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OFFICE OF
CHEMICAL SAFETY AND
POLLUTION PREVENTION

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MEMORANDUM

DATE: February 19, 2013

SUBJECT: Environmental Fate and Ecological Risk Assessment in Support of the Section 3 Registration of the New Chemical Kasugamycin.

TO: Shaunta Hill, Ph.D., Risk Manager Reviewer
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FROM: Melissa Panger, Ph.D., Senior Scientist
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The Environmental Fate and Effects Division (EFED) has completed the environmental fate and ecological risk assessment in support of the Section 3 registration decision on the new agricultural antibiotic kasugamycin (PC Code 230001). Kasugamycin is being proposed for use on orchards (*i.e.*, apple, pear, and walnut) applied as a foliar spray up to four times per year via ground equipment at a maximum single application rate of 0.084 lb a.i./acre (0.094 kg a.i./ha); and fruiting vegetables, with a proposed single maximum application rate of 0.021 lb a.i./acre (0.024 kg a.i./ha) and up to three applications allowed per year.

The results of this screening-level risk assessment indicate that the proposed pome fruit and walnut uses have chronic risk quotients (RQs) that exceed the listed and non-listed species levels of concern for mammals (chronic RQs range from 0.01 to 2.3). Additionally, risk to listed terrestrial plants (monocots) is an uncertainty due to the absence of adequate data to fully assess risks to

terrestrial plants. Direct effects to birds (and, thus, reptiles and terrestrial-phase amphibians), fish (and, thus, aquatic-phase amphibians), aquatic invertebrates, aquatic plants, and non-listed terrestrial plants are not expected from the proposed kasugamycin uses.

The effects of the potential reduction or alteration of the microorganism community from the proposed kasugaycin uses are unknown and are beyond the scope of this risk assessment. Therefore, the potential risks to the environment from the potential impacts to non-target microorganisms from the use of kasugamycin represent an uncertainty in this risk assessment.

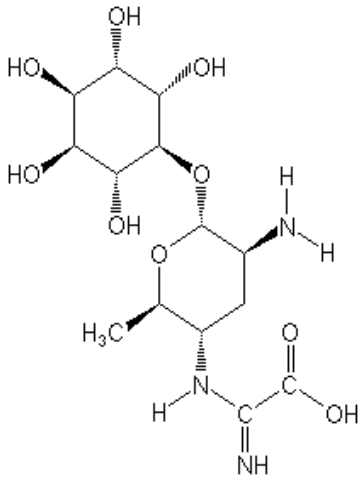
Labeling Recommendations

According to the Label Review Manual, the following label statements are recommended:

Environmental Hazards

> "Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwater or rinsate."

Environmental Fate and Ecological Risk Assessment for the Registration of the New Chemical Kasugamycin



Kasugamycin
[1L-1,3,4/2,5,6-1-Deoxy-2,3,4,5,6-penta-a-hydroxycyclohexyl 2-amino-2,3,4,6-tetradeoxy-4-(α-iminoglycino)-α-D-arabino-hexopyranoside hydrochloride hydrate]
CAS No. 19408-46-9

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

I. EXECUTIVE SUMMARY

A. Nature of Chemical Stressor

Kasugamycin is a new agricultural antibiotic that is proposed for registration by the registrant Arysta LifeScience for use on fruiting vegetables (greenhouse and field tomato/pepper), pome fruit (apple and pear), and walnut. The one kasugamycin end-use product being proposed for registration is KASUMIN® 2L (liquid formulation; 2.3% kasugamycin hydrochloride; equivalent to 2.0% kasugamycin) (EPA EST. No.: 075703-JPN-001). Kasugamycin would be applied as a foliar spray up to four times per year via ground equipment at a maximum single application rate of 0.084 lb a.i./acre (0.094 kg a.i./ha) for the orchard uses (*i.e*., apple, pear, and walnut) according to the proposed label. For fruiting vegetables, the proposed single maximum application rate is 0.021 lb a.i./acre (0.024 kg a.i./ha) with up to three applications allowed per year.

Kasugamycin is produced from *Streptomyces kasugaensis* and belongs to the aminoglycoside class of compounds, a group of antibiotics that inhibit protein synthesis. This class also includes streptomycin, apramycin, kanamycin, paromomycin, and neomycin, some of which have human and/or veterinary medicinal uses. Although it has been previously reported that kasugamycin has never been employed as a human or veterinary-use antibiotic because it is only active against phytopathogenic fungi and bacteria (USEPA, 2005), it has been used clinically to treat urinary tract infections due to *Pseudomonas aeruginosa* (Schuwirth *et al*., 2006).

The use of antibiotics on crops, although minor relative to total antibiotic use, can result in situations that impact the buildup of resistant microorganisms. For example, antibiotics used as agricultural pesticides, such as the proposed uses of kasugamycin, can be applied over large areas of land to densely vegetated fields and orchards. This can lead to the proliferation and rapid spread of resistant genes in the microbial population. Although, kasugamycin may be most active against bacteria or fungi that cause adverse effects to plants, there is evidence to suggest that resistance established in one type of bacteria can be spread to other strains or species of bacteria (via plasmids) (O'Brien, 2002). Although the probability is low, there is a potential for bacterial resistance to cross between plant and human bacteria (McManus and Stockwell, 2001). We highlight the possibility here due to the potential seriousness of the public health threat associated with antibiotic resistance.

B. Conclusions - Exposure Characterization

Kasugamycin is a zwitterion, that is applied as kasugamycin hydrochloride, an acid, and dissociates into its salt immediately after application. Kasugamycin is more likely to sorb to soil (especially clay) in lower pH environments and is mostly present in solution at pH values < 3.23. Kasugamycinic acid will be mostly present in solution between pH values 3.23 to 7.73, and kasuganobiosamine will be mostly present in solution from pH 7.73 to 11.

Kasugamycin is not considered volatile and is not likely prone to atmospheric transport. While kasugamycin is subject to both abiotic (aqueous photolysis and alkaline hydrolysis) and biotic (primarily aerobic metabolism) degradation, its two primary degradates, *i.e*., kasugamycinic acid and kasuganobiosamine, are expected to persist in the environment for varying lengths of time. Due to the uncertainty of the behavior and toxicity of these degradates, the toxicity is assumed to be equivalent to the parent compound, kasugamycin. According to the FAO classification system based on organic carbon partitioning coefficients, kasugamycin is characterized as mobile to moderately mobile. Based on the octanol-water partition coefficient, the compound is not expected to bioaccumulate (K_{ow} = 0.0196).

For the aquatic exposure modeling, a total toxic residue approach, considering the parent compound and the two degradates (kasuganobiosamine and kasugamycinic acid) was used. Peak estimated environmental concentrations (EECs) ranged from 0.41 to 6.53 µg/L for use on apples using the Oregon standard scenario for apples and peppers using the Florida standard scenario, respectively.

Since kasugamycin is a relatively new chemical, no monitoring data were found when searching the California Department of Pesticide Regulation (CDPR) surface water database and USGS NAWQA surface water and ground water database. Likewise, no monitoring data were found for the two degradates, kasugamycinic acid and kasuganobiosamine.

C. Conclusions - Effects Characterization

Based on the available data and EPA's ecotoxicity categories, kasugamycin is classified as practically nontoxic to freshwater and estuarine/marine fish, freshwater and estuarine/marine invertebrates, birds, mammals, and terrestrial invertebrates on an acute exposure basis. Chronic exposure resulted in no statistically significant (confidence level α=0.05) effects at the highest concentration tested (9.5 mg a.i./L) in freshwater fish. There are currently no chronic toxicity data available for aquatic invertebrates (a chronic daphnid study was submitted but it was classified as invalid due to poor reproductive performance in the controls) or estuarine/marine fish (no data have been submitted). Chronic exposure in birds resulted in reduced 14-day survivors (NOAEC = 450 mg a.i./kg-diet). In mammals, chronic exposure resulted in reduced body weights and reduced weight gain (NOAEL = 13.7 mg a.i./kg-bw).

For terrestrial plants, all of the EC_{25} values were less than the limit test application rate and the NOAEC values were equal to the limit test application rate in the vegetative vigor study, for both monocotyledenous (monocot) and dicotyledenous (dicot) plants (*i.e*., EC_{25}< 0.0964 lb a.i./acre and NOAEC = 0.0964 lb a.i./acre). In the seedling emergence study, the EC_{25} values were less than the limit test application rate and the NOAEC was equal to the limit test application rate for all dicots tested (*i.e*., EC_{25}< 0.0925 lb a.i./acre and NOAEC = 0.0925 lb a.i./acre). For monocots, all of the EC_{25} values were <0.0925 lb a.i./acre, however, the NOAEC values for corn and wheat were < 0.0925 lb a.i./acre based on statistically significant reduced dry weight (18% and 37% inhibition,

respectively, compared to controls). Additionally, although not statistically significant, onion had inhibitions in dry weight of 26%. The most sensitive nonvascular aquatic plant tested was the freshwater cyanobacteria (blue-green algae) *Anabaena flos-aquae* with an EC_{50} value of 0.65 mg a.i./L and a NOAEC value <0.08 mg a.i./L based on a reduction in cell density; vascular aquatic plants were several orders of magnitude less sensitive with an EC_{50} value of 86 mg a.i./L.

D. Potential Risks to Non-target Organisms

The results of this screening-level risk assessment indicate that the proposed pome fruit and walnut uses have chronic risk quotients (RQs) that exceed the listed and non-listed species levels of concern for mammals (chronic RQs range from 0.01 to 2.3). Additionally, risk to listed terrestrial plants (monocots) is an uncertainty due to the absence of adequate data to fully assess risks to terrestrial plants. Direct effects to birds (and, thus, reptiles and terrestrial-phase amphibians), fish (and, thus, aquatic-phase amphibians), aquatic invertebrates, aquatic plants, and non-listed terrestrial plants are not expected from the proposed kasugamycin uses.

Table 1: Screening-Level Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Kasugamycin.

LISTED TAXON	POTENTIAL DIRECT EFFECTS	POTENTIAL INDIRECT EFFECTS
Terrestrial and semi-aquatic plants - monocots	Yes[1] (all uses)	Yes[2]
Terrestrial and semi-aquatic plants - dicots	No	Yes[2]
Birds	No	Yes[2]
Terrestrial-phase amphibians	No	Yes[2]
Reptiles	No	Yes[2]
Mammals	Yes (chronic; pome fruit and walnut uses)	Yes[2]
Aquatic plants	No	Yes[2]
Freshwater fish	No	Yes[2]
Aquatic-phase amphibians	No	Yes[2]
Freshwater crustaceans	No	Yes[2]
Mollusks	No	Yes[2]
Marine/estuarine fish	No	Yes[2]
Marine/estuarine crustaceans	No	Yes[2]

[1] Risk to this taxon is an uncertainty due to that fact that a NOAEC could not be established in the available data.
[2] The potential for adverse effects to those species that rely on mammals or those obligated to monocots cannot be precluded. Indirect effects may include general habitat modification, host plant loss, and food supply disruption.

E. Uncertainties

Since aerobic soil metabolism data are only available on one soil type and data are recommended on four soil types, there is uncertainty regarding the potential variability associated with aerobic soil metabolism rates (MRIDs 47945718).

The soil column leaching study (MRID 479457-15) was performed using three foreign soils that could not be identified as typical of pesticide use areas in the United States. Thus, there is uncertainty surrounding the leaching potential of kasugamycin,

kasugamycinic acid, and kasuganobiosamine, as it relates to US soils. To inform this uncertainty, it would be helpful to have a crosswalk describing the type of soils between the foreign soils and representative US soils. Additionally, the preferred batch equilibrium method of measuring sorption coefficients only examined sorption in four soils when this measurement is recommended for five soils. Therefore, sorption in the natural environment may be more variable than that reflected for the four soils (MRID 479457-14). It is important to have sorption coefficients of all representative soils in order to provide a more accurate assessment when calculating exposure. Otherwise, there is an uncertainty in whether the calculated aquatic exposure values are conservative enough. Chemicals may be more or less mobile depending on the soil and the organic matter content.

An area depicted as Area-1 in a chromatogram for the anaerobic aquatic metabolism study (MRID 479457-21) was a major degradate at a maximum of 16.2% of the applied at 63 days, but was not seen at termination of the study. This degradate was not identified as one of the residues of concern, kasuganobiosamine or kasugamycinic acid, but it was believed to have been an intermediate that may have formed one of those two degradates from kasugamycin. As a result, Area-1 is an uncertainty.

There are currently no toxicity data available for the two primary degradates (kasugamycinic acid and kasuganobiosamine), so their toxicity is an uncertainty. Because of this uncertainty, the two degradates are assumed to be equally toxic as the parent.

Acceptable toxicity data are not available to assess the effects of kasugamycin to freshwater invertebrates from chronic exposure or estuarine/marine mollusks from acute exposure. The submitted chronic daphnid study is classified as invalid because there was poor reproductive performance in the controls (*i.e.*, the controls averaged less than 60 young per adult). Based on the available data, aquatic invertebrates would need to be significantly more sensitive on a chronic exposure basis than an acute exposure basis for a chronic risk LOC to be exceeded (*i.e.*, aquatic invertebrates would need to be >11,885 times more sensitive to kasugamycin on a chronic exposure basis than on an acute exposure basis to exceed the chronic LOC of 1). Since this is unlikely given the toxicity profile for this chemical, risk to aquatic invertebrates from chronic exposure to kasugamycin is not expected, and additional data would not likely alter our risk conclusions.

