ground Application)		

Agency Endpoints based on Time-weighted Average Concentrations



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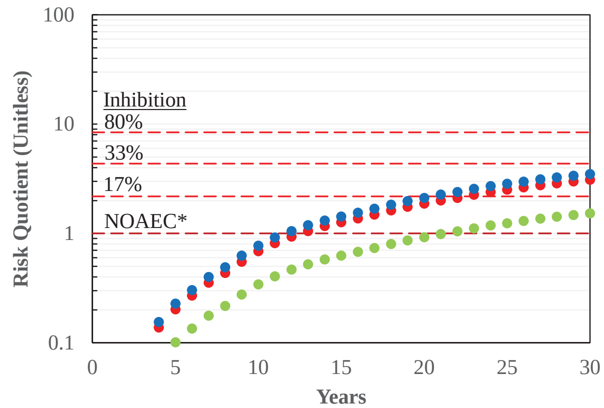

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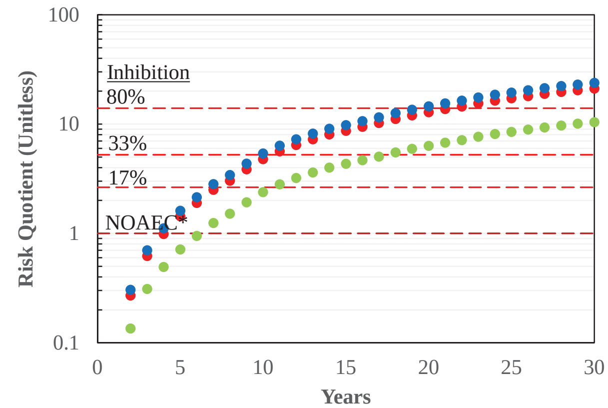
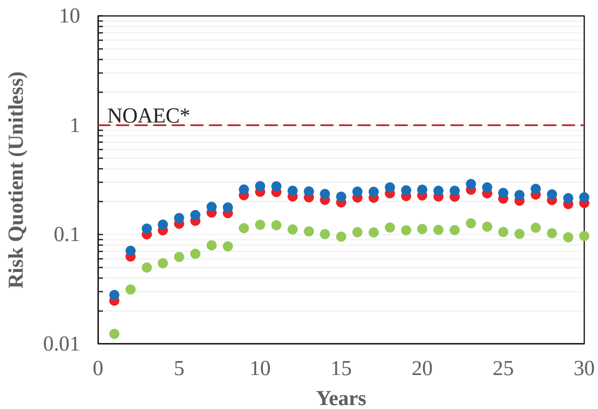
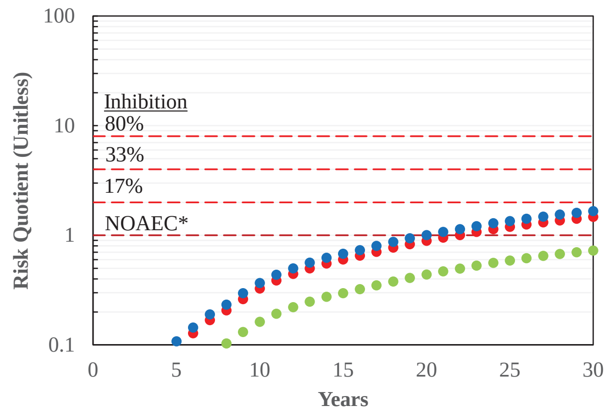


*Based on a NOAEC of 0.28 µg/L

Registrant-suggested Endpoints



*Based on a NOAEC of 2.56 µg/L



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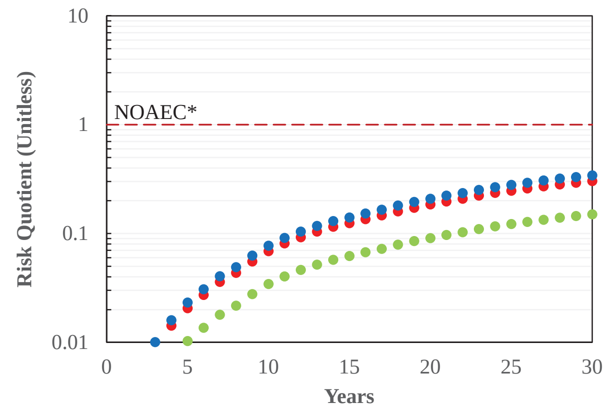

*Based on a NOAEC of 19.5 µg/L

- Three applications per year for 30 years
- Two applications per year for 30 years
- One application per year for 30 years

Appendix 2 Figure 1. Continued.

<table>
<tr><th>Flubendiamide</th><th colspan="2">Des-iodo</th></tr>
<tr><th>Benthic Pore Water</th><th>Overlying Water</th><th>Benthic Pore Water</th></tr>
<tr><th colspan="3">Leafy Vegetables based on CAlettuceSTD Scenario (Aerial Application)</th></tr>
<tr><td colspan="3">Agency Endpoints based on Time-weighted Average Concentrations</td></tr>
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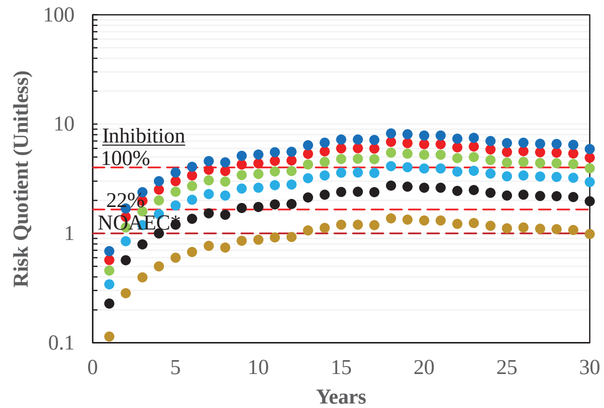
<td>
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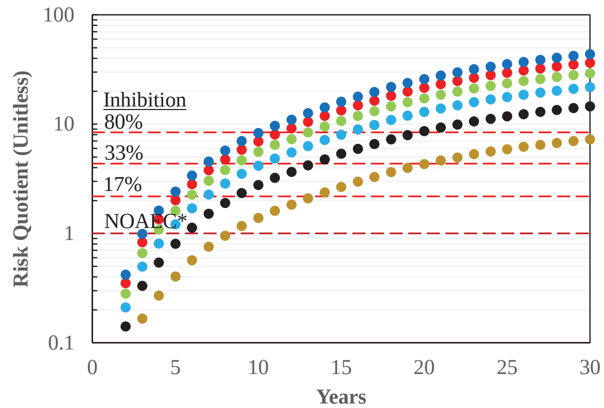
<td>
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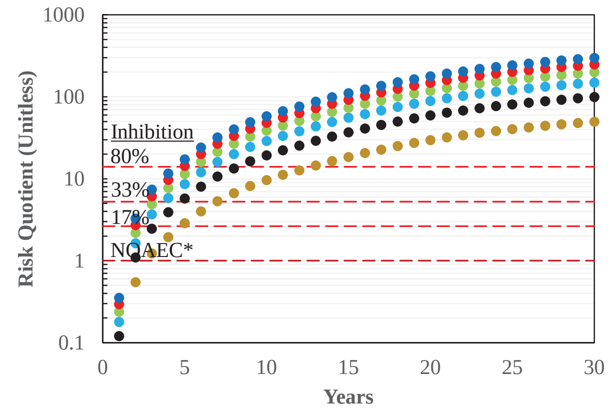
<td>
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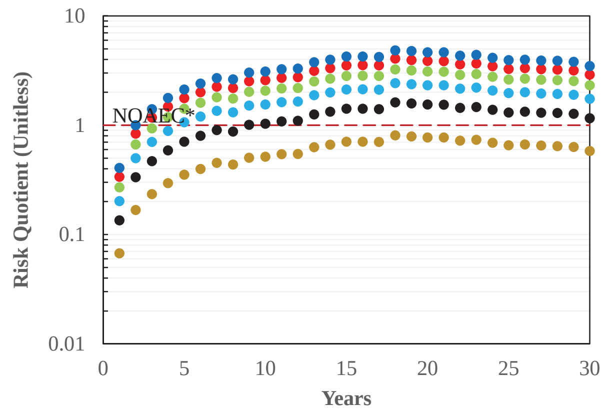
<td>
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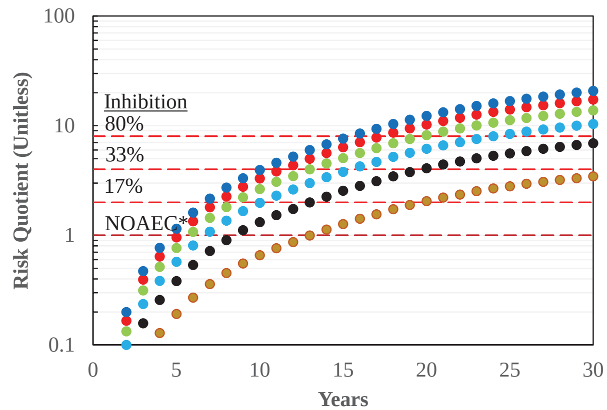
<td>
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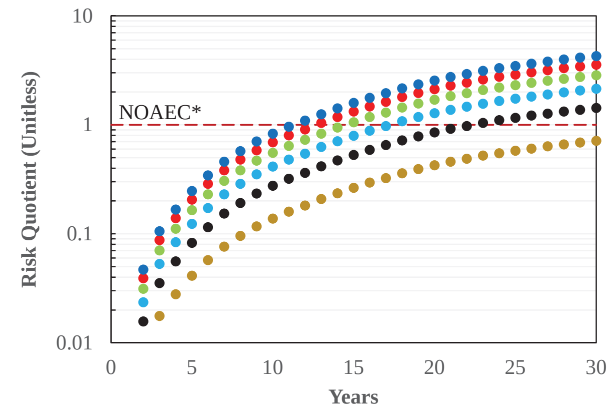
<td>
*Based on a NOAEC of 19.5 µg/L</td>
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<tr><td colspan="3">● Six applications per year for 30 years
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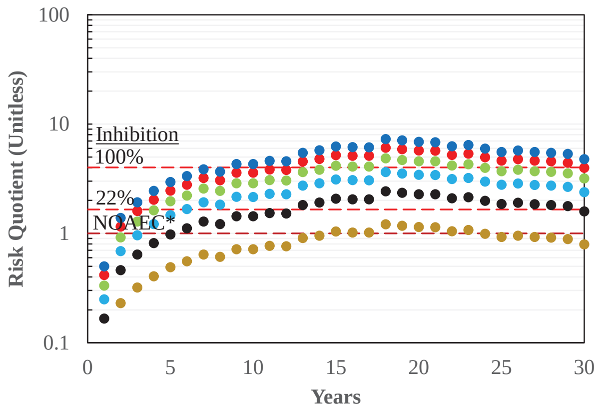
</table>

Appendix 2 Figure 1. Continued.