The submitted estuarine/marine mollusk study (MRID 47945724) is classified as supplemental because the average shell growth in the controls (1.9 mm) did not meet the minimum 2.0 mm for new shell growth during the study. Although the 1.9 mm is close to the recommended 2.0 mm, the shell growth inhibition would have been 50% in the 33 mg a.i./L concentration group if the controls had met the 2.0 mm minimum for new growth. Therefore, the results from this study should not be used quantitatively in risk assessment. However, even if the EC_{50} was 33 mg a.i./L (the concentrations where effects on shell growth were observed) in the mollusk study, the resulting RQ [*i.e.*, <0.001 (6.53 µg a.i./L (peak EEC)/33,000 µg a.i./L)] is less than the Agency's acute risk LOC for aquatic animals. Therefore, the likelihood of direct risk to aquatic animals from

acute exposure to kasugamycin from the proposed uses is considered low, and additional data would not likely alter our risk conclusions.

For dicots, none of the RQs for kasugamycin exceed the Agency's listed species LOC (RQ>1.0) for terrestrial plants based on results from the TerrPlant v. 1.2.1 (RQs range from <0.1 to 0.46). For monocots, onion and wheat had inhibitions in dry weight of 26% and 37%, respectively, in the seedling emergence study (corn also had a statistically significant inhibition of 18%). These effects were seen at a limit concentration rate (0.0925 lb a.i./acre) above the currently proposed maximum application rate (0.084 lb a.i./acre). Off the site of application, TerrPlant assumes exposure levels to non-target plants via runoff is roughly 50% of the application rate. If effects are linear (which is an assumption since there is no dose-response information from the Tier I plant study), the effects in non-target plants found adjacent to the site of application would be below the 20% effect level. Under these assumptions, risks to non-listed monocots would not be expected. However, because definitive no-effect values were not established for monocots in the seedling emergence study, risk to listed monocots from the proposed use of kasugamycin is an uncertainty.

Additionally, bacteria serve an essential role in cycling nutrients and energy in the environment (*e.g.*, through decomposition of organic materials and Nitrogen-fixation). The effects of the potential reduction or alteration of the microorganism community from the proposed kasugaycin uses are unknown and are beyond the scope of this risk assessment. Therefore, the potential risks to the environment from the potential impacts to non-target microorganisms from the use of kasugamycin represent an uncertainty in this risk assessment.

II PROBLEM FORMULATION

The purpose of this assessment is to evaluate the environmental fate and ecological risks for the registration of the new chemical kasugamycin (1L-1,3,4/2,5,6-1-Deoxy-2,3,4,5,6-penta-a-hydroxycyclohexyl 2-amino-2,3,4,6-tetradeoxy-4-(α-iminoglycino)-α-D-arabino-hexopyranoside hydrochloride hydrate) (PC Code: 230001). As a new fungicide/bactericide being proposed for use in the United States, EPA is required under the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) to ensure that kasugamycin does not have the potential to cause unreasonable adverse effects to the environment. Potential effects to listed species (*i.e.*, species on the federal list of endangered and threatened wildlife and plants) are also considered under the Endangered Species Act in order to ensure that the registration of kasugamycin is not likely to jeopardize the continued existence of such listed species or adversely modify their habitat. To these ends, this assessment follows EPA guidance on conducting ecological risk assessments (USEPA 1998) and the Office of Pesticide Program's policies for assessing risk to non-target and listed organisms (USEPA 2004).

Among the end products of the EPA pesticide registration process is a determination of whether a product is eligible for registration and, if so, a description of how the product may be used. A label represents the legal document which stipulates how and where a given pesticide may be used. End-use labels describe the formulation type, acceptable methods of application, where the product may be applied, and any restrictions on how applications may be conducted. Thus, the use, or potential use, described by the pesticide's labels is considered "the action" being assessed. This assessment is in support of the new chemical registration of kasugamycin.

A. Stressor Source and Distribution

1. Source and Intensity

Kasugamycin, an antibiotic used as a fungicide, is a new chemical that is undergoing registration (as the active ingredient in one manufacturing product and one end-use product) by the registrant Arysta LifeScience. The kasugamycin end-use product being proposed for registration in the United States is KASUMIN® 2L [2.3% kasugamycin hydrochloride (equivalent to 2.0% kasugamycin)] (EPA EST. No.: 075703-JPN-001). According to the proposed label, the product would be used to control fireblight in pome fruit (apple and pear), walnut blight in walnut, and bacterial speck and bacterial spot in fruiting vegetables (greenhouse and field tomato and pepper). Only the proposed field uses for tomatoes and peppers, along with the proposed pome fruits and walnut uses, will be assessed here, since the greenhouse uses are indoor uses that would not result in outdoor exposures. Kasugamycin would be applied as a foliar spray via ground application.

2. Physical/Chemical/Fate and Transport Properties

Kasugamycin is a fungicide/bactericide that belongs to the aminoglycoside class of compounds. The aminoglycosides also include the antibiotics streptomycin, apramycin,

kanamycin, paromomycin, and neomycin. Kasugamycin is applied as kasugamycin hydrochloride, an acid, and dissociates into an salt immediately after application. . Kasugamycin is mostly present in solution at pH values < 3.23, while kasugamycinic acid will be mostly present in solution between pH values 3.23 to 7.73, and kasuganobiosamine will be mostly present in solution from pH 7.73 to 11.

Kasugamycin is also a zwitterion, which means it contains a carboxylic acid fragment and an amino group. This means that in more acidic pHs, kasugamycin will act more like a cation. As a result, kasugamycin is more likely to sorb to soil (especially clay) in lower pH environments. As the pH increases, the zwitterion will act more like an anion, and will be less likely to sorb to soil. The major routes of degradation for kasugamycin are aqueous photolysis**,** aerobic biodegradation**,** and hydrolysis. Its major routes of degradation are aqueous photolysis**,** aerobic biodegradation**,** and hydrolysis.

Based on the United Nations' Food and Agriculture Oranganization (FAO) Mobility classification[1] and organic carbron partition coefficient (K_{oc}) values, kasugamycin is classified as mobile to moderately mobile. Biodegradation studies of kasugamycin parent produced kasugamycinic acid under aerobic and anaerobic conditions and kasuganobiosamine under anaerobic conditions. The mobility of kasugamycin acid and kasuganobiosamine is expected to be similar to or greater than the parent compound. Therefore, they will likely range from highly mobile to moderately mobile.

Kasugamycin is highly soluble in water with an aqueous solubility of 228 g/L at 25ºC. The compound is not expected to bioaccumulate with an octanol-water partition coefficient (K_{ow}) of 0.0196 at 23°C and pH 5 With a vapor pressure of 1.3×10^{-2} torr at 25°C, the compound does not appear to volatilize (MRID 479457-19).

3. Pesticide Type, Class, and Mode of Action

Kasugamycin is an antibiotic/bactericide produced from *Streptomyces kasugaensis* and belongs to the aminoglycoside class of antibiotics that inhibit protein synthesis. This class also includes streptomycin, apramycin, kanamycin, paromomycin, and neomycin, some of which have human and/or veterinary medicinal uses. Although it has been previously reported that kasugamycin has never been employed as a human or veterinary-use antibiotic because it is only active against phytopathogenic fungi and bacteria (USEPA, 2005), it has been used clinically to treat urinary tract infections caused by *Pseudomonas aeruginosa* (Schuwirth *et al*., 2006).

4. Overview of Pesticide Usage

[1] FAO. 2000. Appendix 2. Parameters of pesticides that influence processes in the soil. In FAO Information Division Editorial Group (Ed.), *Pesticide Disposal Series 8. Assessing Soil Contamination. A Reference Manual*. Rome: Food & Agriculture Organization of the United Nations (FAO). Available at **http://www.fao.org/DOCREP/003/X2570E/X2570E06.htm** (Accessed July 10, 2009).

Since this is a new chemical, the Agency does not have any usage information for kasugamycin. The proposed registration is for fruiting vegetables, pome fruits, and walnuts. Kasugamycin is a fungicide/bactericide that is applied as a foliar spray (via ground equipment) up to four times per year at a maximum application rate of 0.084 lb a.i./acre/application (maximum proposed annual application rate is 0.336 lb a.i./acre). There is one kasugamycin end-use product being proposed for registration in the United States. The proposed formulation is KASUMIN® 2L [a liquid formulation containing 2.3% kasugamycin hydrochloride (equivalent to 2% kasugamycin; 0.168 lb a.i./gallon of product)]. According to the proposed label, the product would be used to control bacteria which causes fire blight in pome fruit (*e.g.*, *Erwinia amylovora*), walnut blight in walnuts (*Xanthom onas campestris pv. juglandis*), and bacterial speck (*Pseudomonas syringae pv. tomato*) and bacterial spot (*Xanthomonas campestris pv. vesicatoria*) in fruiting vegetables.

B. Receptors

1. Aquatic and Terrestrial Effects

Table 2 gives examples of taxonomic groups and species tested to help understand potential ecological effects of pesticides to non-target organisms. Within each of these very broad taxonomic groups, a measure of effect from either acute or chronic exposure is selected from the available test data.

Table 2 Taxonomic Groups and Test Species Evaluated for Ecological Effects in Screening-Level Risk Assessments.

Taxonomic Group	Example(s) of Representative Species
Birds[1]	Mallard duck (*Anas platyrhynchos*) Bobwhite quail (*Colinus virginianus*)
Mammals	Laboratory rat (*Rattus norvegicus*)
Terrestrial invertebrates	Honey bee (*Apis mellifera L.*)
Freshwater fish[2]	Bluegill sunfish (*Lepomis macrochirus*) Rainbow trout (*Oncorhynchus mykiss*)
Freshwater invertebrates	Water flea (*Daphnia magna*)
Estuarine/marine fish	Sheepshead minnow (*Cyprinodon variegatus*)
Estuarine/marine invertebrates	Mysid (*Americamysis bahia)* Eastern oyster (*Crassostrea virginica*)
Terrestrial plants[3]	Monocots – corn (*Zea mays*) Dicots – soybean (*Glycine max*)
Aquatic plants and algae	Duckweed (*Lemna gibba*) Green algae (*Pseudokirchneriella subcapitata*)

[1] Birds represent surrogates for amphibians (terrestrial phase) and reptiles.
[2] Freshwater fish may be surrogates for amphibians (aquatic phase).
[3] Four species of two families of monocots, of which one is corn; six species of at least four dicot families, of which one is soybeans.

2. Ecosystems Potentially at Risk

The ecosystems potentially at risk include the areas adjacent to the application sites and water bodies adjacent to the application sites and downstream. In addition, organisms

that use the application site as part of their habitat (*e.g.*, birds foraging for insects within application areas) are also considered to be part of the ecosystems potentially at risk.

C. Assessment Endpoints

FIFRA Part 158 guideline toxicity tests (CFR 40 §158.630, 2009) are intended to determine pesticidal effects on a variety of organisms, including birds, mammals, fish, terrestrial and aquatic invertebrates, and plants. These tests include both short-term and long-term exposure periods and evaluate the survival, reproduction, and/or growth of laboratory species. The studies, when available, are used to evaluate the potential of a pesticide to cause adverse effects, to determine whether further testing is required, and to determine the need for precautionary label statements to minimize the potential adverse effects to non-target animals and plants (CFR 40 §158.630, 2009).

Assessment endpoints are intended to represent valued attributes of the environment that, if detrimentally altered, could pose a risk to the environment. The assessment endpoints of this ecological risk assessment include terrestrial and aquatic animal and plant mortality following acute exposure to kasugamycin and terrestrial and aquatic animal reproduction, growth and survival effects from chronic exposure to kasugamycin. Surrogate species are used to represent all freshwater fish (2000+) and bird (680+) species in the United States. For mammals, acute studies are usually limited to the Norway rat or the house mouse. Usually data from estuarine/marine testing are limited to a crustacean, a mollusk, and a fish. The assessment of risk or hazard makes the assumption that avian toxicity is similar to terrestrial-phase amphibians and reptiles, unless more appropriate data are available. The same assumption is made for fish and aquatic-phase amphibians. The most sensitive toxicity endpoints are used from surrogate test species to estimate treatment-related direct effects on mortality and reproductive and growth assessment endpoints.

For terrestrial and semi-aquatic plants, the screening assessment endpoints for non-target species (crops and non-crop plant species) are based on the emergence of seedlings and vegetative vigor of annuals. Measures of effect for this assessment focus on impacts on plant emergence and/or on active growth.

For aquatic plants, the assessment endpoint is the maintenance and growth of standing crop or biomass. Measures of effect for this assessment focus on nonvascular, *e.g.*, algae, and vascular plant, *e.g.*, duckweed (*Lemna gibba*), growth rates and biomass measurements.

The Agency acknowledges that pesticides have the potential to exert indirect effects upon listed organisms by, for example, perturbing forage or prey availability, altering the extent of nesting habitat, and creating gaps in the food chain. In conducting a screen for indirect effects, the endpoints for each taxonomic group are used to make inferences concerning the potential for indirect effects upon listed species that rely upon non-listed organisms as resources critical to their life cycle.

The endpoints are typically derived from registrant-submitted studies which have undergone review and were classified as "acceptable" (conducted under guideline conditions and considered to be scientifically valid) or "supplemental" (conditions deviated from guidelines but the results are considered to be scientifically valid). For more details on EFED's study classification system and study guidelines, see USEPA 2004.