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Leafy Vegetables based on CAlettuceSTD Scenario (Ground Application)

Agency Endpoints based on Time-weighted Average Concentrations



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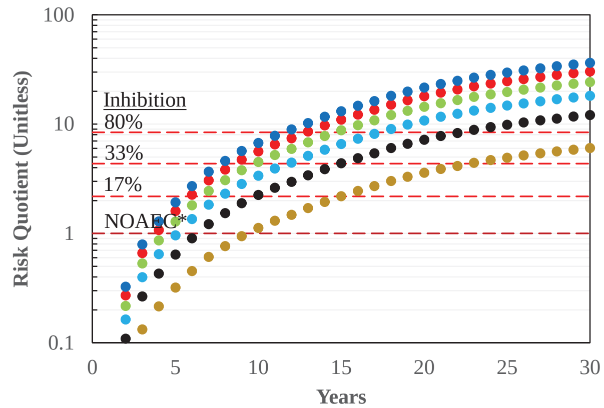
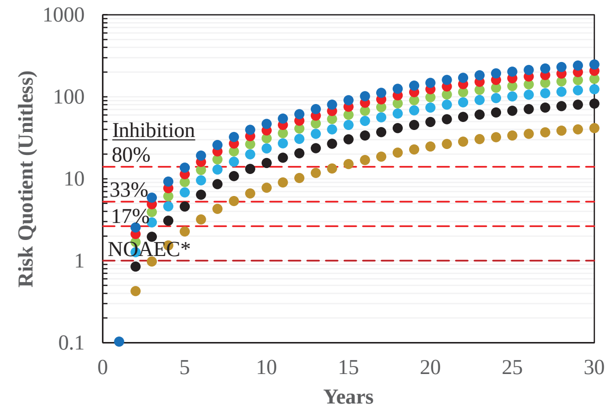
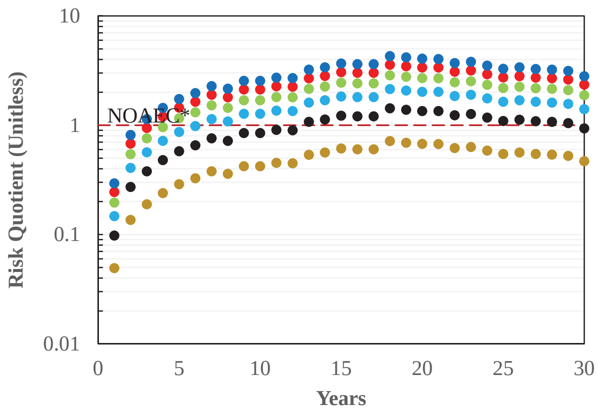


*Based on a NOAEC of 1.89 µg/L

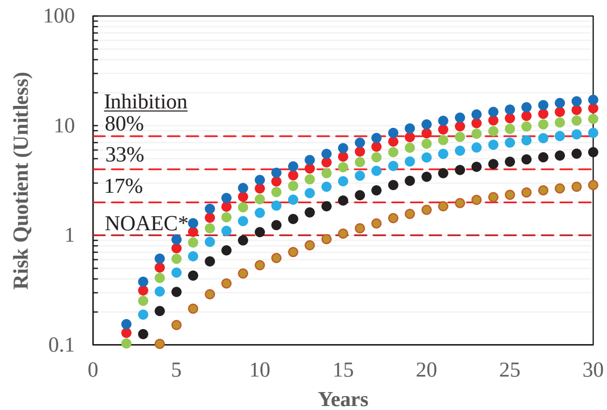


*Based on a NOAEC of 0.28 µg/L

Registrant-suggested Endpoints



*Based on a NOAEC of 2.56 µg/L



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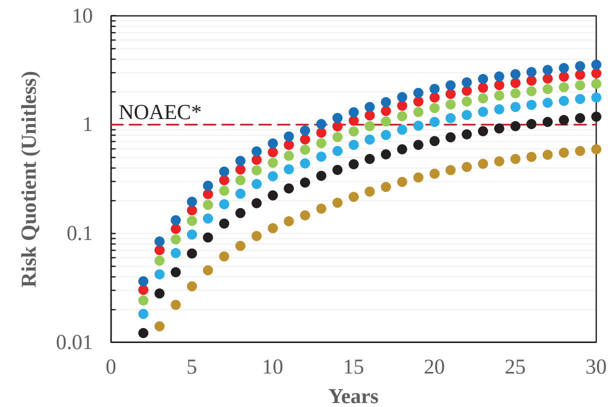


*Based on a NOAEC of 19.5 µg/L

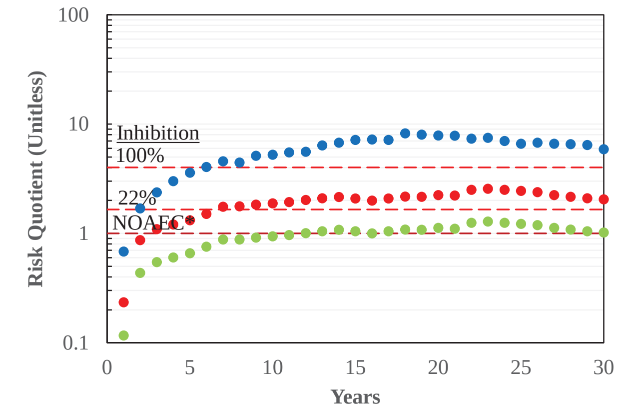
- Six applications per year for 30 years
- Five applications per year for 30 years
- Four applications per year for 30 years
- Three applications per year for 30 years
- Two applications per year for 30 years
- One application per year for 30 years

Appendix 2 Figure 1. Continued.

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Legume Vegetables based on CARowCropRLF_V2 Scenario (Aerial Application)

Agency Endpoints based on Time-weighted Average Concentrations



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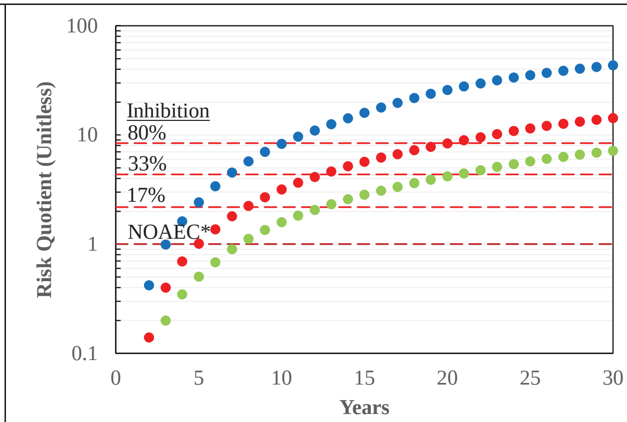

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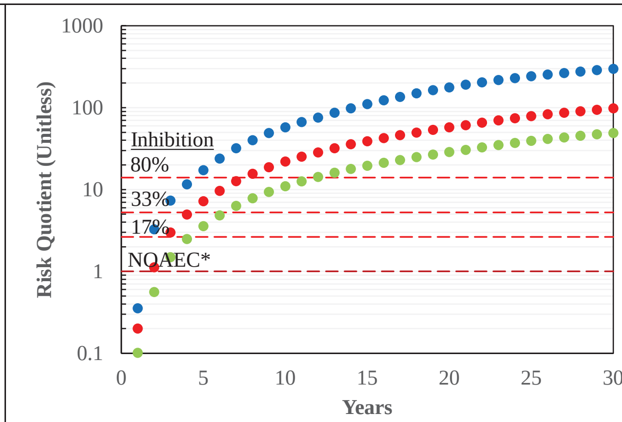
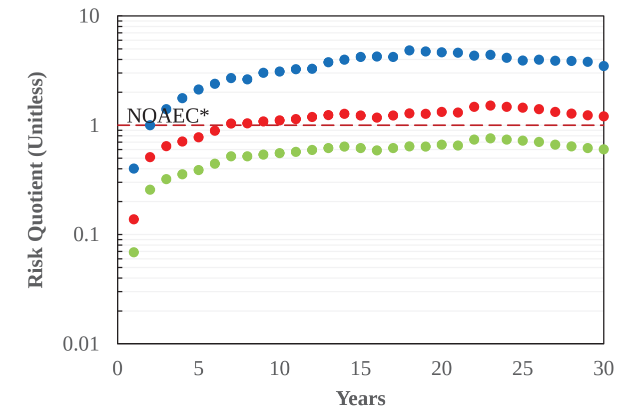


*Based on a NOAEC of 0.28 µg/L

Registrant-suggested Endpoints



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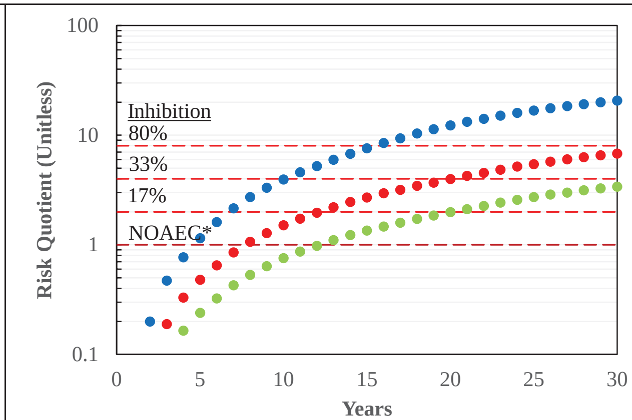

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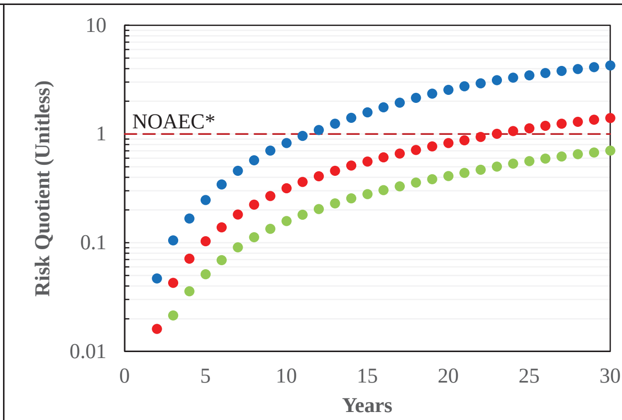

*Based on a NOAEC of 19.5 µg/L

- Three applications per year for 30 years
- Two applications per year for 30 years
- One application per year for 30 years

Appendix 2 Figure 1. Continued.