Assessment endpoints can also be derived from the open literature. Guidelines for incorporation of open literature into ecological risk assessments are described in USEPA (2004). Toxicity data from the open literature are identified via the ECOTOX[2] search engine, maintained by the U.S. EPA Office of Research and Development (ORD). In order to be included in the ECOTOX database, papers must meet several criteria (again, see USEPA 2004 for details). Data that pass the ECOTOX screen are evaluated relative to the data provided by the registrant, and may be incorporated qualitatively or quantitatively into the risk assessment. Specific studies may warrant inclusion in the risk assessment when:

(1) tested endpoints are more sensitive than those in registrant data;
(2) the test data are based on underrepresented taxa;
(3) the data include ecologically relevant endpoints not normally evaluated in registrant studies

A total of four kasugamycin studies from the open literature were identified in the public version of ECOTOX (available at: http://cfpub.epa.gov/ecotox/quick_query.htm). Three were aquatic studies (*e.g.*, tadpoles and aquatic snails) and one was a terrestrial study (mice) (see **APPENDIX A**). None of the studies are usable for risk assessment purposes; three are published in Japanese and data specific to kasugamycin could not be located in the remaining study. Therefore, no ecotoxicity data from the open literature are included as assessment endpoints.

Although all endpoints are measured at the individual level, they can provide some insight about the potential for adverse effects at higher levels of biological organization (*e.g.* populations and communities). For example, pesticide effects on individual survivorship have important implications for both population rates and habitat carrying capacity.

D. Conceptual Model

The conceptual model used to depict the potential ecological risk associated with kasugamycin is fairly generic and assumes that as a fungicide/bactericide, kasugamycin is capable of affecting terrestrial and aquatic organisms (animals and plants) provided environmental concentrations are sufficiently elevated as a result of proposed label uses. Therefore, we will consider potential exposure as a result of direct applications, spray drift, and runoff.

[2] USEPA 2011. Ecotoxicity database http://cfpub.epa.gov/ecotox/

1. Risk Hypotheses

For this assessment, the risk to non-target organisms is based on potential effects from the application of kasugamycin to the environment. The Agency presumes the following risk hypothesis for this screening level assessment:

> *Based on mode of action, the proposed use patterns, and the sensitivity of non-target aquatic and terrestrial species, the proposed uses of kysugamycin have the potential to reduce survival, reproduction, and/or growth in terrestrial and aquatic animals and plants through direct application, spray drift and/or runoff.*

In order for a chemical to pose an ecological risk, it must reach non-target organisms at concentrations found to cause adverse effects. The assessment of ecological exposure pathways in this assessment includes an examination of the source and potential migration pathways to kasugamycin exposure, and the determination of potential adverse effects on non-target species.

2. Diagram

Application methods for kasugamycin involve foliar spray applications via ground equipment. Ecological receptors that may potentially be exposed to kasugamycin include terrestrial and semi-aquatic wildlife (*i.e.*, mammals, birds, amphibians, terrestrial invertebrates, and reptiles) and plants. In addition, aquatic receptors (*e.g.*, freshwater and estuarine/marine fish and invertebrates, amphibians, and plants) may also be exposed as a result of potential movement of kasugamycin via spray drift and/or runoff from the site of application to aquatic environments. The assessment following the process depicted in **Figure 1** (aquatic exposure) and **Figure 2** (terrestrial exposure) forms the basis for identifying potential endpoints, stressors, and ecological effects associated with kasugamycin use.

Since volatility of kasugamycin does not appear to be an issue, this assessment does not take into account atmospheric transport in estimating environmental concentrations. Exposure to terrestrial animals is based primarily on dietary consumption of foliar residues while aquatic assessments assume that all major potential routes of direct exposure are accounted for.

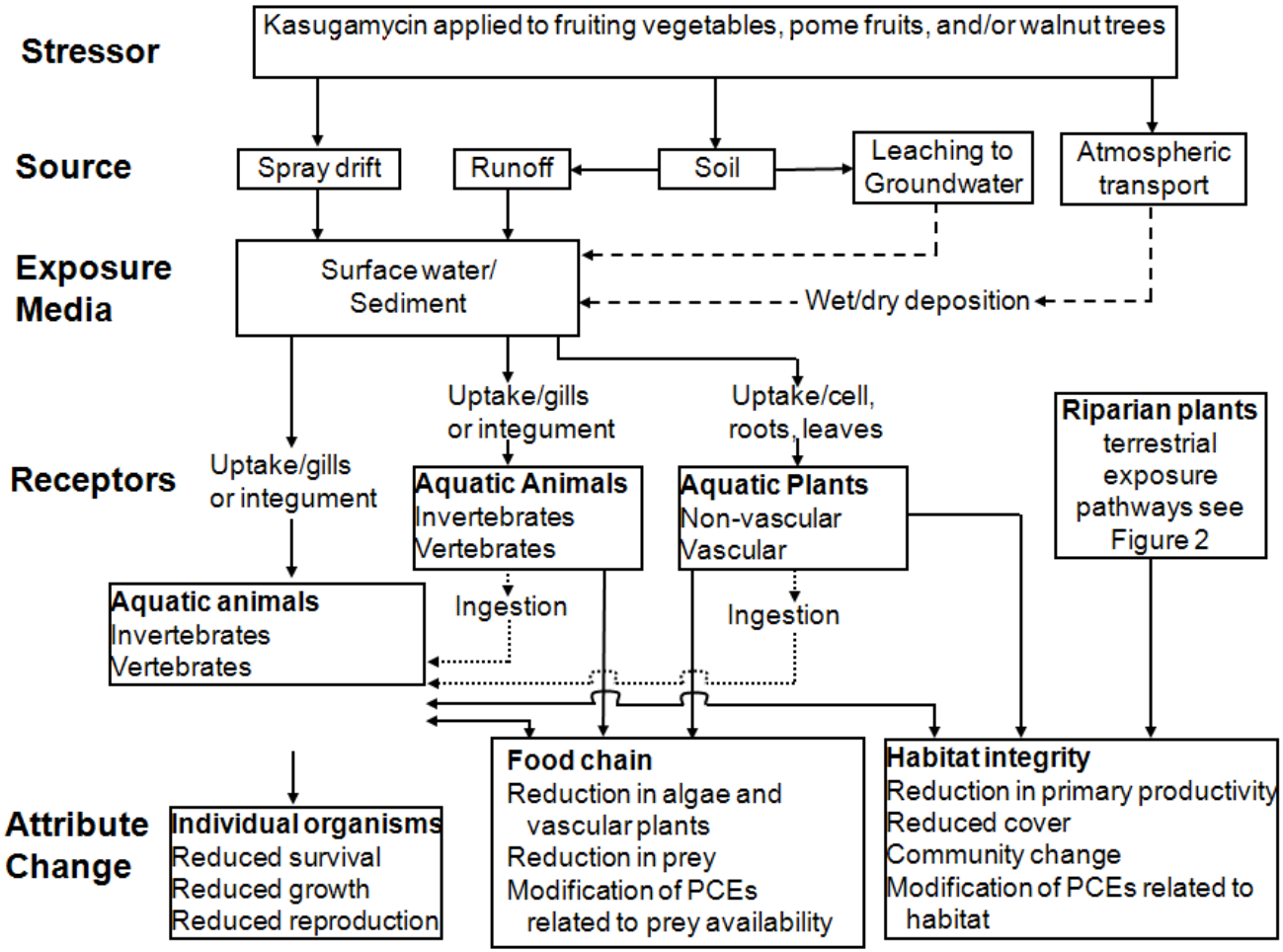

Figure 1: Conceptual model depicting stressors, exposure pathways, and potential effects to aquatic organisms from the proposed uses of kasugamycin. Dotted lines indicate exposure pathways that are hypothesized to have a low likelihood of contributing to ecological risk.

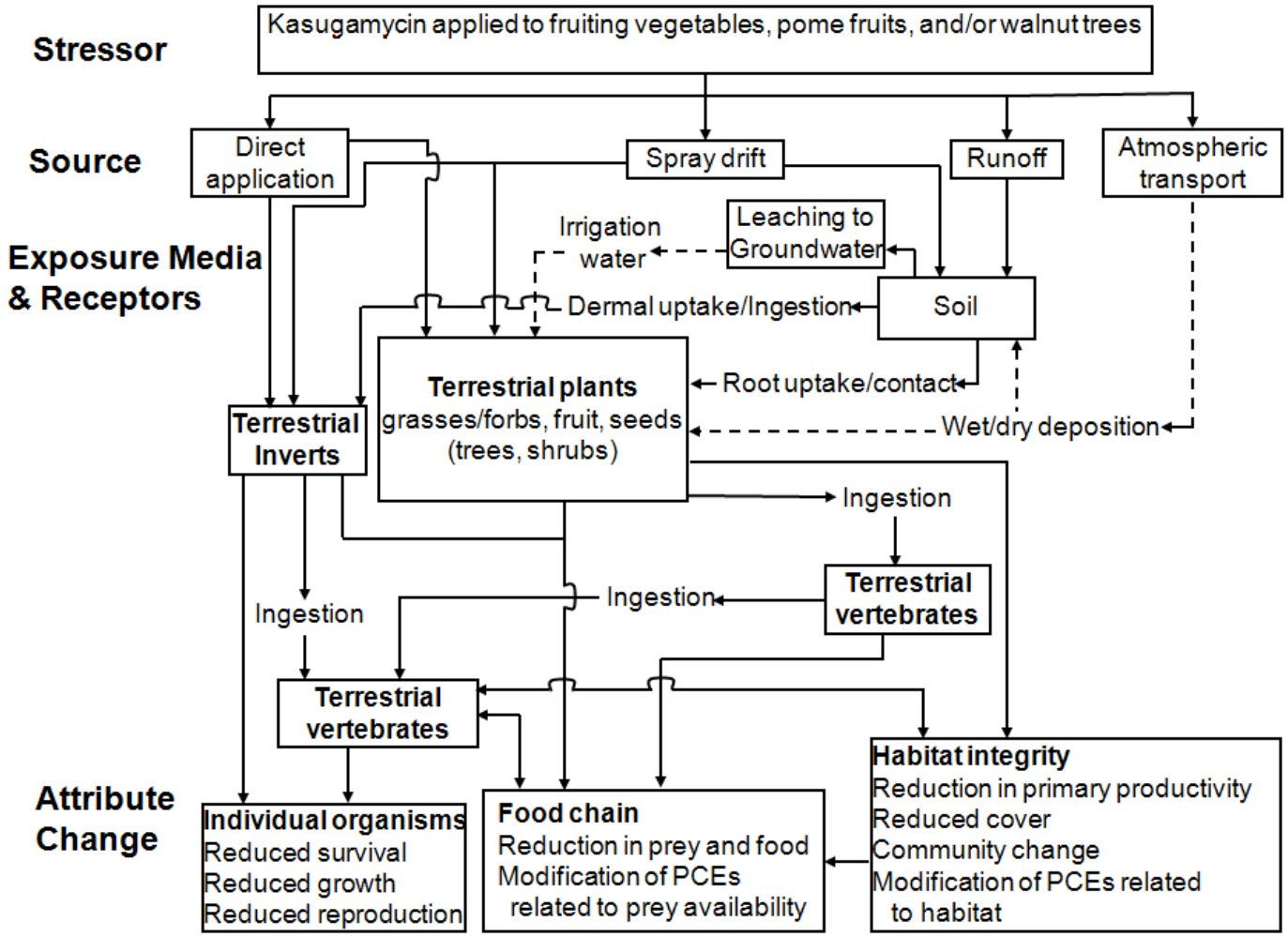

Figure 2: Conceptual model depicting stressors, exposure pathways, and potential effects to terrestrial organisms from the proposed uses of kasugamycin. Dotted lines indicate exposure pathways that are hypothesized to have a low likelihood of contributing to ecological risk.

E. Analysis Plan

As with any pesticide, there is concern regarding the potential effects kasugamycin use may pose to non-target animals and plants. This document characterizes the environmental fate of kasugamycin to assess whether proposed label uses of kasugamycin on fruiting vegetables, pome fruits, and walnuts provide a means of exposure to non-target species. Additionally, the toxicity of kasugamycin is characterized, then both potential exposure and effects are integrated to estimate the likelihood of adverse effects (risk) to non-target Federally listed (endangered or threatened) and non-listed animals and plants that could potentially impact the registration decision of kasugamycin under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Food Quality Protection Act (FQPA), and the Endangered Species Act (ESA).

The maximum proposed label application rates for use of kasugamycin on fruiting vegetables, pome fruits, and walnuts were selected for modeling environmental concentrations for this screening-level deterministic (risk-quotient based) assessment. The most sensitive toxicity endpoints from surrogate test species are used to estimate treatment-related effects on growth, and survival. The aquatic estimated environmental concentrations (EECs) are based on the parent and the two degradates of concern, kasuganobiosamine and kasugamycinic acid, using a total toxic residue (TTR) approach. Because a default 35-day foliar half-life is used in the terrestrial modeling, the terrestrial EECs are expected to account for both the parent and its two degradates of concern (even though only the parent chemical is modeled).

In the following sections, we characterize the use, environmental fate, and ecological effects of kasugamycin and, using a risk quotient (ratio of exposure concentration to effects concentration) approach, we estimate the potential for adverse effects on non-target terrestrial and aquatic animals and plants. Although risk is often defined as the likelihood and magnitude of adverse ecological effects, the risk quotient-based approach does not provide a quantitative estimate of likelihood and/or magnitude of an adverse effect. Such estimates may be possible through a more refined, probabilistic assessment; however, they are beyond the scope of this screening-level assessment.

1. Preliminary Identification of Data Gaps and Methods

The following data gaps and uncertainties were identified in this risk assessment:

Environmental Fate:

Since aerobic soil metabolism data are only available on one soil type and data are recommended to be conducted with four soil types, there is uncertainty regarding the potential variability associated with aerobic soil metabolism rates (MRID 479457-18). To address this uncertainty, the single half life value of 73 days was multiplied by three (per EFED modeling input guidance), resulting in an adjusted value of 273 days. Although this study is classified as supplemental and was used in the modeling, data on

additional soils could help to better characterize the rates of transformation in other soil types.