<table>
<tr><th>Flubendiamide</th><th colspan="2">Des-iodo</th></tr>
<tr><th>Benthic Pore Water</th><th>Overlying Water</th><th>Benthic Pore Water</th></tr>
<tr><th colspan="3">Legume Vegetables based on CARowCropRLF_V2 Scenario (Ground Application)</th></tr>
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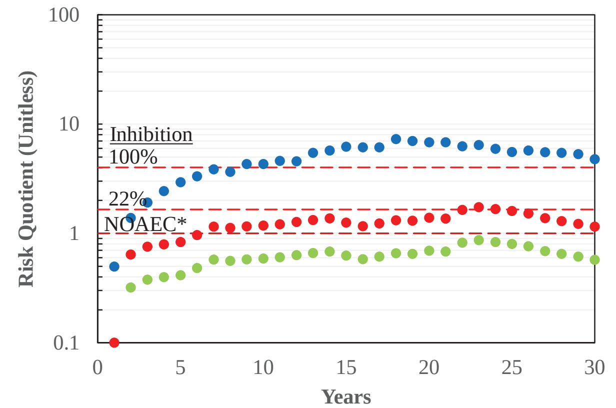
<td>

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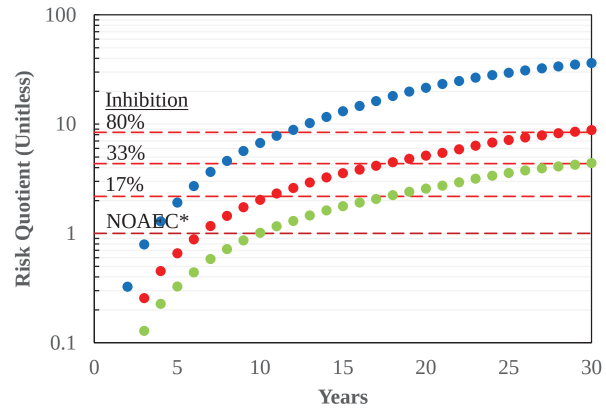
<td>

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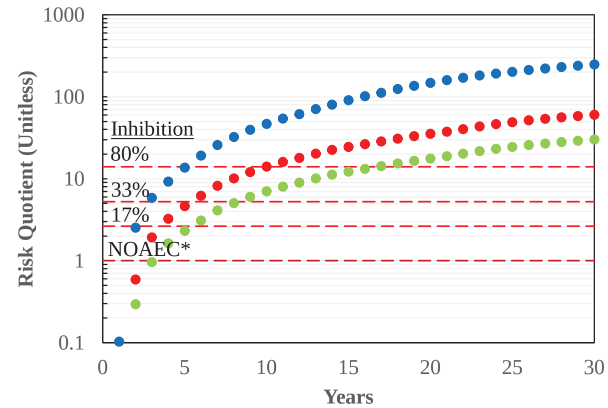
<td>

*Based on a NOAEC of 0.28 µg/L</td>
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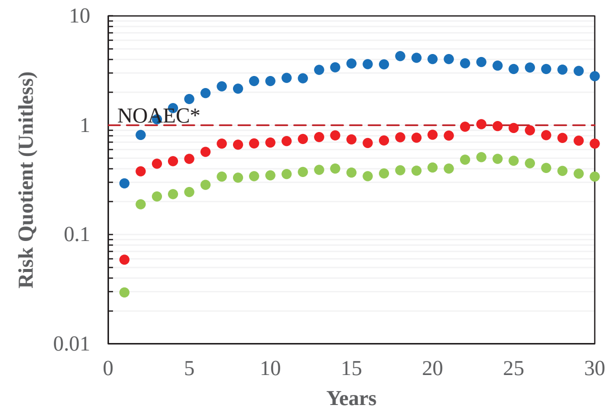
<td>

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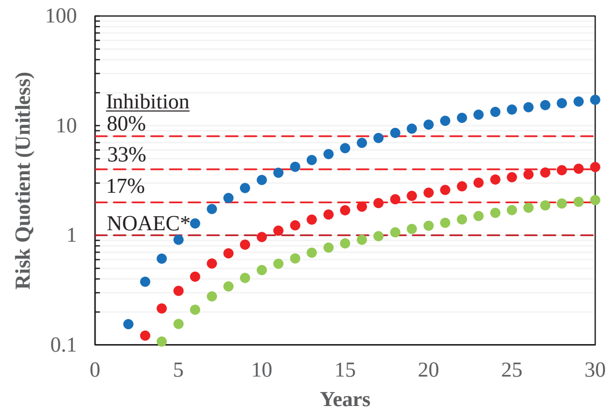
<td>

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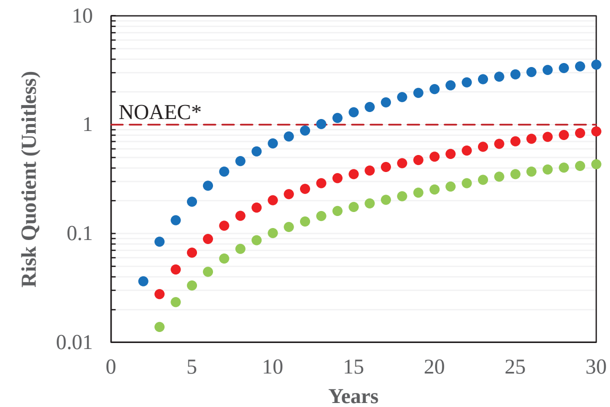
<td>

*Based on a NOAEC of 19.5 µg/L</td>
</tr>
<tr><td colspan="3">● Three applications per year for 30 years
● Two applications per year for 30 years
● One application per year for 30 years</td></tr>
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Appendix 2 Figure 1. Continued.

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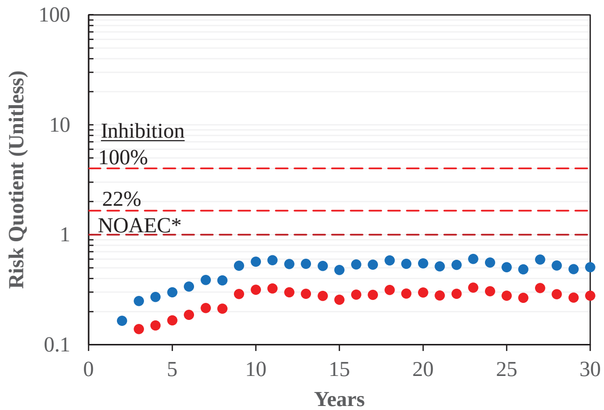
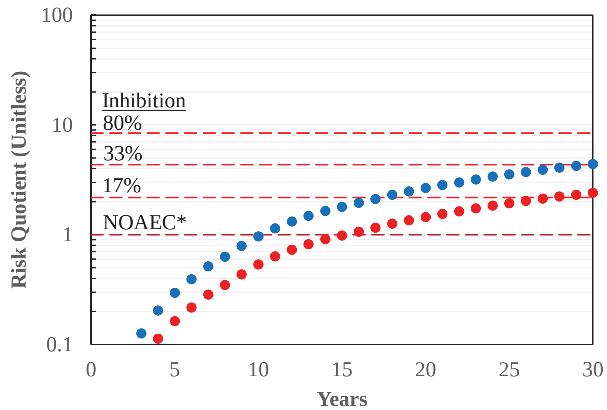
<tr><th>Flubendiamide</th><th colspan="2">Des-iodo</th></tr>
<tr><th>Benthic Pore Water</th><th>Overlying Water</th><th>Benthic Pore Water</th></tr>
<tr><th colspan="3">High Exposure Scenario: Pome Fruit (Single Application Rate = 0.156 lb ai/A) based on CAfruit_WirrigSTD Scenaio (Air Blast Application)</th></tr>
<tr><td colspan="3">Agency Endpoints based on Time-weighted Average Concentrations</td></tr>
<tr>
<td>

*Based on a NOAEC of 1.51 µg/L</td>
<td>

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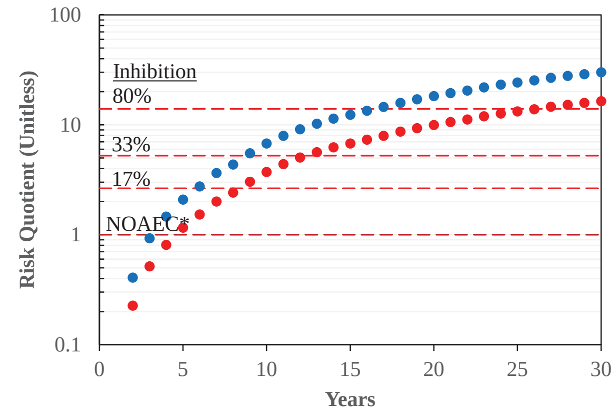
<td>

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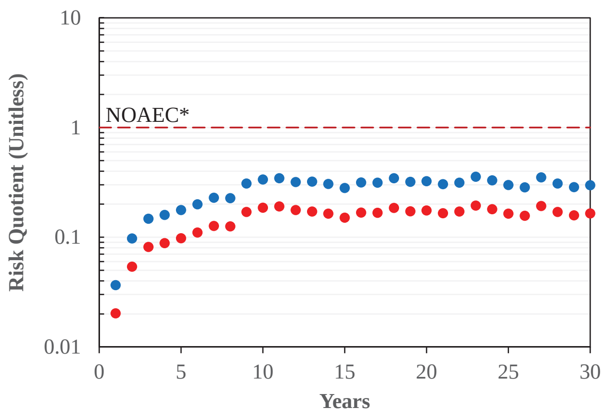
<td>

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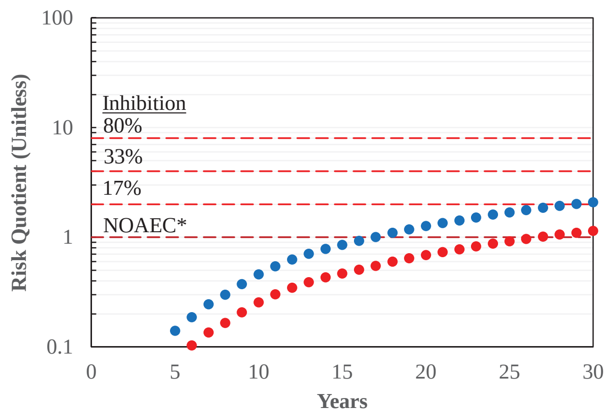
<td>

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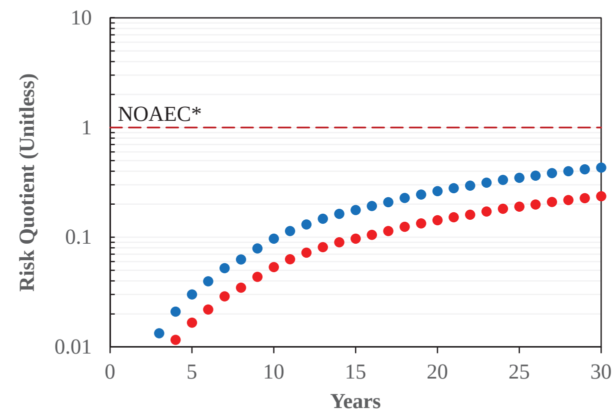
<td>

*Based on a NOAEC of 19.5 µg/L</td>
</tr>
<tr><td colspan="3">● Two applications per year for 30 years
● One application per year for 30 years</td></tr>
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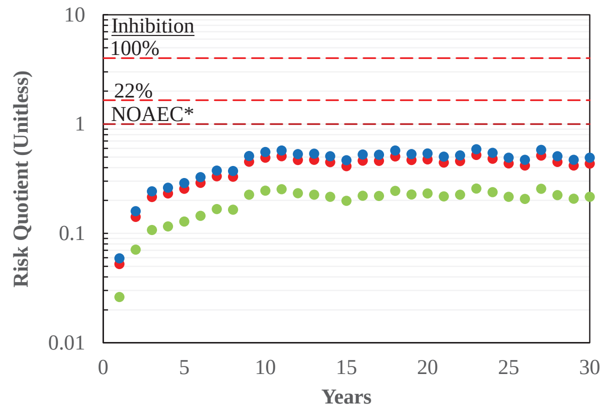
Appendix 2 Figure 1. Continued.

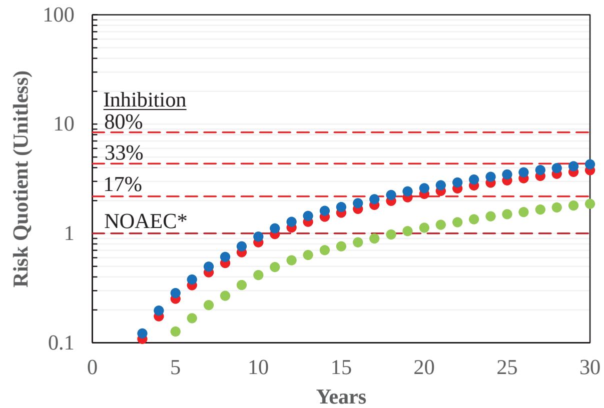
Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Stone Fruit based on CAfruit_WirrigSTD Scenario (Airblast Application)

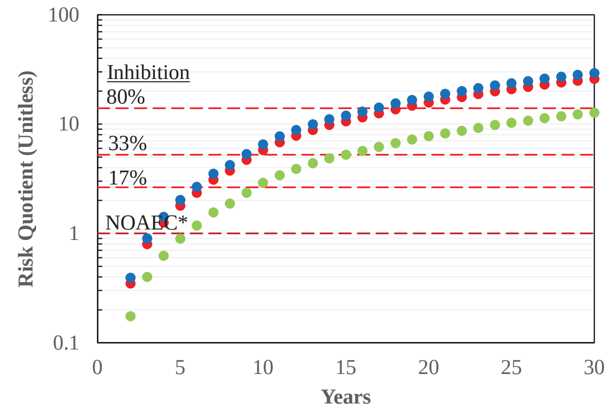
Agency Endpoints based on Time-weighted Average Concentrations



*Based on a NOAEC of 1.51 µg/L

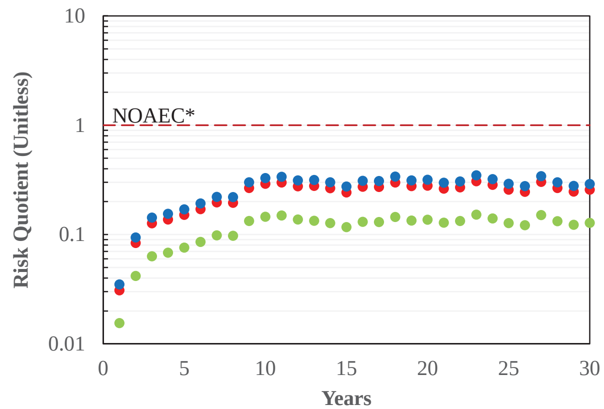


*Based on a NOAEC of 1.89 µg/L

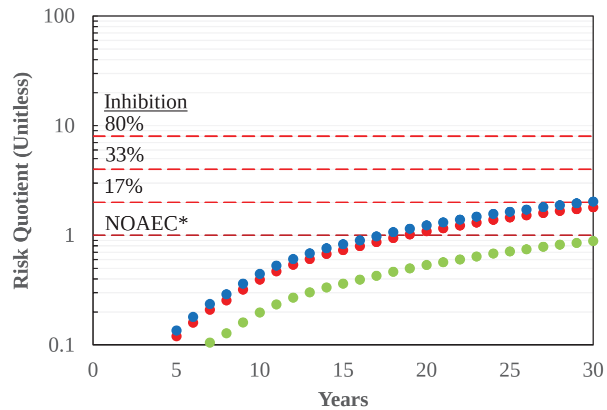


*Based on a NOAEC of 0.28 µg/L

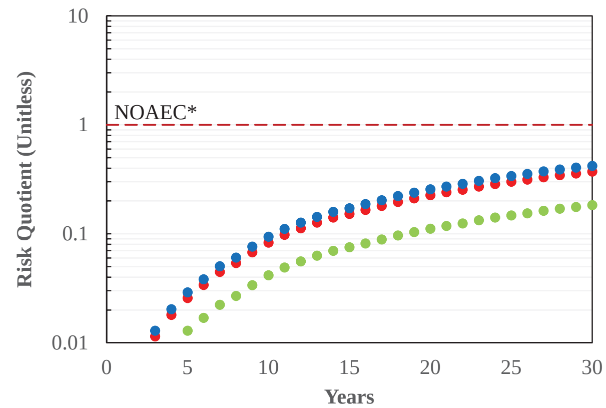
Registrant-suggested Endpoints



*Based on a NOAEC of 2.56 µg/L



*Based on a NOAEC of 4.0 µg/L



*Based on a NOAEC of 19.5 µg/L

- Three applications per year for 30 years
- Two applications per year for 30 years
- One application per year for 30 years

Appendix 2 Figure 1. Continued.