Ecological Effects:

Acceptable toxicity data are not available to assess the effects of kasugamycin to freshwater invertebrates from chronic exposure or estuarine/marine mollusks from acute exposure. Additionally, the results from the available Tier I terrestrial plant seedling emergence study was not able to establish a NOAEC for three species of monocots.

2. Measures to Evaluate Risk Hypotheses and Conceptual Model

a. Measures of Exposure

In order to estimate risks of kasugamycin exposures in aquatic and terrestrial environments, all exposure modeling and resulting risk conclusions will be made based on maximum proposed application rates as discussed in Section III.B.2.a. Measures of exposure are based on aquatic and terrestrial models that estimate environmental concentrations of kasugamycin using maximum proposed labeled application rates and application methods that have the greatest potential for off-site transport of the chemical. The models used to generate aquatic estimated environmental concentrations (EEC) are the Pesticide Root Zone Model (PRZM) coupled with the EXposure Analysis Model System (EXAMS). The model used to produce terrestrial EECs on food items is T-REX. The model used to derive EECs relevant to terrestrial and wetland plants is TerrPlant. These models are parameterized using relevant reviewed registrant-submitted environmental fate data. Additionally, the Screening Imbibition Program (SIP) and the Screening Tool for Inhalation Risk (STIR) were used to determine if drinking water and/or inhalation, respectively, are potentially significant routes of concern for terrestrial animals.

PRZM (v3.12.2, May 2005) and EXAMS (v2.98.4.6, April 2005) are screening simulation models coupled with the graphical user interface, PE (v5.0, November 2006) to generate daily exposures and 1-in-10-year EECs of kasugamycin that may occur in surface water bodies adjacent to application sites receiving kasugamycin through runoff and spray drift. PRZM simulates pesticide application, movement and transformation on an agricultural field and the resultant pesticide loadings to a receiving water body via runoff, erosion, and spray drift. EXAMS simulates the fate of the pesticide and resulting concentrations in the water body. The standard watershed geometry used for ecological pesticide assessments assumes application to a 10-hectare agricultural field that drains into an adjacent 1-hectare water body that is 2 meters deep (20,000 m^3 volume) with no outlet. The composite model PRZM/EXAMS is used to estimate screening-level exposure of aquatic organisms to kasugamycin. The measure of exposure for aquatic species is the 1-in-10-year peak or rolling mean concentration. The 1-in-10-year peak is used for estimating acute exposures of direct effects to aquatic organisms. The 1-in-10-year 60-day mean is used for assessing the effects to fish and aquatic-phase amphibians

from chronic exposure. The 1-in-10-year 21-day mean is used for assessing the effects on aquatic invertebrates from chronic exposure.

The Residues of Concern Knowledgebase Subcommittee (ROCKS) has determined (DP387527) that parent kasugamycin and its two major degradation products kasuganobiosamine and kasugamycinic acid should be considered as residues of concern (ROC) when evaluating kasugamycin. It is assumed that the toxicity of these two degradates are equivalent to the parent compound and will be assessed using the total toxic residues approach. This approach was used to determine the environmental fate data parameters for modeling in conjunction with the *Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides,* Version 2.1, October 22, 2009 and the draft Guidance for Modeling Pesticides Total Toxic Residues (TTR) May 20, 2009.

The AgDRIFT spray drift model (v2.01; May 2001) is used to assess exposures of organisms to kasugamycin deposited on terrestrial habitats by spray drift.

The registrant has provided a suite of studies pertinent to most Subdivision N guidelines, which provide environmental fate data for these measures of exposure.

b. Measures of Effect

Measures of effect are obtained from a suite of registrant-submitted guideline studies conducted with a limited number of surrogate species. The test species are not intended to be representative of the most sensitive species but rather are selected based on their ability to thrive under laboratory conditions. The acute measures of effect routinely used for listed and non-listed animals in screening level assessments are the LD_{50}, LC_{50} or EC_{50}, depending on taxa (see **Table 3**). LD stands for "Lethal Dose", and LD_{50} is the amount of a material, given all at once, that is estimated to cause the death of 50% of a group of test organisms. LC stands for "Lethal Concentration" and LC_{50} is the concentration of a chemical that is estimated to kill 50% of a sample population. EC stands for "Effective Concentration" and the EC_{50} is the concentration of a chemical that is estimated to produce some measured effect in 50% of the test population. Endpoints for chronic measures of exposure for listed and non-listed animals are the NOAEL or NOAEC. NOAEL stands for "No Observed-Adverse-Effect-Level" and refers to the highest tested dose of a substance that has been reported to have no harmful (adverse) effects on a test population. The NOAEC (*i.e.*, "No-Observed-Adverse-Effect-Concentration") is the highest test concentration at which none of the observed results were statistically different from the control. For non-listed plants, only acute exposures are assessed (*i.e.*, EC_{25} for terrestrial plants and EC_{50} for aquatic plants). For listed terrestrial plants the Agency uses the EC_5 or NOAEC (see **Table 3**).

Consistent with EPA test guidelines, the registrant has provided a suite of ecological effect data that comply with good laboratory testing requirements.

Table 3 Acute and Chronic Measures of Effect.

TAXA	ASSESSMENT	MEASURE OF EFFECT
Aquatic Animals (*Freshwater fish and inverts. and estuarine/marine fish and inverts.*)	Acute	Lowest tested EC_{50} or LC_{50} (acute toxicity tests)
	Chronic	Lowest NOAEC (early life-stage or full life-cycle tests)
Terrestrial Animals *Birds*	Acute/Sub-acute	Lowest LD_{50} (single oral dose) and LC_{50} (subacute dietary)
	Chronic	Lowest NOAEC (21-week reproduction test)
Terrestrial Animals *Mammals*	Acute	Lowest LD_{50} (single oral dose test)
	Chronic	Lowest NOAEC (two-generation reproduction test)
Plants *Terrestrial non-listed (monocots and dicots)*	Acute/Chronic	Lowest EC_{25} (seedling emergence and vegetative vigor)
Plants *Terrestrial listed (monocots and dicots)*	Acute/Chronic	EC_{05} or NOAEC associated with the lowest EC_{25} (seedling emergence and vegetative vigor)
Plants *Aquatic non-listed (vascular and non-vascular)*	Acute/Chronic	Lowest EC_{50}
Plants *Aquatic listed (vascular and algae)*	Acute/Chronic	EC_{05} or NOAEC associated with the lowest EC_{50}

III. ANALYSIS

A. Use Characterization

A Section 18 (Emergency Exemption) allowance was granted for the use of kasugamycin on apples in Michigan (2008). The proposed kasugamycin registration being assessed here is for fruiting vegetables (tomatoes and peppers grown in greenhouses and in the field), pome fruits (apple and pear), and walnuts. Based on National Agricultural Statistics Service (NASS) data (from 2004 and 2006), approximately 422,200 acres of tomatoes; 60,600 acres of bell peppers (for fresh market) (specific national data for other peppers could not be located); 384,460 acres of apples (40% in Washington alone), 63,430 acres of pears, and 214,000 acres of walnuts (all in the state of California) are harvested each year in the United States (see **Figs. 3**, **4**, and **5**). The maps are provided to illustrate that the potential kasugamycin use sites are found throughout much of the US. These represent potential markets for kasugamycin in the United States.

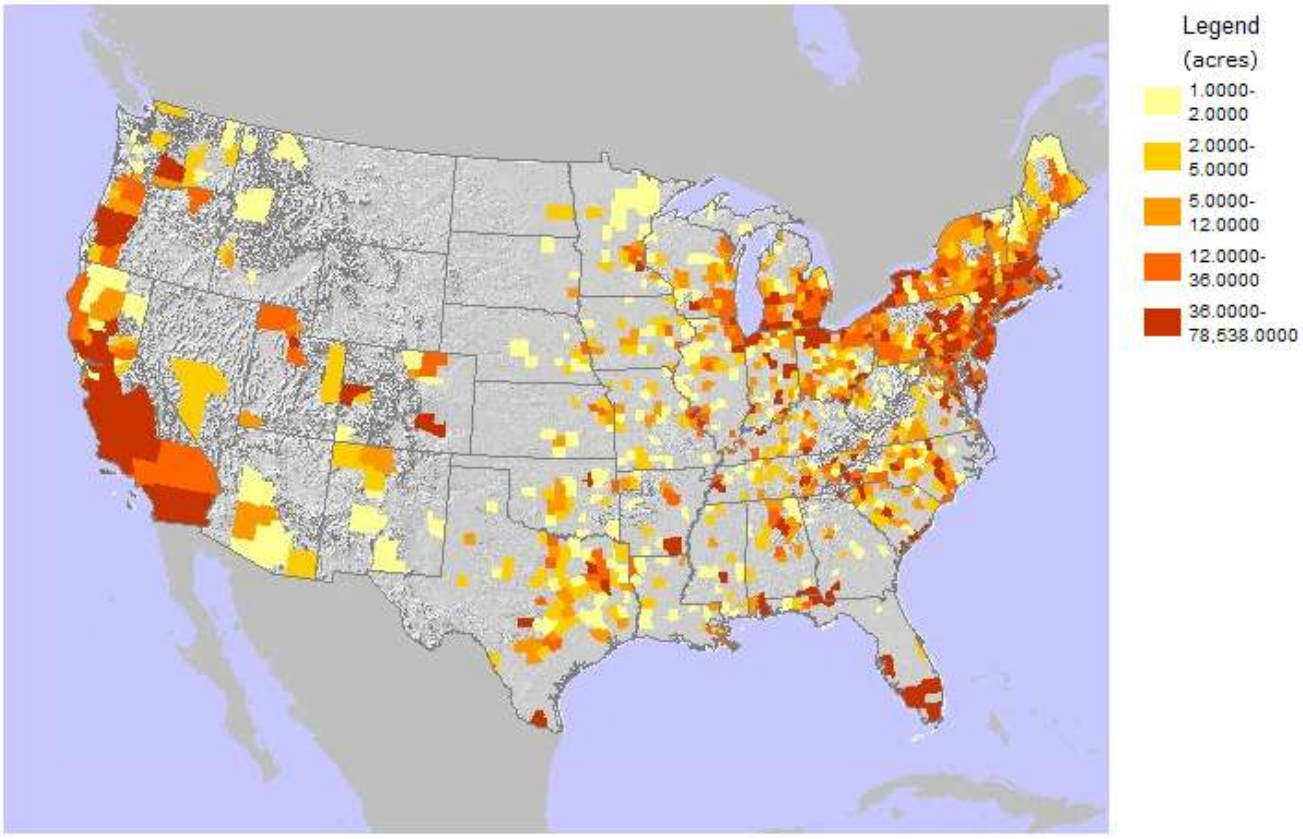

Figure 3 Acres of Tomatoes Harvested By County in the United Stated in 1997 (based on information from USDA-NASS).

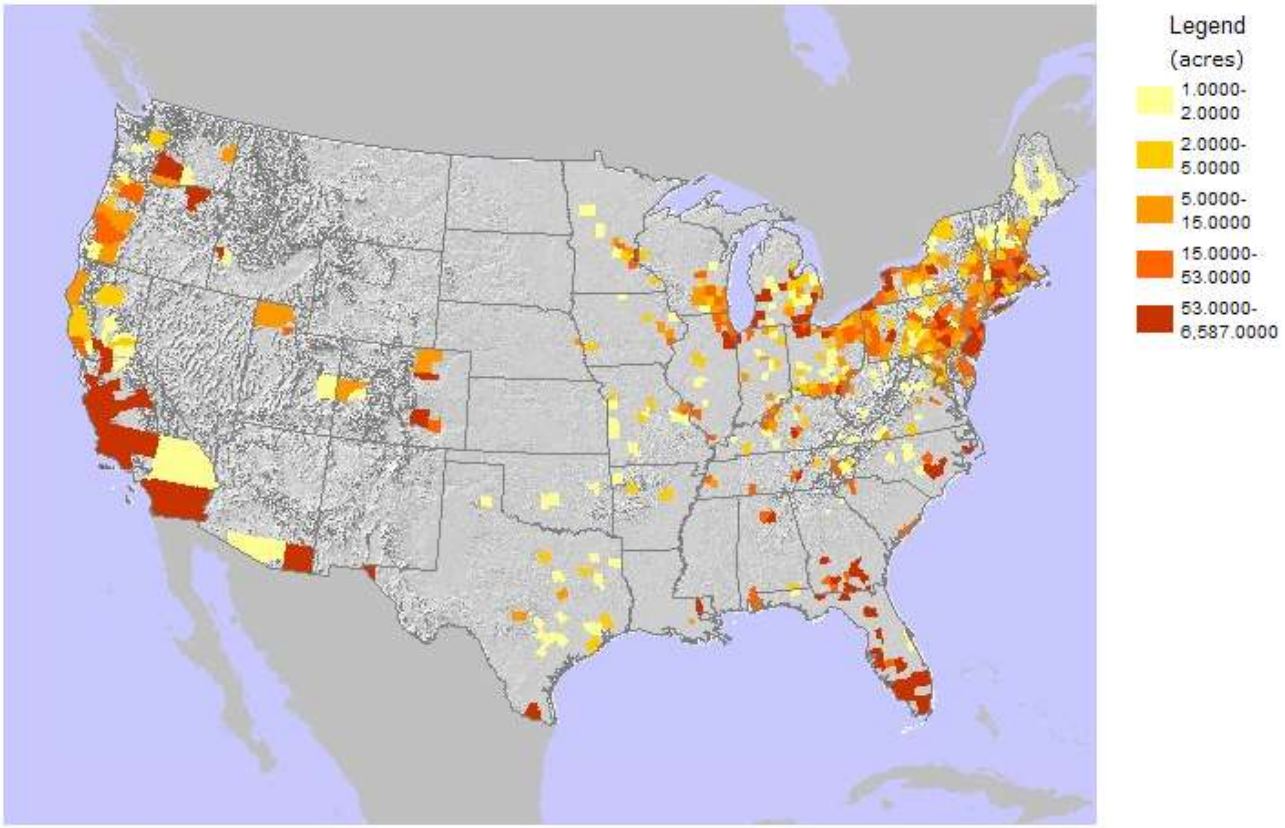

Figure 4 Acres of Sweet Peppers Harvested By County in the United Stated in 1997 (based on information from USDA-NASS).