<table>
<tr><th>Flubendiamide</th><th colspan="2">Des-iodo</th></tr>
<tr><th>Benthic Pore Water</th><th>Overlying Water</th><th>Benthic Pore Water</th></tr>
<tr><td colspan="3">Strawberry based on CAStrawberry-noplasticRLF_V2 Scenario (Aerial Application)</td></tr>
<tr><td colspan="3">Agency Endpoints based on Time-weighted Average Concentrations</td></tr>
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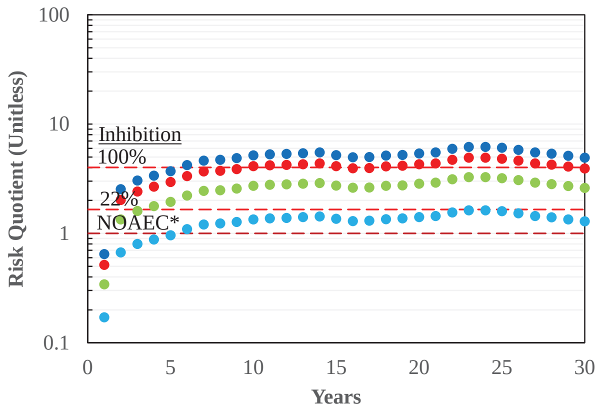
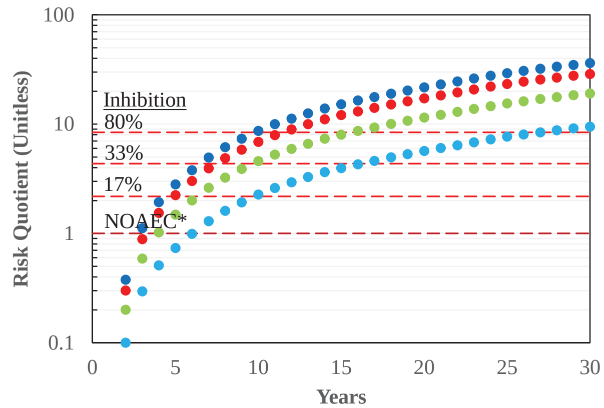
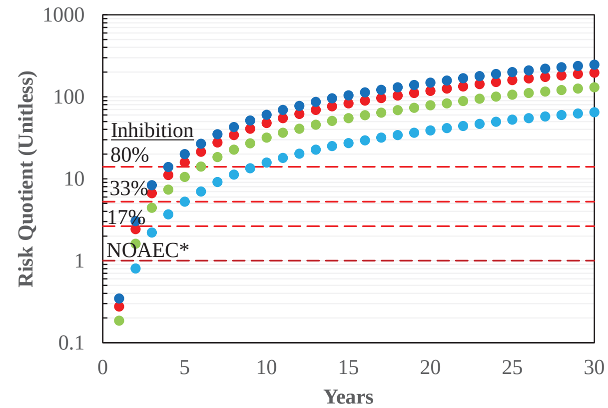
<td>
*Based on a NOAEC of 1.51 µg/L</td>
<td>
*Based on a NOAEC of 1.89 µg/L</td>
<td>
*Based on a NOAEC of 0.28 µg/L</td>
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<tr><td colspan="3">Registrant-suggested Endpoints</td></tr>
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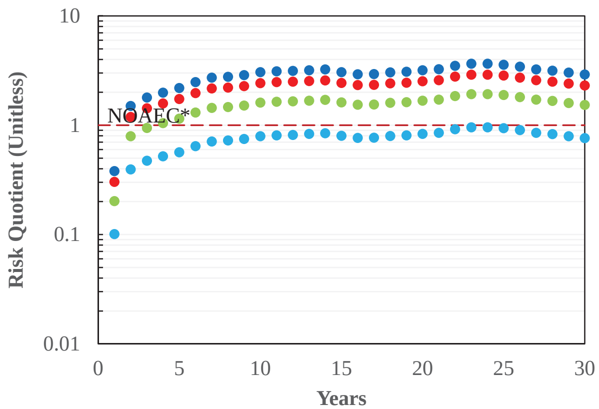
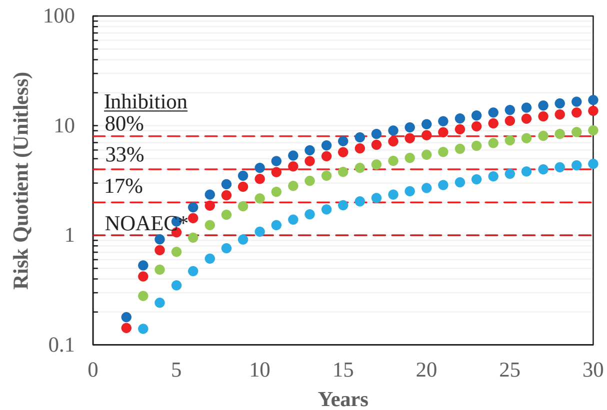
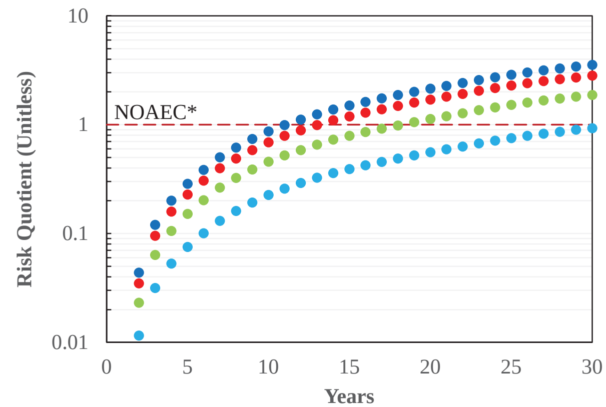
<td>
*Based on a NOAEC of 2.56 µg/L</td>
<td>
*Based on a NOAEC of 4.0 µg/L</td>
<td>
*Based on a NOAEC of 19.5 µg/L</td>
</tr>
<tr><td colspan="3">● Four applications per year for 30 years
● Three applications per year for 30 years
● Two applications per year for 30 years
● One application per year for 30 years</td></tr>
</table>

Appendix 2 Figure 1. Continued.

<table>
<tr><th colspan="1">Flubendiamide</th><th colspan="2">Des-iodo</th></tr>
<tr><th>Benthic Pore Water</th><th>Overlying Water</th><th>Benthic Pore Water</th></tr>
<tr><th colspan="3">Strawberry based on CAStrawberry-noplasticRLF_V2 Scenario (Ground Application)</th></tr>
<tr><td colspan="3">Agency Endpoints based on Time-weighted Average Concentrations</td></tr>
<tr>
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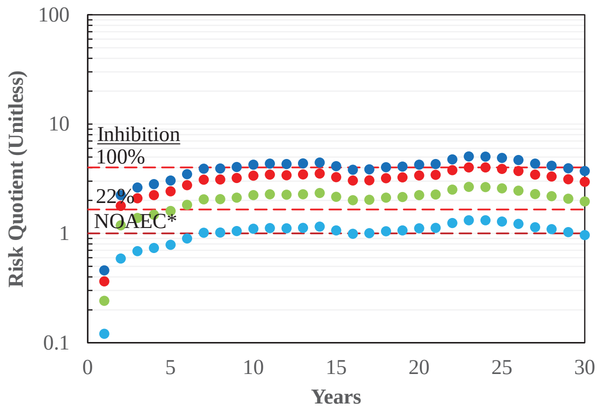

*Based on a NOAEC of 1.51 µg/L
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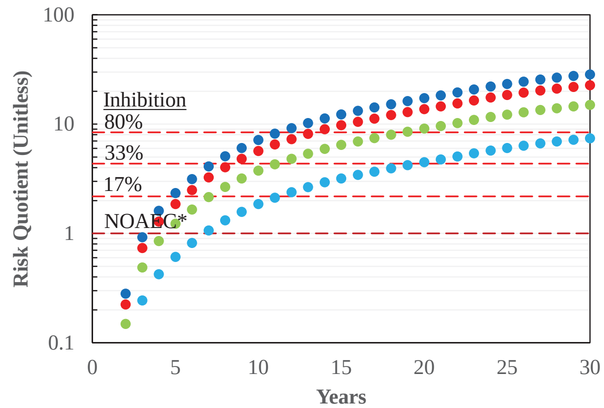

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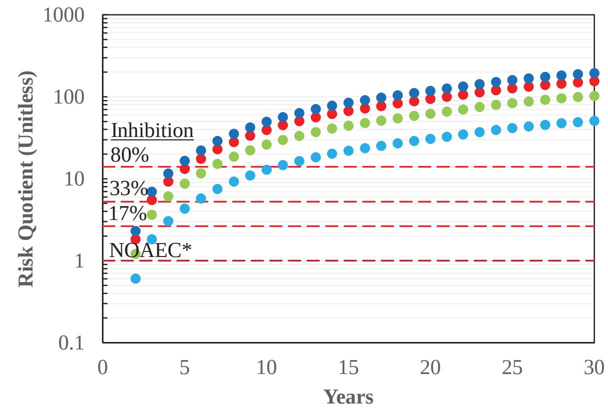

*Based on a NOAEC of 0.28 µg/L
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<tr><td colspan="3">Registrant-suggested Endpoints</td></tr>
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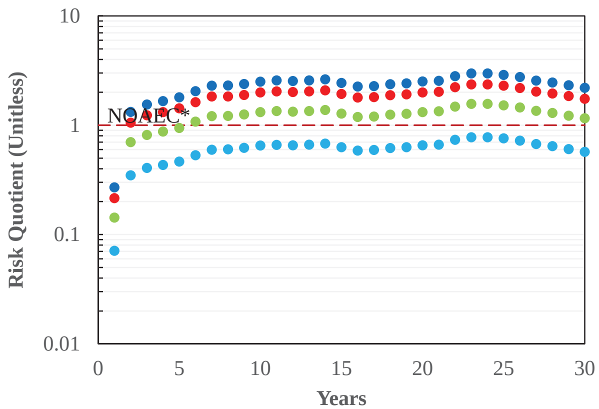

*Based on a NOAEC of 2.56 µg/L
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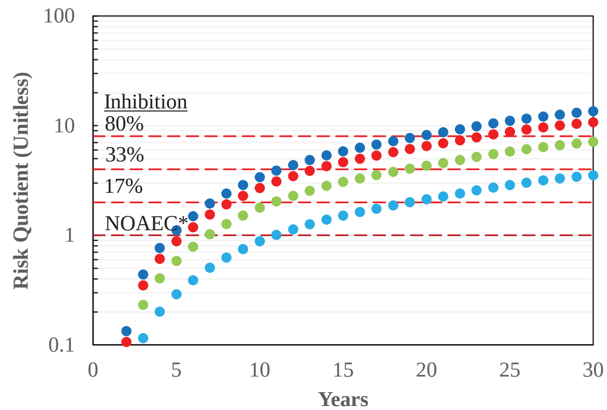

*Based on a NOAEC of 4.0 µg/L
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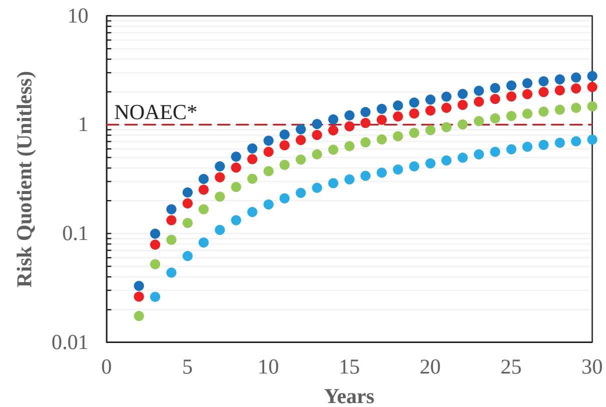


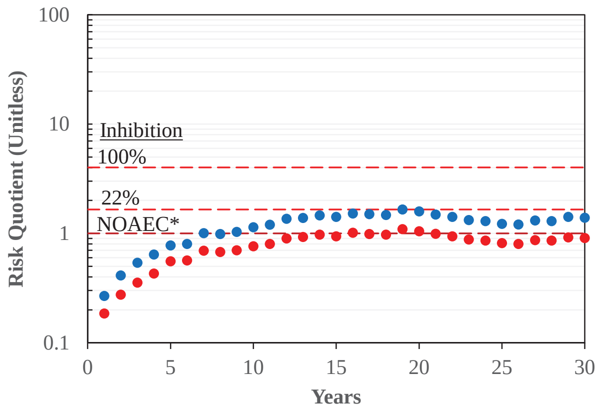
*Based on a NOAEC of 19.5 µg/L
</td>
</tr>
<tr><td colspan="3">Four applications per year for 30 years
Three applications per year for 30 years
Two applications per year for 30 years
One application per year for 30 years</td></tr>
</table>

Appendix 2 Figure 1. Continued.