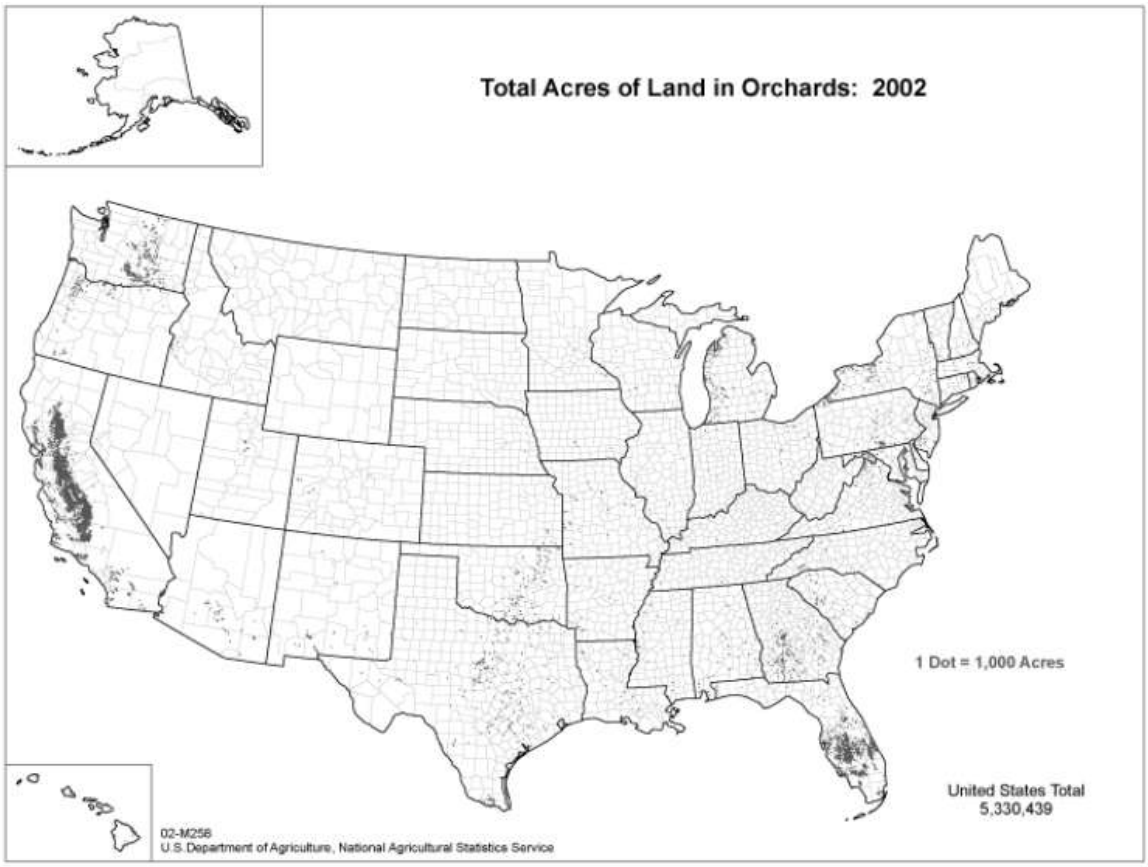

Figure 5 Acres of Land in Orchards in the United Stated in 2002 (based on information from USDA-NASS).

Kasugamycin is applied as a foliar spray via ground equipment. There is one kasugamycin end-use product being proposed for registration in the United States: KASUMIN® 2L (liquid formulation; 2.3% kasugamycin hydrochloride; equivalent to 2.0% kasugamycin; the product does not contain any other active ingredients) (EPA EST. No.: 075703-JPN-001). According to the proposed label, kasugamycin can be applied at a single maximum application rate of 0.084 lb a.i./acre (0.094 kg a.i./ha) and a yearly maximum application rate of 0.336 lb a.i./acre (0.38 kg a.i./ha) for pome fruits and walnuts (see **Table 4**). At most, it can be applied four times per year with a minimum application interval of 3 days (pome fruits).

Table 4 Application Information from the Proposed Kasugamycin Label (KASUMIN 2L; 2.0 % Kasugamycin)[1].

Crop	Maximum Individual Application Rate lbs a.i./A	Number of Applications/ year	Minimum Application Interval (days)	Max Annual Application Rate in lbs a.i./A/year	Application Method	Comments
Fruiting vegetables (tomato/pepper)	0.021	3/season	7	0.063/year	Ground	None
Pome fruit (apple and pear)	0.084	4/year[2]	3	0.336/year	Ground	- Do not make more than two consecutive applications - Do not use alternate tree-row application method - Do not apply after petal fall
Walnut	0.084	4/season	14	0.336/year	Ground	- Do not use alternate tree-row application method

[1] There is 0.168 lb a.i. (kasugamycin) in one gallon of KASUMIN 2L.
[2] This is not specified on the label; it is assumed by dividing the maximum application rate allowed/year (256 fl oz of product) by the maximum single application rate (64 fl oz of product).

B. Exposure Characterization

1. Environmental Fate and Transport Characterization

a. Degradation

Kasugamycin is a fungicide/bactericide that belongs to the aminoglycoside class of compounds. Kasugamycin is applied as kasugamycin hydrochloride, an acid, and dissociates into its salt immediately after application. Kasugamycin is mostly present in solution at pH values < 3.23, while kasugamycinic acid will be mostly present in solution between pH values 3.23 to 7.73, and kasuganobiosamine will be mostly present in solution from pH 7.73 to 11.

Kasugamycin is also a zwitterion, contains a carboxylic acid fragment and an amino group. This means that in more acidic pHs, kasugamycin will act more like a cation. As a result, kasugamycin is more likely to sorb to soil (especially clay) in lower pH environments. As the pH increases, the zwitterion will act more like an anion, and will be less likely to sorb to soil. The major routes of degradation for kasugamycin are aqueous photolysis**,** aerobic biodegradation**,** and hydrolysis.

Abiotic routes of degradaton include photolysis and hydrolysis. In the aqueous photolysis study (MRID 479457-16), the half-life in natural lake water was 17.4 days as opposed to the phototransformation half-life in sterile water of 630 days[3]. The hydrolysis study showed that kasugamycin tends to degrade much faster in neutral to alkaline

[3] This is an adjusted half-life assuming 12 hr days and 12 hr nights.

environments. The hydrolysis half-life at pH 4, 5, 7, and 9 was 462, 630, 79.7, and 11.4 days, respectively (MRID 464855-01).

Biotic routes of degradation include soil and aquatic metabolism under both aerobic and anaerobic conditions. The aerobic aquatic metabolism half-life was approximately 45 days in lake water-loamy sand sediment and river water-clay loam sediment (MRID 479457-20). In soil, the half-life was 73 days in an aerobic clay-loam soil (MRID 479457-18), and 147 days in an aerobic/anaerobic soil metabolism study performed under paddy conditions (MRID 479457-19). The anaerobic aquatic metabolism study total system half-life was 105 days (MRID 479457-21)**.**

Biodegradation studies of kasugamycin parent produced kasugamycinic acid under aerobic and anaerobic conditions and kasuganobiosamine under anaerobic conditions. In these studies, the kasuganomycinic acid was present at 3.1% at 180 days (the termination of the paddy study) in non-sterile soil and 12% in the sterile soil. Kasugamycinic acid was seen at a maximum of 31% after 14 days in the aerobic aquatic metabolism study, but was only present at 0.6% by the termination of the study (100 days). In the anaerobic metabolism study, kasugamycinic acid was present at 29% at termination of the study (368 days) and a maximum of 36% at 185 days into the study. Kasuganoboisamine was a major degradate in the anaerobic aquatic metabolism study alone with 45% present in the total system at study termination (368 days) and a maximum of 48% present in the total system after 277 days. Kasuganobiosamine was also detected in the aerobic aquatic metabolism, but was not quantified. Chemical structures for the parent compound and its principle degradates can be found in **Appendix H**.

b. Mobility and Transport

Based on the FAO Mobility classification[4], kasugamycin is classified as mobile (10 mL/g in sand) to moderately mobile (151 mL/g in sandy clay loam, 345 mL/g in sandy loam, and 364 mL/g in clay loam (MRID 479457-14). At termination (25-33 days) of a soil column leaching study (MRID 479457-15) kasugamycin and its degradates were not found in the leachate. The mobility of kasugamycin acid and kasuganobiosamine is expected to be similar to or greater than the parent compound. Therefore, they will likely range from highly mobile to moderately mobile. Both of these degradates have the potential to be found in drinking water and ground water.

Kasugamycin is highly soluble in water (228 g/L at 25ºC and pH 7). The pK_a for kasugamycin is $pKa_1 = 3.23$ (kasugamycin mostly present in solution at pH values < 3.23), $pKa_2 = 7.73$ (kasugamycinic acid mostly present in solution between pH values 3.23 to 7.73), $pKa_3 = 11.0$ (kasuganobiosamine mostly present in solution from pH 7.73 to 11). With a vapor pressure of 1.3×10^{-2} mPa at 25°C (MRID 479457-19), the

[4] FAO. 2000. Appendix 2. Parameters of pesticides that influence processes in the soil. In FAO Information Division Editorial Group (Ed.), *Pesticide Disposal Series 8. Assessing Soil Contamination. A Reference Manual*. Rome: Food & Agriculture Organization of the United Nations (FAO). Available at **http://www.fao.org/DOCREP/003/X2570E/X2570E06.htm**

compound does not appear to volatilize. The compound is not expected to bioaccumulate with an octanol-water partition coefficient (K_{ow}) of 0.0196 at 23°C and pH 5 (MRID 479457-16).

c. Field Studies

Field dissipation studies of kasugamycin indicate that the compound did not leach nor persist appreciably under the conditions tested. Soil dissipation of kasugamycin under U.S. field conditions was studied using bare plots of loamy sand soil near Madera, California (Site 1), Ephrata, Washington (Site 2), North Rose, New York (Site 3), and Chula, Georgia (Site 4). Dissipation half-lives were only calculated for site 2 (Washington, $t_{1/2}$ = 5.7 days, r^2= 0.88) and site 3 (New York, $t_{1/2}$ = 12.3 days, r^2= 0.46). The compound did not leach further than 0-15 cm in soil from Georgia, New York, and Washington, and not further than the 15-30 cm depth in California soil. The degradate kasugamycinic acid was not detected above the LOQ at any sampling interval. No other degradates were examined in this study. The two dissipation half-lives calculated reflect the residues of the parent compound in the 0-15 cm soil layer as kasugamcyin was only detected at those two sites (MRID 481326-02).

c. Degradates

Major degradates (*e.g.*, those present at ≥10% applied radioactivity) of kasugamycin include:

- kasugamycinic acid (found in aerobic/anaerobic soil metabolism (paddy) study, aerobic aquatic and anaerobic metabolism studies, hydrolysis study, aqueous photolysis study, and soil column leaching study)
- kasuganobiosamine (found in aerobic and anaerobic aquatic metabolism studies, soil column leaching study, and aqueous photolysis study)
- carbon dioxide (CO_2)
- Area-1 (an unidentified degradate found in anaerobic aquatic metabolism study).

For structures of the degradates and the parent, and a summary of studies each degradate was found in along with how much was present please see **Appendix H**.

Area-1 was the name given to an unidentified major degradate in the anaerobic aquatic metabolism study (MRID 479457-21) at a maximum of 16% of the applied at 63 days, but was not seen at termination of the study. This degradate was not identified as the parent compound, kasuganobiosamine, or kasugamycinic acid and is believed to be an intermediate compound; therefore, its similarity to the parent compound is uncertain.

Carbon dioxide was a major degradate in the aerobic aquatic metabolism study (MRID 479457-20) and the aerobic soil metabolism study (MRID 479457-18) at levels up to 46% and 55% of the applied, respectively. It is uncertain if the gas is a degradate produced from hydrolysis because volatiles were not collected in the hydrolysis study. It was a minor photolytic degradate seen at a maximum of 0.2% in the aquatic photolysis study(MRID 479457-16).

Minor (*e.g.*, those present at <10% applied radioactivity) degradates of kasugamycin include a few uncharacterized residues:

- M-1 (found in aerobic aquatic metabolism study at a max of 6.2%)
- M-2 (found in aerobic aquatic metabolism study at a max of 2.2%)
- Area-3 (found in anaerobic aquatic metabolism study at a max of 5.5%)

The Health Effects Division's Residues of Concern Knowledgebase Subcommittee (ROCKS) has previously determined (DP387527) that parent kasugamycin and its two major degradation products, *i.e.*, kasuganobiosamine and kasugamycinic acid, should be considered as the residues of concern (ROC). Therefore, the estimated environmental concentrations (EECs) represent the combined residues of the fungicide/bactericide kasugamycin plus its major degradation products.

2. Measures of Aquatic Exposure

a. Aquatic Exposure Modeling

The environmental fate properties used for modeling for the combined residues are summarized in **Table 5**.

Environmental fate data parameters used in the modeling were selected from the submitted studies in general accordance with *Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides*[5] (Version 2.1, October 22, 2009) and the draft Guidance for Modeling Pesticides Total Toxic Residues (TTR) May 20, 2009. Please note that the half-lives for the hydrolysis study at pH 5 and photolysis study did not need to be recalculated using the TTR method because the two degradates of concern did not form since the parent did not degrade. In addition, the half-life for the aerobic soil metabolism study was not recalculated since neither of the degradates of concern were detected in the study.

Detailed description, documentation, and direct links for running models used for estimating aquatic environmental concentrations can be found at:
http://www.epa.gov/oppefed1/models/water/index.htm

Table 5 Summary of model input parameters used for the ecological risk assessment

Parameter	Modeling Input Value[2]	Basis for selection per Guidance	Source
Molecular Weight	433.84	Parent value	MRID 479457-19
Solubility @ 25 °C	228,000 mg/L @ pH-7	Parent value	MRID 479457-19
Vapor Pressure	9.83×10^{-8} torr	Parent (Most conservative)	MRID 479457-19
Henry's Constant	2.46×10^{-13} atm m^3 /mol	NA	Estimated by Calculation (VP*MW)÷(760*solubility)

[5] http://www.epa.gov/oppefed1/models/water/input_parameter_guidance.htm

Table 5 Summary of model input parameters used for the ecological risk assessment

Parameter	Modeling Input Value[2]	Basis for selection per Guidance	Source
Hydrolysis Half-life[1]	pH 5 = 630 pH 7 = 1155 pH 9 = 6932	Parent, Parent and degradates* Parent and degradates*	MRID 46485501
Aquatic Photolysis Half-life[1]	Stable (630 days)	Parent	MRID 479457-16
Photolysis on soil Half-life [1]	No Data	No Data	No Data
Aerobic Aquatic Metabolism Half-life[1]	45.4 days (Lake water-loamy sand sediment), 44.2 days (River water-clay loam sediment). **upper 90th percentile confidence bound on the mean= 43.3 days**	Parent and degradates**	MRID 479457-20
Anaerobic Aquatic Metabolism Half-life [1]	Stable	Degradate (kasuganobiosamine)	MRID 479457-21
Organic Carbon Partition Coefficient (K_{oc}) (mL/g)	10 (sand), 151 (sandy clay loam), 364 (clay loam), 345 (sandy loam) **Mean = 218**	Parent (Lowest mean K_{oc} of available data)	MRID 479457-14
Ground Spray Drift Application Efficiency	0.01 Ground 0.99 Ground	NA	EFED Guidance
FEXTRA - foliar apps PRZM Foliar Extraction	0.5 (frac/cm rain)	NA	EFED Guidance
Aerobic Soil Metabolism Half-life[1]	73 days (multiply by 3 per guidance = **219 days**)	Parent	MRID 479457-18

[1] Half-lives are re-calculated as per half-life guidance for a ***new set of data*** that ***combine all stressors*** (TTR), so that calculated half-lives represent the decline of all of the species of the TTR when they are present in the study.

*Kasugamycinic acid was the only degradate seen in the study.

**The amount of kasuganobiosamine was not quantified.

The aquatic EECs for the various scenarios and application practices are listed **Table 6.** See **APPENDIX D** for an example of the output from PRZM/EXAMS. Peak EECs ranged from 0.41 to 6.53 µg/L for use on apples using the Oregon standard scenario for apples and peppers using the Florida standard scenario, respectively.

Table 6 Calculated EECs for the use of Kasugamycin on Apples, Pears, Walnuts, Tomatoes, and Peppers based on proposed application rates and intervals.

Crop /Site	Crop Scenario	App Rate (lbsA)	App Rate (kg/ha)	Max # of Apps (Apps/yr)	Interval Between Apps (Days)	App. method	App. Date	Peak EEC ppb	21 Day EEC pbb	60 Day EEC pbb
Apple /Pear	CAfruit_ WirrigSTD	0.084	0.09	4	3	ground	1-Apr	0.54	0.47	0.38
	NCapple STD						3-May	2.10	1.86	1.48
	ORapple STD						30-Apr	0.41	0.37	0.29
	PAapple STD						10-May	1.66	1.43	1.06
Walnut	CAalmond_Wirrig STD				14		2-Aug	2.44	2.10	1.73
	GAPecans STD						21-Sep	4.72	4.28	4.00
	ORfilberts STD						15-Apr	0.76	0.67	0.54
Pepper	FLpeppers STD	0.021	0.024	3	7		15-Nov	6.53	5.57	3.30
Tomato	CAtomato_WirrigSTD						1-Jul	1.49	1.34	1.20
	FLtomato STD						21-Apr	6.28	5.49	4.53
	PAtomato STD						30-Jun	3.00	2.58	2.14

b. Aquatic Exposure Monitoring and Field Data

Kasugamycin is a relatively new chemical, for which there are no monitoring data available. The California Department of Pesticide Regulation (CDPR) surface water database (http://www.cdpr.ca.gov/docs/emon/surfwtr/surfcont.htm and USGS NAWQA surface and ground water database (http://infotrek.er.usgs.gov/apex/f?p=136:1:0::NO:::) were evaluated for available monitoring data of which none were located. Also, no monitoring data on kasuganobiosamine or kasugamycinic acid were found.

3. Measures of Terrestrial Exposure

a. Terrestrial Exposure Modeling

The application method for the proposed kasugamycin use on fruiting vegetables, pome fruits, and walnuts is limited to foliar spray via ground equipment. Therefore, for this terrestrial exposure assessment, we consider only foliar applications. The EEC values used for terrestrial animal exposure are derived from the Kenaga nomograph, as modified by Fletcher *et al.* (1994), based on a large set of actual field residue data. The upper limit values from the nomograph represent the 95th percentile of residue values from actual field measurements (Hoerger and Kenaga, 1972). The Fletcher *et al.* (1994) modifications to the Kenaga nomograph are based on measured field residues from 249 published research papers, including information on 118 species of plants, 121 pesticides,

and 17 chemical classes. These modifications represent the 95th percentile of the expanded data set. Risk quotients are based on the most sensitive LC_{50} and NOAEC for birds (bobwhite quail and mallard duck) and LD_{50} for mammals (based on lab rat studies).

We derive terrestrial estimated environmental concentrations (**Table 7**) for kasugamycin using the maximum proposed single application rates (for plants) and maximum annual application rate (animals). Terrestrial exposure estimates for avian and mammalian risk assessments were derived using the T-REX model (version 1.3.1, December 22, 2006). The default 35-day foliar half-life value was used for modeling EECs on terrestrial food items. A complete description of the input parameters and output is contained in **APPENDIX E**.

Table 7 EECs on Potential Food Items Following Label-Specified Applications of Kasugamycin Using the T-REX Model (ppm).

USE	DIETARY-BASED EECs	KENAGA VALUES Upper Bound
Fruiting vegetables (tomato/pepper)[1]	Short Grass	13.3
	Tall Grass	6.1
	Broadleaf Plants/Small Insects	7.5
	Fruits/Pods/Seeds/Large Insects	0.8
Pome fruit (apple and pear)[2]	Short Grass	73.9
	Tall Grass	33.9
	Broadleaf Plants/Small Insects	41.6
	Fruits/Pods/Seeds/Large Insects	4.6
Walnut[3]	Short Grass	55.8
	Tall Grass	25.6
	Broadleaf Plants/Small Insects	31.4
	Fruits/Pods/Seeds/Large Insects	3.5

[1] Inputs: 3 applications at 0.021 lb a.i./acre with a 7-day application interval.
[2] Inputs: 4 applications at 0.084 lb a.i./acre with a 3-day application interval.
[3] Inputs: 4 applications at 0.084 lb a.i./acre with a 14-day application interval.

Exposure to upland and wetland plants is estimated using the TerrPlant (v1.2.1) screening model. TerrPlant estimates potential exposure from a single application using default assumptions for runoff (5% given solubility is >100 ppm) and spray drift (1% given a ground application of a liquid formulation) (**Table 8**). See **APPENDIX F** for more information.

Table 8 EECs on Plants Following Label-Specified Ground Applications of Kasugamycin Using the TerrPlant Model (lbs a.i./A).

USE	RATE	ADJACENT UPLAND LOADING[1]	ADJACENT WETLAND LOADING	DRIFT ONLY
Fruiting vegetables (tomato/pepper)	0.021 lbs ai/A	0.001	0.011	0.0002

USE	RATE	ADJACENT UPLAND LOADING[1]	ADJACENT WETLAND LOADING	DRIFT ONLY
Pome fruit (apple and pear) and walnut	0.084 lbs ai/A	0.005	0.043	0.0008

[1]Loading is runoff plus drift (lbs ai/A)

C. Ecological Effects Characterization

Based on the available data, kasugamycin is classified as practically nontoxic to freshwater and estuarine/marine fish, freshwater and estuarine/marine invertebrates, birds, mammals, and terrestrial invertebrates on an acute exposure basis. Chronic exposure resulted in no statistically significant (α=0.05) effects at the highest concentration tested (9.5 mg a.i./L) in freshwater fish. Chronic toxicity data are not available for estuarine/marine fish (data have not been submitted) or aquatic invertebrates (the submitted study is classified as invalid). Chronic exposure in birds resulted in reduced 14-day survivors (NOAEC = 450 mg a.i./kg-diet). In mammals, chronic exposure resulted in reduced body weights and reduced weight gain (NOAEL = 13.7 mg a.i./kg-bw).

For terrestrial plants, the effect concentrations for 25% of the plants tested (EC_{25}) values were less than the limit test application rates, *i.e.*, EC_{25}<0.0925 lb a.i./acre and EC_{25}<0.0964 lb a.i./acre, in the seedling emergence and vegetative vigor studies, respectively, for both monocotyledenous (monocot) and dicotyledenous (dicot) plants. Both of the limit test treatment rates are higher than the maximum proposed single application rate of 0.084 lbs a.i./acre. All of the NOAEC values were equal to the limit test application rate in the vegetative vigor study, for both monocots and dicots (*i.e.*, NOAEC = 0.0964 lb a.i./acre). In the seedling emergence study, the the NOAEC values were equal to the limit test application rate for all dicots tested (*i.e.*, NOAEC = 0.0925 lb a.i./acre). For monocots, the NOAEC values for corn and wheat were < 0.0925 lb a.i./acre based on statistically significant reduced dry weight (18% and 37% inhibition, respectively, compared to controls). Additionally, although not statistically significant, onion had inhibitions in dry weight of 26%.

The most sensitive aquatic plant tested was the cyanobacteria (blue-green algae) *Anabaena flos-aquae* with an EC_{50} value of 0.65 mg a.i./L and a NOAEC value <0.08 mg a.i./L based on a reduction in cell density. See **Table 9** for the most sensitive measurement endpoints considered in this assessment for estimating risks to non-target taxa.

Table 9 Summary of Specific Assessment Endpoints for Animals and Plants Considered in this Assessment for Estimating Risks to Non-target Taxa.

TAXA	MEASURE OF EFFECT		
Survival, growth and/ or reproduction of:	**Species**	**Toxicity**	**Endpoint**
Freshwater Fish	***Acute***		
	Pimephales promelas Fathead minnow	LC_{50} = >110 mg/L	Mortality
	Chronic		
	Pimephales promelas Fathead minnow	NOAEC = 9.5 mg a.i./L	No effects at the highest concentration tested
Freshwater Invertebrates	***Acute***		
	Daphnia magna Waterflea	EC_{50} = >66.2 mg/L	Mortality/immobility
	Chronic		
	The submitted study is invalid	N/A[1]	N/A
Estuarine/Marine Fish	***Acute***		
	Cyprinodon variegates Sheepshead minnow	LC_{50} = >110 mg./L	Mortality
	Chronic		
	No data submitted	N/A	N/A
Estuarine/Marine Invertebrates	***Acute***		
	Americamysis bahia Mysid	LC_{50} >100 mg/L	Mortality
	Chronic		
	Not Available	Not Available	N/A
Aquatic Plants	***Acute***		
	Lemna gibba Duckweed	EC_{50} = 86 mg a.i./L	Reduction in frond number
	Listed		
	Lemna gibba Duckweed	NOAEC = 26 mg a.i./L	Reduction in frond number
	Acute		
	Anabaena flos-aquae Cyanobacteria	EC_{50} = 0.65 mg a.i./L	Reduction in cell density
	Listed		
	Anabaena flos-aquae Cyanobacteria	NOAEC <0.08 mg a.i./L	Reduction in cell density
Birds	***Acute***		
	Colinus virginianus Northern bobwhite quail	LC_{50} = >4,858 mg/kg-diet LD_{50} = >2,000 mg/kg-bw	Mortality
	Chronic		
	Colinus virginianus Northern bobwhite quail	NOAEC = 450 mg a.i./kg-diet	Reduced 14-day survivors
Mammals	***Acute***		
	Rattus Norvegicus Norway Rat	LD_{50} = >5,000 mg a.i./kg-bw	No effects were noted in the study.
	Chronic		
	Rattus Norvegicus Norway Rat	NOAEL = 13.7 mg a.i./kg-bw	Based on decreased body weights and weight gain in adult males
Terrestrial	***Acute***		