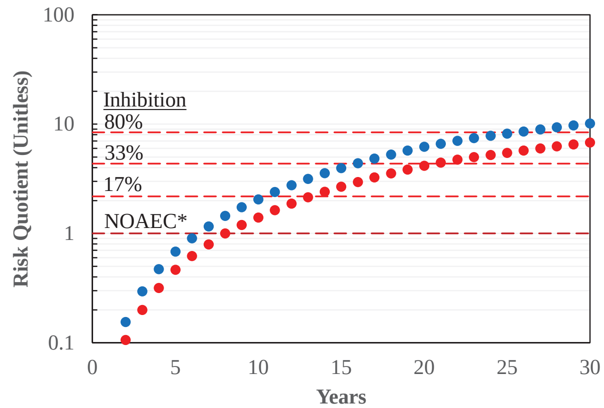
Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water

Tobacco based on NCtobaccoSTD Scenario using a TN Weather File (W13882.dvf; Aerial Application)

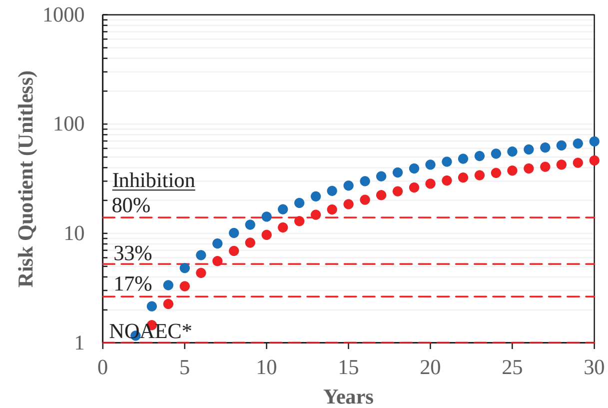
Agency Endpoints based on Time-weighted Average Concentrations



*Based on a NOAEC of 1.51 µg/L

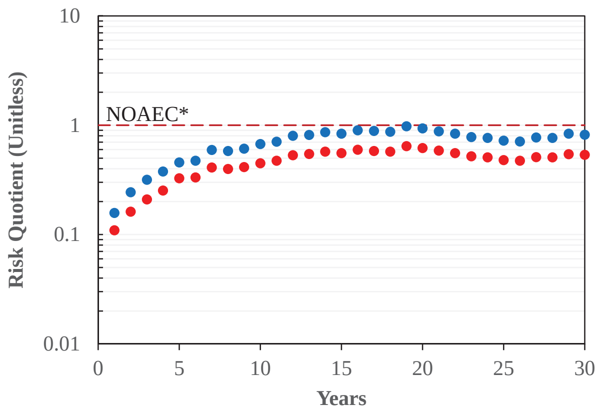


*Based on a NOAEC of 1.89 µg/L

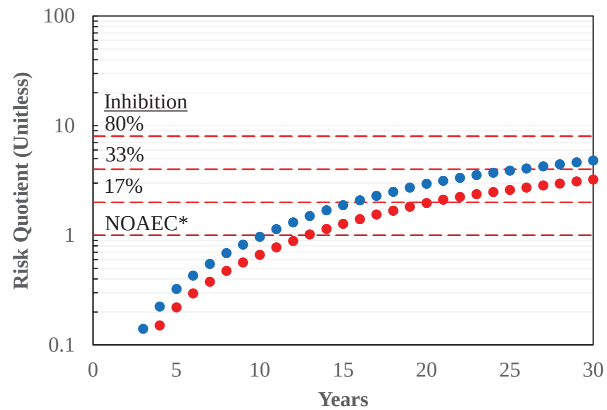


*Based on a NOAEC of 0.28 µg/L

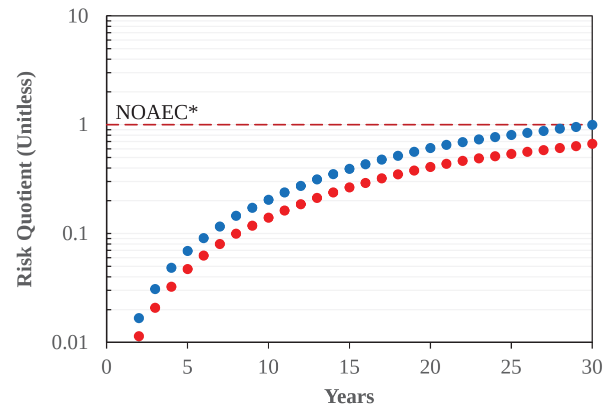
Registrant-suggested Endpoints



*Based on a NOAEC of 2.56 µg/L



*Based on a NOAEC of 4.0 µg/L



*Based on a NOAEC of 19.5 µg/L

● Two applications per year for 30 years

● One application per year for 30 years

Appendix 2 Figure 1. Continued.

<table>
<tr><th>Flubendiamide</th><th colspan="2">Des-iodo</th></tr>
<tr><th>Benthic Pore Water</th><th>Overlying Water</th><th>Benthic Pore Water</th></tr>
<tr><th colspan="3">Tobacco based on NCtobaccoSTD Scenario using a TN Weather File (W13882.dvf; Ground Application)</th></tr>
<tr><td colspan="3">Agency Endpoints based on Time-weighted Average Concentrations</td></tr>
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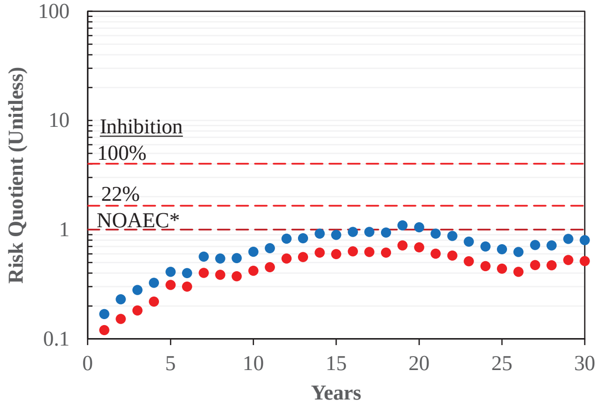
<td>

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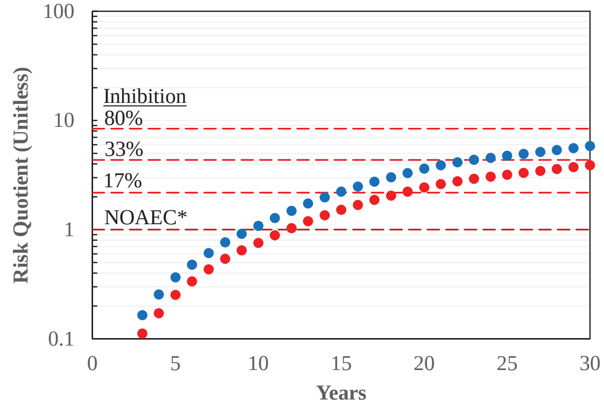
<td>

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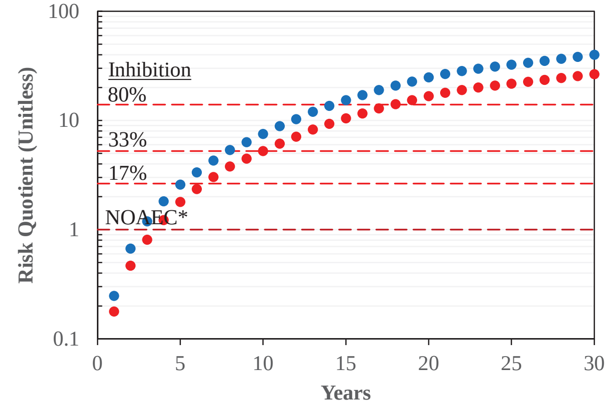
<td>

*Based on a NOAEC of 0.28 µg/L</td>
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<tr><td colspan="3">Registrant-suggested Endpoints</td></tr>
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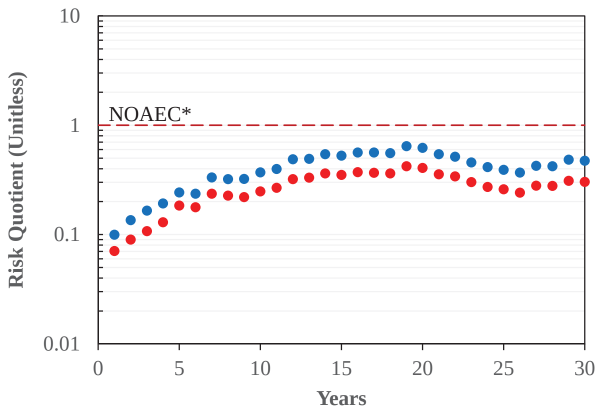
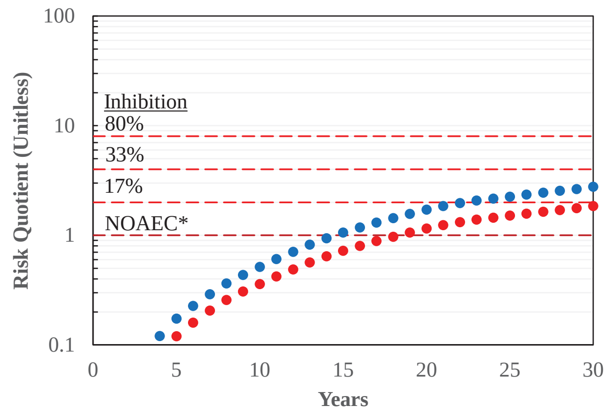
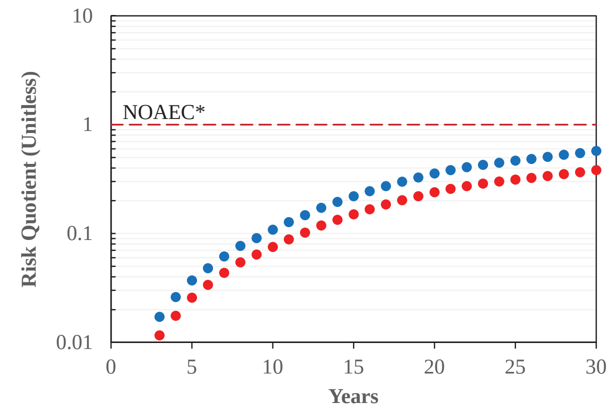
<td>

*Based on a NOAEC of 2.56 µg/L</td>
<td>

*Based on a NOAEC of 4.0 µg/L</td>
<td>

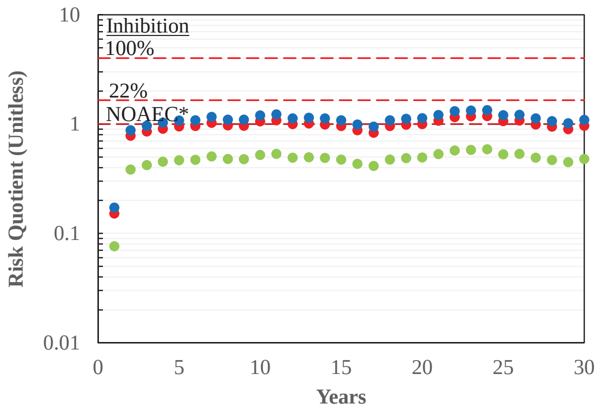
*Based on a NOAEC of 19.5 µg/L</td>
</tr>
<tr><td colspan="3">● Two applications per year for 30 years
● One application per year for 30 years</td></tr>
</table>

Appendix 2 Figure 1. Continued.

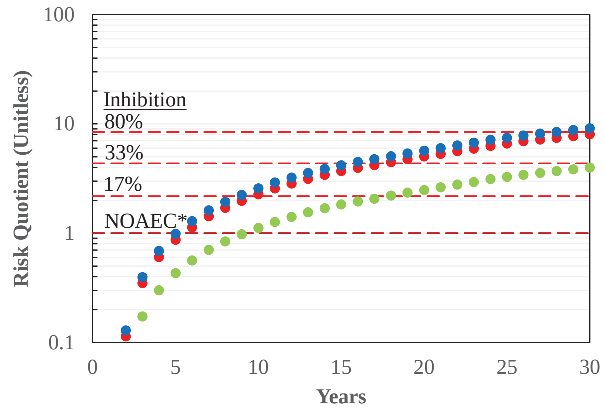
Flubendiamide	Des-iodo	
Benthic Pore Water	**Overlying Water**	**Benthic Pore Water**

Tree Nuts based on CAalmond_WirrigSTD Scenario (Airblast Application)

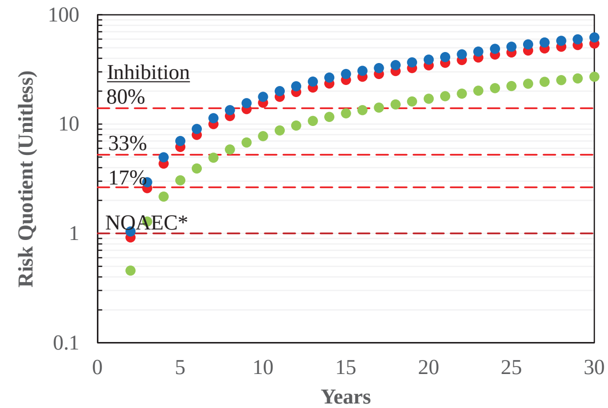
Agency Endpoints based on Time-weighted Average Concentrations



*Based on a NOAEC of 1.51 µg/L

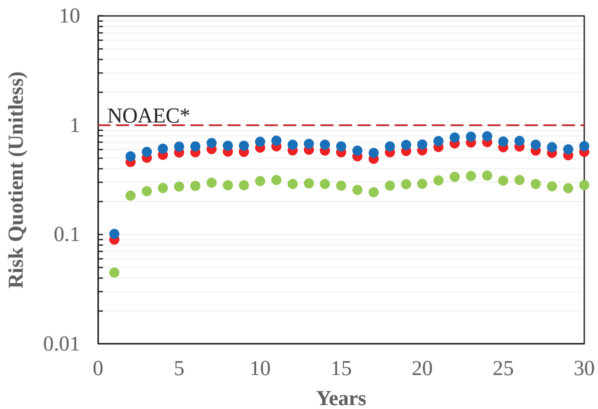


*Based on a NOAEC of 1.89 µg/L

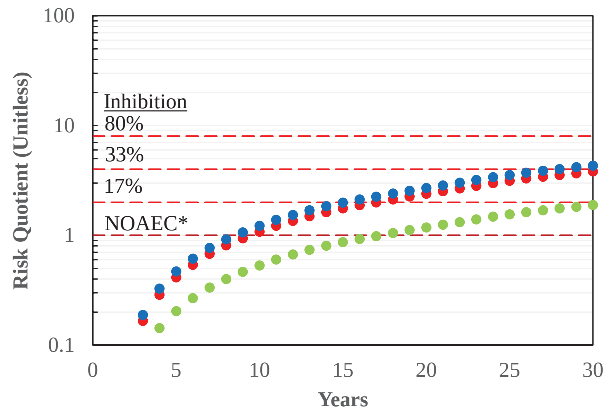


*Based on a NOAEC of 0.28 µg/L

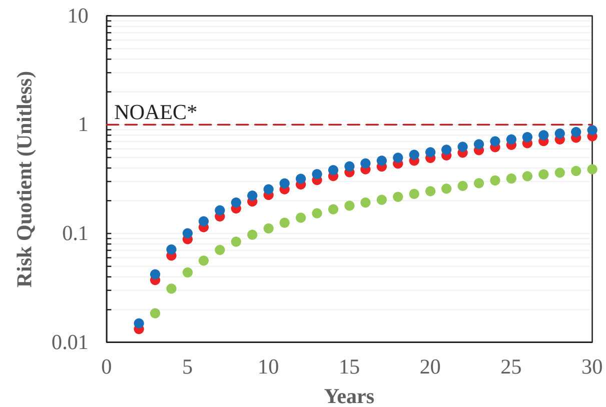
Registrant-suggested Endpoints



*Based on a NOAEC of 2.56 µg/L



*Based on a NOAEC of 4.0 µg/L



*Based on a NOAEC of 19.5 µg/L

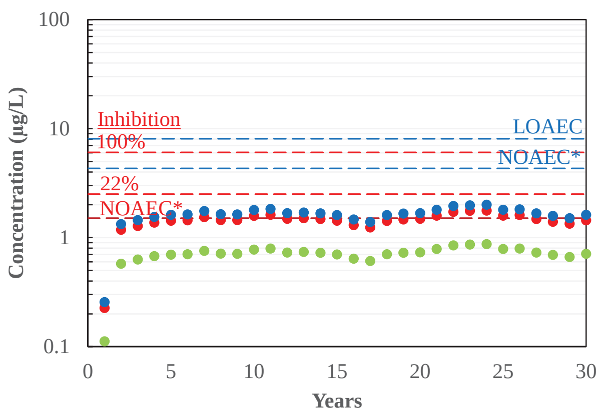
- Three applications per year for 30 years
- Two applications per year for 30 years
- One application per year for 30 years

Appendix 2 Figure 1. Continued.

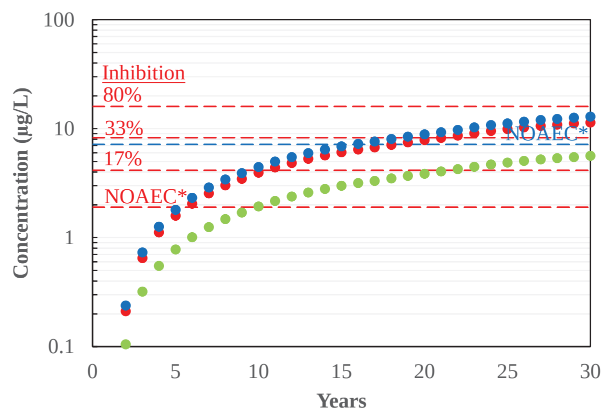
Appendix 3. Results of the Tree Nut and Cucurbit vegetable Use Assessments with the Des-iodo Aqueous Photolysis Half-life Included.

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water
Tree Nut Assessment based on CA Almond Scenario (Airblast Application with Maximum Photolysis Rate and 30-ft Spray Drift Buffer)		

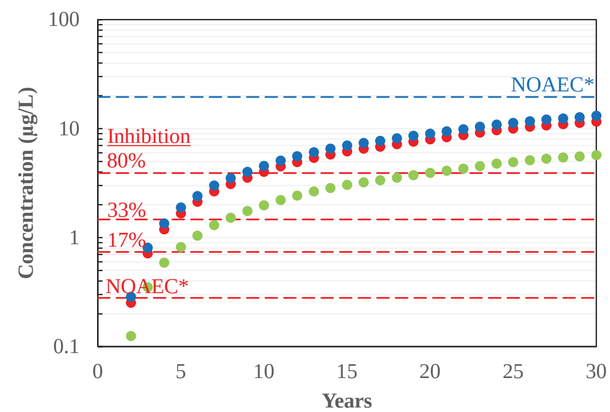
Agency Endpoints based on Time-weighted Average Concentrations



*Based on NOAECs of 1.51 µg/L (**red** dashed lines and labels; MRID 46817022 – spiked water) or 4.32 µg/L (**blue** dashed lines; MRID 49661801 – spiked sediment).