TAXA	MEASURE OF EFFECT		
Survival, growth and/ or reproduction of:	**Species**	**Toxicity**	**Endpoint**
Invertebrates	*Apis mellifera* Honey Bee	LD_{50} = >100 µg/bee (contact) LD_{50} = 30.3 µg/bee (oral)	Mortality
Terrestrial Plants	***Non-listed (Seedling Emergence)***		
	Monocot: corn (*Zea mays)*; onion (*Allium cepa)*; ryegrass (*Lolium perenne)*; and wheat, (*Triticum aestivum*)	EC_{25} = >0.0925 lb a.i./acre	N/A
	Dicot: sugarbee (*Beta vulgaris)*; radish (*Raphanus sativus)*; lettuce (*Lactuca sativa)*; flax (*Linum usitatissimum)*; soybean (*Glycine max)*; and tomato (*Lycopersicon esculentum*)		
	Listed (Seedling Emergence)		
	Monocot: corn (*Zea mays)*; and wheat, (*Triticum aestivum*)	NOAEC = <0.0925 a.i./acre	Based on reduced dry weight; for all other monocots tested, the NOAEC = 0.0.0925 lb a.i./acre [although not statistically significant, onion (*Allium cepa)* had inhibitions of 26%].
	Dicot: sugarbee (*Beta vulgaris)*; radish (*Raphanus sativus)*; lettuce (*Lactuca sativa)*; flax (*Linum usitatissimum)*; soybean (*Glycine max)*; and tomato (*Lycopersicon esculentum*)	NOAEC = 0.0.0925 lb a.i./acre	N/A
	Non-listed (Vegetative vigor)		
	Monocot: corn (*Zea mays)*; onion (*Allium cepa)*; ryegrass (*Lolium perenne*), and wheat, (*Triticum aestivum*)	EC_{25} >0.0964 lbs a.i./acre	N/A
	Dicot: sugarbeet (*Beta vulgaris)*; radish (*Raphanus sativus)*; lettuce (*Lactuca sativa*); flax (*Linum usitatissimum)*; soybean (*Glycine max)*; and tomato (*Lycopersicon esculentum*)		

TAXA	MEASURE OF EFFECT		
Survival, growth and/ or reproduction of:	**Species**	**Toxicity**	**Endpoint**
	Listed (Vegetative vigor)		
	Monocot: corn (*Zea mays)*; onion (*Allium cepa)*; ryegrass (*Lolium perenne*), and wheat, (*Triticum aestivum*)	NOAEC = 0.0964 lbs a.i./A	N/A
	Dicot: sugarbeet (*Beta vulgaris)*; radish (*Raphanus sativus)*; lettuce (*Lactuca sativa*); flax (*Linum usitatissimum)*; soybean (*Glycine max)*; and tomato (*Lycopersicon esculentum*)		

[1] N/A = not applicable

1. Aquatic Effects Characterization

a. Aquatic Animals

Toxicity studies were submitted for two freshwater fish, *i.e*., rainbow trout (*Oncorhychus mykiss*) and fathead minnow (*Pimephales promelas*), one freshwater invertebrate, *i.e*., waterfleas (*Daphnia magna*), one estuarine/marine fish, *i.e*., sheepshead minnow (*Cyprinodon variegates*), one estuarine/marine mollusk, *i.e*., Eastern oyster (*Crassostrea virginica*), and one estuarine/marine crustacean, *i.e*., mysid shrimp (*Americamysis bahia*), all exposed to technical grade kasugamycin (see **Table 10**).

Table 10 Submitted Toxicity Data for Kasugamycin and Aquatic Animals.

TAXON	ENDPOINT	FORMULATION	MRID	STUDY CLASS-IFICATION	COMMENTS
FRESHWATER FISH					
Acute					
Rainbow trout (*Oncorhynchus mykiss*)	96-hr LC_{50} >120 mg a.i./L	TGAI (71.5% a.i.)	47945726	Acceptable	NOAEC = 120 mg a.i./L (the highest concentration tested)
Fathead minnow (*Pimephales promelas*)	96-hr LC_{50} >110 mg a.i./L	TGAI (71.5% a.i.)	47945727	Acceptable	NOAEC = 110 mg a.i./L (the highest concentration tested)
Chronic					
Fathead minnow (*Pimephales promelas*)	NOAEC: 9.5 mg ai/L LOAEC: >9.5 mg ai/L	TGAI (71.5% a.i.)	47945730	Acceptable	NOAEC = 9.5 mg a.i./L (the highest concentration tested)
ESTUARINE/MARINE FISH					
Acute					
Sheepshead minnow (*Cyprinodon variegatus*)	96-hr LC_{50} >110 mg a.i./L	TGAI (71.5% a.i.)	47945728	Acceptable	NOAEC = 110 mg a.i./L (the highest concentration tested)
Chronic					
No data available					
FRESHWATER INVERTEBRATES					
Acute					
Water flea (*Daphnia magna*)	48-hr EC_{50} > 66.2 mg a.i./L	TGAI (73% a.i.)	47945723	Acceptable	NOAEC = 66.2 mg a.i./L (the highest concentration tested)
Mysid (*Americamysis bahia*)	96-hr LC50 >100 mg a.i./L	TGAI (71.5% a.i.)	47945725	Acceptable	NOAEC = 100 mg a.i./L (the highest concentration tested)
Eastern oyster (*Crassostrea virginica*)	96-hr EC_{50} >110 mg a.i./L	TGAI (71.5% a.i.)	47945724	Supplemental	NOAEC = 8.7 mg a.i./L (shell deposition); the average shell growth in the controls (1.9 mm) did not meet the minimum 2.0 mm for new shell growth during the study. There was 47% shell growth inhibition at the middle concentration tested [33 mg a.i./L (mean measured)], while the inhibitions at the two highest concentrations tested were 42 and 37%. (55 and 110 mg a.i./L, respectively).
Chronic					
No data available (the submitted chronic daphnid study is classified as invalid due to poor reproductive performance in the controls)					

Acute toxicity tests for rainbow trout (MRID 47945726), fathead minnow (MRID 47945727), sheepshead minnow (MRID 47945728), daphnid (MRID 47945723), and mysid (MRID 47945725) all resulted in no effects, including sublethal effects, to the species at the highest treatment level tested. The Eastern oyster study (MRID 47945724) resulted in an EC_{50} value greater than the highest concentration tested (>110 mg a.i./L), but there were statistically significant effects on shell growth that resulted in a NOAEC value of 8.7 mg a.i./L. The oyster study is classified as supplemental because the average shell growth in the controls (1.9 mm) did not meet the minimum 2.0 mm for new shell growth during the study. Although the 1.9 mm is close to the recommended 2.0 mm, the shell growth inhibition was 47% in the 33 mg a.i./L (mean measured concentration) treatment group (the middle concentration tested), while the shell growth inhibitions were 42 and 37% for the highest two concentrations tested (55 and 110 mg a.i./L, respectively). Therefore, there is uncertainty regarding the endpoints in this study. For acute effects, the following endpoints will be used to assess the risk of kasugamycin to aquatic animals: freshwater fish LC_{50} >110 mg a.i./L; freshwater invertebrate EC_{50} >66.2 mg a.i./L; estuarine/marine fish LC_{50} >110 mg a.i./L; and estuarine/marine invertebrate LC_{50} >100 mg a.i./L (**Table 9**).

A freshwater fish early life stage on fathead minnow resulted in a NOAEC of 9.5 mg a.i./L, the highest concentration tested (MRID 479457-30). Therefore, for chronic effects, a NOAEC of 9.5 mg a.i./L will be used to assess the risk of kasugamycin to freshwater fish. No chronic data for kasugamycin and freshwater invertebrates, estuarine/marine fish, or estuarine/marine invertebrates are currently available.

Based on these submitted studies, kasugamycin is classified as practically nontoxic to freshwater and estuarine/marine fish and invertebrates on an acute exposure basis. There were no mortalities or sublethal effects at the highest treatment levels tested in most of the acute studies and all of the LC_{50} or EC_{50} endpoints for aquatic animals are 'greater than' values. These 'greater than' endpoints are not used to calculate RQ values here; however, they are used to help characterize potential risk in the 'Risk Description' section of this assessment.

b. Aquatic Plants

Studies were submitted for a freshwater vascular plant [duckweed (*Lemna gibba*)], cyanobacteria (blue-green algae; *Anabaena flos-aquae),* a freshwater diatom (*Navicula pelliculosa*), a green algae (*Pseudokirchneriella subcapitata* formerly known as *Selenastrum capricornutum*), and a marine diatom (*Skeletonema costatum*) exposed to technical grade kasugamycin (see **Table 11**).

Table 11 Submitted Toxicity Data for Kasugamycin and Aquatic Plants.

TAXON	ENDPOINT	FORMULATION	MRID	STUDY CLASS-IFICATION	COMMENTS
AQUATIC VASCULAR PLANTS					
Duckweed (*Lemna gibba*)	EC_{50} = 86 mg a.i./L NOAEC = 26 mg a.i./L	TGAI (71.5% a.i.)	479457-43	Acceptable	LOAEC = 63 mg a.i./L [based on reduced yield (frond number)]
AQUATIC NON-VASCULAR PLANTS					
Cyanobacteria (*Anabaena flos-aquae*)	EC_{50} = 0.65 mg a.i./L NOAEC <0.080 mg a.i./L EC_{05} = 0.20 mg a.i./L	TGAI (71.5% a.i.)	479457-44	Acceptable	Most sensitive endpoint was cell density
Green Algae (*Pseudokirchneriella subcapitata*)	EC_{50} = 3.9 mg a.i./L NOAEC = 1.1 mg a.i./L	TGAI (71.5% a.i.)	479457-45	Acceptable	LOAEC = 2.8 mg a.i./L [based on cell density and yield (based on cell density)]
Marine Diatom (*Skeletonema costatum*)	EC_{50} > 110 mg a.i./L NOAEC = 110 mg a.i./L	TGAI (71.5% a.i.)	479457-46	Acceptable	The % growth inhibition of cell density in the treated algal culture as compared to the control ranged from -37 to 2%.
Freshwater Diatom (*Navicula pelliculosa*)	EC_{50} = 90 mg a.i./L NOAEC = 52 mg a.i./L	TGAI (71.5% a.i.)	479457-47	Acceptable	LOAEC = 115 mg a.i./L (based on cell yield)

The EC_{50} for duckweed, based on reduced yield (frond number) in a 7-day toxicity study, is 86 mg a.i./L (MRID 479457-43). In this study the associated NOAEC was 26 mg a.i./L, based on reduced yield. Therefore, an EC_{50} value of 86 mg a.i./L and a NOAEC of 26 mg a.i./L will be used to assess the risk of kasugamycin to vascular aquatic plants (macrophytes).

Toxicity tests using nonvascular aquatic plants resulted in 96-hour EC_{50} values ranging from 0.65 mg a.i./L for reductions in cell density in cyanobacteria (*Anabaena flos-aquae*) (MRID 479457-44) to > 110 mg a.i./L in the marine diatom (*Skeletonema costatum*) (MRID 479457-46). The lowest EC_{50} value of 0.65 mg a.i./L and the associated EC_{05} value of 0.20 mg a.i./L for reductions in cell density in *Anabaena flos-aquae* will be used to assess the risk of kasugamycin to nonvascular aquatic plants.

2. Terrestrial Effects Characterization

a. Terrestrial Animals

Birds

Based on the LD_{50} values for the northern bobwhite quail (*Colinus virginianus*), mallard duck (*Anas platyrhynchos*), and Zebra finch (*Taeniopygia guttata*) of >2,000 mg a.i./kg-bw, kasugamycin is characterized as “practically nontoxic" to avian species on an acute oral-exposure basis (MRIDs 479457-32, 479457-31, and 479457-33, respectively) (see **Table 12**). Kasugamycin is no more than “slightly toxic” to avian species on a sub-acute dietary-exposure basis, with LC_{50} values of > 4,858 mg/kg-diet reported for northern bobwhite quail (MRID 479457-35) and mallard ducks (MRID 479457-34). In this assessment, a subacute dietary LC_{50} value of >4,858 mg a.i./kg-diet and an acute oral LD_{50} of >2,000 mg a.i./kg body weight will be used to assess the risk of kasugamycin to birds.

Table 12 Submitted Toxicity Data for Kasugamycin and Birds.