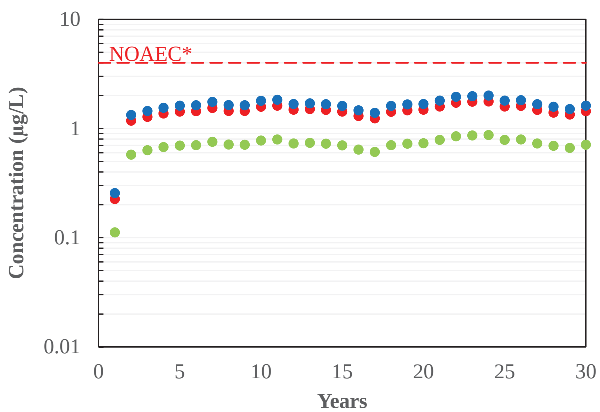


*Based on a NOAEC of 1.89 µg/L (**red** dashed lines and labels; MRID 46817023 – spiked water) or 7.18 µg/L (**blue** dashed line; MRID 48175605 – spiked sediment).

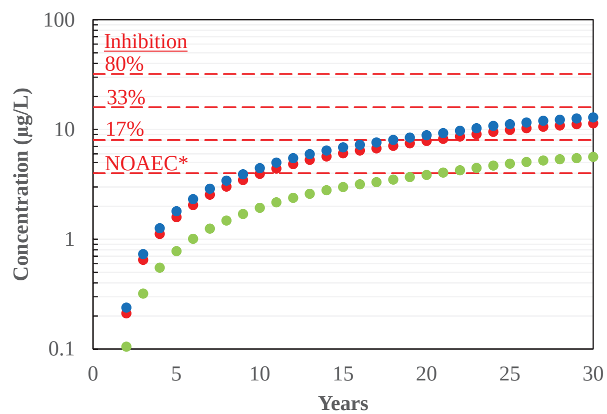


*Based on a NOAEC of 0.28 µg/L (**red** dashed lines and labels; MRID 46817023 – spiked water) or 19.5 µg/L (**blue** dashed line; MRID 48175605 – spiked sediment).

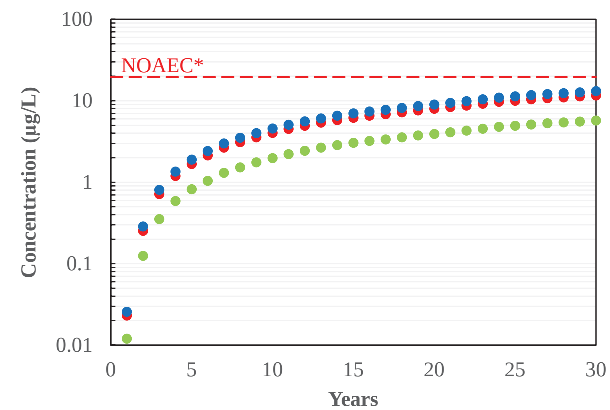
Registrant-suggested Endpoints



*Based on a NOAEC of 2.56 µg/L



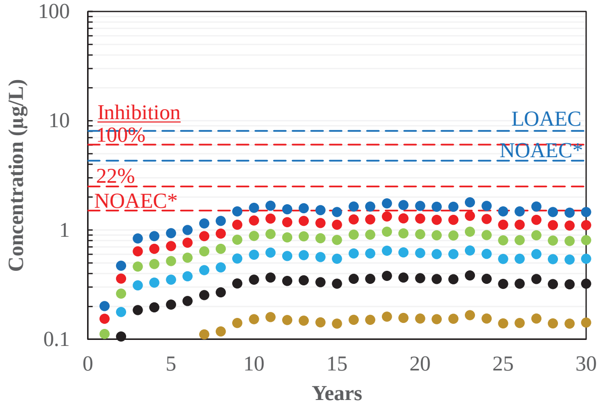
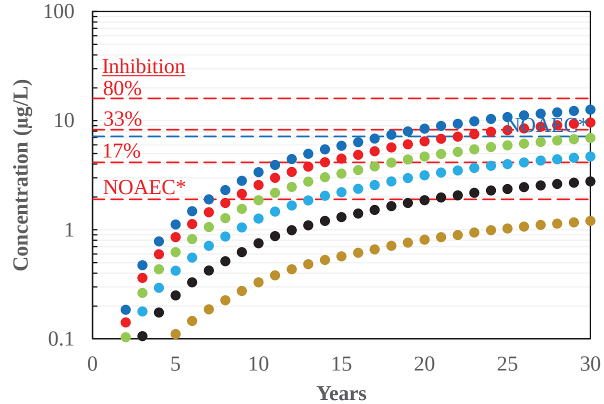
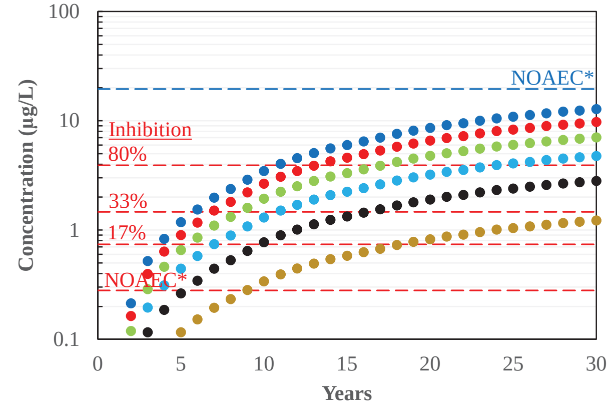
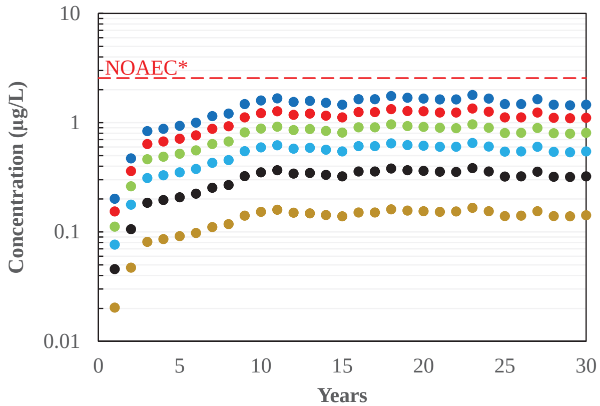
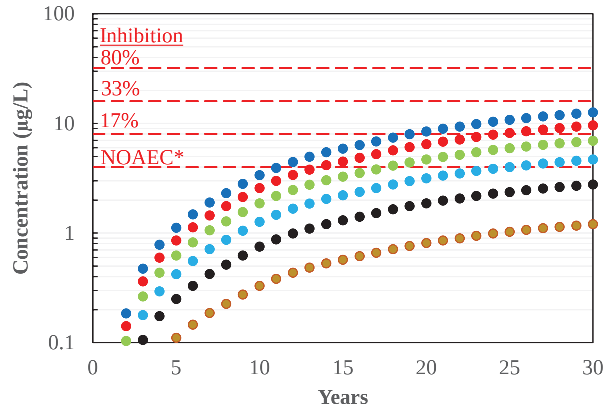
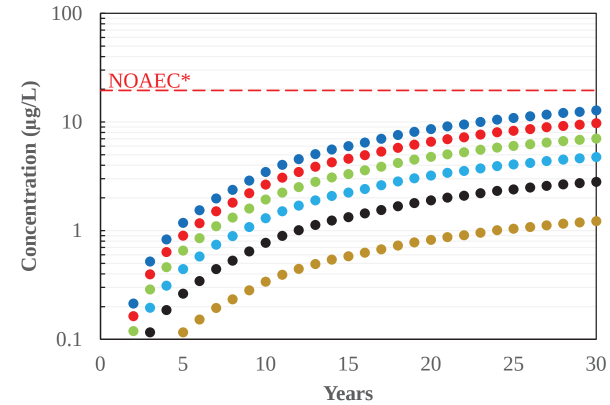
*Based on a NOAEC of 4.0 µg/L



*Based on a NOAEC of 19.5 µg/L

● Three applications per year for 30 years
● Two applications per year for 30 years
● One application per year for 30 years

Appendix 3 Figure 1. Comparison of Time-weighted Average Concentration Endpoints and Registrant-suggested Endpoints for the Tree Nut Scenario

Flubendiamide	Des-iodo	
Benthic Pore Water	Overlying Water	Benthic Pore Water
Cucurbit Vegetable based on CAMelonsRLF_V2 Scenario (Ground Application with Maximum Photolysis Rate and 30-ft Spray Drift Buffer)		
Agency Endpoints based on Time-weighted Average Concentrations		
		
*Based on NOAECs of 1.51 µg/L (**red** dashed lines and labels; MRID 46817022 – spiked water) or 4.32 µg/L (**blue** dashed lines; MRID 49661801 – spiked sediment).	*Based on a NOAEC of 1.89 µg/L (**red** dashed lines and labels; MRID 46817023 – spiked water) or 7.18 µg/L (**blue** dashed line; MRID 48175605 – spiked sediment).	*Based on a NOAEC of 0.28 µg/L (**red** dashed lines and labels; MRID 46817023 – spiked water) or 19.5 µg/L (**blue** dashed line; MRID 48175605 – spiked sediment).
Registrant-suggested Endpoints		
		
*Based on a NOAEC of 2.56 µg/L	*Based on a NOAEC of 4.0 µg/L	*Based on a NOAEC of 19.5 µg/L
● Six applications per year for 30 years ● Five applications per year for 30 years ● Four applications per year for 30 years ● Three applications per year for 30 years ● Two applications per year for 30 years ● One application per year for 30 years		

Appendix 3 Figure 2. Comparison of Time-weighted Average Concentration Endpoints and Registrant-suggested Endpoints for the Cucurbit Vegetable Scenario.

Appendix 4. Flubendiamide Chemical Parameter Inputs to the Surface Water Concentration Calculator