TAXON	ENDPOINT	FORMULATION	MRID	STUDY CLASS-IFICATION	COMMENTS
Acute Oral					
Bobwhite quail (*Colinus virginianus*)	14-day LD_{50} >2,000 mg a.i./kg-bw	TGAI (73.9% a.i.)	479457-32	Acceptable	NOAEL = 2,000 mg a.i./kg-bw; although frank sublethal effects were noted in the study (*i.e.*, weight changes), the highest concentration tested is > 10x the estimated environmental concentration (based on the proposed label: 4 applications at 0.084 lb a.i./acre). Therefore, a definitive LD_{50} value is not needed at this time to fully assess risks to birds (including federally listed and non-listed species).
Mallard duck (*Anas platyrhynchos*)	14-day LD_{50} >2,000 mg a.i./kg-bw	TGAI (73.9% a.i.)	479457-31	Acceptable	NOAEL = 2,000 mg a.i./kg-bw (no mortality or sublethal effects noted in the study)
Zebra finch (*Taeniopygia guttata*)	14-day LD_{50} >2,000 mg a.i./kg-bw	TGAI (70.3% a.i.)	479457-33	Acceptable	NOAEL = 2,000 mg a.i./kg-bw; although frank sublethal effects were noted in the study (*i.e.*, reduced female weight gain), the highest concentration tested is > 10x the estimated environmental concentration (based on the proposed label: 4 applications at 0.084 lb a.i./acre). Therefore, a definitive LD_{50} value is not needed at this time to fully assess risks to birds (including federally listed and non-listed species).
Sub-Acute Dietary					
Bobwhite quail (*Colinus virginianus*)	8-day LC_{50} >4858 mg ai/kg-diet	TGAI (73.9% a.i.)	479457-35	Acceptable	NOAEC = 4858 mg ai/kg diet (there were no effects noted in the study)
Mallard duck (*Anas platyrhynchos*)	8-day LC_{50} >4858 mg ai/kg-diet	TGAI (73.9% a.i.)	479457-34	Acceptable	NOAEC: <581 mg ai/kg diet (based on reduced weight gain and feed consumption); Although frank sublethal effects were noted in the study (*i.e.*, reduced weight gain), the highest concentration tested is > 10x the estimated environmental concentration (based on the proposed label: 4 applications at 0.084 lb a.i./acre, 3-day application interval). Therefore, a

TAXON	ENDPOINT	FORMULATION	MRID	STUDY CLASS-IFICATION	COMMENTS
					definitive LD_{50} value is not needed at this time to fully assess risks to birds (including federally listed and non-listed species).
Chronic					
Bobwhite quail (*Colinus virginianus*)	NOAEC = 450 mg a.i./kg-diet LOAEC = 913 mg a.i./kg-diet	TGAI (70.3% a.i.)	479457-37	Acceptable	The LOAEC was based on reduced (14%) 14-day survivors.
Mallard duck (*Anas platyrhynchos*)	NOAEC = 913 mg a.i./kg-diet LOAEC >913 mg a.i./kg-diet	TGAI (70.3% a.i.)	479457-36	Acceptable	There were no effects noted in the study.

In all of the avian acute and sub-acute toxicity studies submitted, there were no mortalities at the highest treatment levels tested (*i.e.*, all of the LD_{50} and LC_{50} endpoints are 'greater than' values), therefore, these endpoints are not used to calculate RQ values here. They are, however, used to help characterize risk in the 'Risk Description' section of this assessment.

Frank sublethal effects (*i.e.,* reduced feed consumption and/or reduced weight gain) were noted in the acute oral studies for bobwhite quail and zebra finch and the sub-acute dietary study using mallard ducks. Although frank sublethal effects were noted in these studies, the highest concentrations tested are > 10x the estimated environmental concentration (based on the proposed label: 4 applications at 0.084 lb a.i./acre, 3-day application interval). The '10x' factor is based on the current acute listed species LOC for birds and mammals (*i.e.*, RQ > 0.1 or $1/10^{th}$ the acute/sub-acute endpoint value). Therefore, a definitive LD_{50} or LC_{50} value is not needed at this time to fully assess risks to birds (including federally listed and non-listed species).

Avian reproduction studies were performed for kasugamycin in two species, northern bobwhite quail and mallard duck. The lowest LOAEC was for the bobwhite quail (913 mg/kg-diet) based on reduced (14% when compared to controls) 14-day survivors (MRID 479457-37). The lowest NOAEC was also for the bobwhite quail (450 mg a.i./kg-diet) (MRID 479457-37). There were no statistically significant (α=0.05) effects noted in the mallard reproduction study (NOAEC = 913 mg a.i./kg-diet) (MRID 479457-36). For the purposes of this risk assessment, 450 mg a.i./kg-diet serves as the toxicological endpoint for evaluating chronic effects in birds (**Table 9**).

Mammals

Based on the LD_{50} value for the Norway rat (*Rattus norvegicus*) of >5,000 mg a.i./kg-bw, kasugamycin is characterized as "practically nontoxic" to mammalian species on an acute oral-exposure basis (MRID 459100-12; the study is classified as 'acceptable') (see **Table 9**). There were no mortalities or sublethal effects noted in the study. In this assessment,

an LD_{50} value of >5,000 mg a.i./kg- will be used to assess the risk of kasugamycin to mammals.

A 2-generation study was performed for kasugamycin in *R. norvegicus*. The lowest NOAEL was 13.7 mg a.i./kg-bw based on decreased body weghts and body weight gains in adult males (MRID 45910023; this study is classified as 'acceptable'). The NOAEL for reproductive effects was 70.3 mg a.i./kg-bw based on decreased fertility and fecundity in the F_1 parents for both litters and an increased pre-coital interval during the mating period for the F_2 litter. For the purposes of this risk assessment, 13.7 mg a.i./kg-bw serves as the toxicological endpoint for evaluating chronic effects in mammals.

Terrestrial Invertebrates

The registrant submitted one guideline, *i.e.*, acute honey bee (*Apis mellifera*) contact toxicity study, and two non-guideline, *i.e.*, acute honey bee oral toxicity and an acute earthworm, terrestrial invertebrate toxicity studies for kasugamycin. These studies resulted in the following: a honey bee acute contact LD_{50} of >100 µg a.i./bee (MRID 47945738); a honey bee acute oral LD_{50} of 30.3 µg a.i./bee (MRID 47945739); and an EC_{50} of >1,000 mg a.i./kg dry weight (dw) substrate for earthworms (MRID 47945740). Therefore, kasugamycin is classified as 'practically nontoxic' to non-target terrestrial invertebrates on an acute oral and contact exposure basis. In the acute contact study with honey bees, the NOAEL was 100 µg a.i./bee (the highest concentration tested) and mortality in the study ranged from 0 to 16.7% in the different treatment groups. In the acute oral bee study a definitive NOAEC could not be determined due to ≥ 23% mortality in all treatment groups. There were no mortalities or sublethal effects noted in the earthworm study, therefore the NOAEC is 1,000 mg a.i./kg-dw substrate (the highest concentration tested).

b. Terrestrial Plants

The effects of the proposed kasugamycin formulation, Kasumin 2L (2.2% a.i.), was tested on various monocots and dicots in Tier I seedling emergence and vegetative vigor studies.

Results of the Tier I seedling emergence study showed no measurable effects to dicots at the limit test treatment level of 0.0925 lb a.i./acre (MRID 47945741). Therefore, for dicots, the EC_{25} is >0.0925 lb a.i./acre and the NOAEC is 0.0925 lb a.i./acre (see **Table 13**). For monocots, all of the EC_{25} values were >0.0925 lb a.i./acre, however, the NOAEC for corn and wheat was <0.0925 lb a.i./acre based on reduced dry weight (18% and 37% inhibition, respectively, compared to controls). Additionally, although not statistically significant, onion had inhibitions in dry weight of 26%. Due to the variability within species and low statistical power of the study, the calculated EC_{25} values were all below the highest treatment level even though there were growth inhibitions greater than 25% noted in some of the species. The Tier 1 seedling emergence test also exhibited increased growth in terms of dry weight for sugarbeet, soybean, lettuce, flax, and tomato; for radish, there were no differences in dry weight

between controls and treated plants; however, there were inhibitions in dry weight (21%) for ryegrass relative to controls. Because the Tier 1 seedling emergence study resulted in effects of >25% on some of the species tested, there is uncertainty regarding the potential effects of kasugamycin. For the purposes of this assessment, a NOAEC of <0.0925 lb a.i./acre and an EC_{25} of >0.0925 lb a.i./acre are used to assess the effects of exposure to kasugamycin on seedling emergence in non-listed and listed terrestrial plants (monocots). For dicots, a NOAEC of 0.0925 lb a.i./acre and an EC_{25} of >0.0925 lb a.i./acre are used.

Results of the Tier I vegetative vigor study failed to identify the most sensitive monocot or dicot, *i.e.*, all effects were below a 10% difference from the control (MRID 479457-42) (see **Table 13**). Therefore, the EC_{25} and NOAEC values for monocots and dicots are > 0.0964 lb a.i./acre and 0.0964 lb a.i./acre, respectively.

Table 13 Submitted Toxicity Data for Kasugamycin and Terrestrial Plants.

TAXON	ENDPOINT	FORMULATION	MRID	STUDY CLASS-IFICATION	COMMENTS
Terrestrial plants (seedling emergence)	Monocot: all monocots tested: EC_{25} >0.0925 lbs a.i./acre Corn and wheat: NOEC <0.0925 lbs a.i./acre (based on dry weight) Dicot: All dicots tested: EC_{25} >0.0925 lbs a.i./acre All dicots tested: NOEC = 0.0925 lbs a.i./acre	Kasumin 2L (2.2% a.i.)	47945741	Acceptable	Corn and wheat had statistically significant growth inhibitions when compared to controls (18% and 37% inhibition, respectively). Although not statistically significant, onion and ryegrass had inhibitions of 26% and 21%.
Terrestrial plants (vegetative vigor)	Monocot and Dicot: All monocots and dicots tested: EC_{25} >0.0964 lbs a.i./acre All monocots and dicots tested: NOEC = 0.0964 lbs a.i./acre (based on dry weight)	Kasumin 2L (2.2% a.i.)	47945742	Acceptable	All effects were below 10% difference from the control

IV. Risk Characterization

A. Risk Estimation - Integration of Exposure and Effects Data

Toxicity data and exposure estimates are used to evaluate the potential for adverse ecological effects on non-target species. For this screening-level assessment of kasugamycin, the deterministic risk quotient method is used to provide a metric of potential risks. The RQ is a comparison of exposure estimates to toxicity endpoints; estimated exposure concentrations are divided by acute and chronic toxicity values. The resulting unitless RQs are compared to the Agency's levels of concern (LOCs) (see **Table 14**), which are the Agency's interpretive policy such that when LOCs are exceeded, the need for regulatory action may be considered. These criteria are used to indicate when the use of a pesticide, as directed on the label, has the potential to cause adverse effects on non-target organisms.

Table 14 Agency Levels of Concern (LOC)**.**

Risk	Description	RQ	Taxa
Acute	Potential for acute risk to non-target organisms which may warrant regulatory action in addition to restricted use classification	acute RQ > 0.5	aquatic animals, mammals, birds
Acute Restricted Use	Potential for acute risk to non-target organisms, but may be mitigated through restricted use classification	acute RQ > 0.1	aquatic animals
		acute RQ > 0.2	mammals and birds
Acute Listed Species	Listed species may be potentially affected by use	acute RQ > 0.05	aquatic animals
		acute RQ > 0.1	mammals and birds
Chronic	Potential for chronic risk may warrant regulatory action, listed species may potentially be affected through chronic exposure	chronic RQ > 1	all animals
Non-Listed and Listed Plant	Potential for effects in non-listed and listed plants	RQ > 1	all plants

1. Non-target Aquatic Animals and Plants

Aquatic Animals

Kasugamycin is classified as 'practically nontoxic' to fish and aquatic invertebrates on an acute exposure basis. Since there are no definitive acute endpoints available for aquatic animals (*i.e.*, all of the available LC_{50}/EC_{50} values are 'greater than' values and there were no effects noted at the highest concentrations tested), acute RQs are not calculated here.

The only chronic endpoint available for aquatic animals and kasugamycin is for freshwater fish. In the chronic freshwater fish study there were no effects noted at the highest concentration tested resulting in a NOAEC of 9.5 mg a.i./L. The highest 60-day EEC from the aquatic modeling is 4.53 µg a.i./L (FL Tomato scenario). Therefore, the

highest calculated chronic exposure RQ for freshwater fish is <0.001 (4.53 µg a.i./L/9,500 µg). This is below the Agency's LOC (RQ = 1) for chronic risk to aquatic animals.

Chronic exposure data are not currently available for estuarine/marine fish. However, estuarine/marine fish do not appear to be more sensitive to kasugamycin than freshwater fish on an acute exposure basis [there were no effects seen at the highest concentrations tested (>100 mg a.i./L) in the available acute fish studies]. Therefore, freshwater fish (chronic exposure data) will be used as a surrogate for estuarine/marine fish in the absence of additional data.

There are currently no chronic data available for aquatic invertebrates. Aquatic invertebrates would need to be significantly more sensitive on a chronic exposure basis than an acute exposure basis for a chronic risk LOC to be exceeded. Based on the highest 21-day aquatic EEC of 5.57 µg a.i./L (FL Pepper scenario; **Table 6**), and the lowest aquatic invertebrate LC_{50}/EC_{50} value of EC_{50} >66,200 µg a.i./L (daphnid), aquatic invertebrates would need to be >11,885 times more sensitive to kasugamycin on a chronic exposure basis than on an acute exposure basis to exceed the chronic LOC of 1. Since this is unlikely given the toxicity profile for this chemical, risk to aquatic invertebrates from chronic exposure to kasugamycin is not expected.

Aquatic Plants

The highest peak EEC from the aquatic modeling is 6.53 µg a.i./L (FL Pepper scenario). Comparing this EEC with the EC_{50} (86,000 µg a.i./L and 650 µg a.i./L) and $NOAEC/EC_{05}$ values (26,000 µg a.i./L and 200 µg a.i./L) from the most sensitive aquatic vascular (duckweed) and non-vascular plants (cyanobacteria), respectively, results in RQs ≤ 0.03. These RQs are all below the Agency's LOC (RQ < 1) for risk to listed and non-listed aquatic plants.

2. Non-target Terrestrial Animals

Birds

Kasugamycin is classified as 'practically nontoxic' to birds on an acute and sub-acute exposure basis. Since all of the endpoints from the acute and sub-acute avian toxicity studies are non-definitive (*i.e.*, they are 'greater than' values), they will not be used to calculate RQs.

The dietary-based RQs calculated for chronic exposure range from 0.01 to 0.16 using upper 90^{th} percentile Kenaga values. Therefore, none of the avian RQs calculated for chronic exposure exceed the Agency's chronic risk LOC of 1.

Mammals

Kasugamycin is classified as 'practically nontoxic' to mammals on an acute oral exposure basis. Since the endpoint from the toxicity study is non-definitive (*i.e.*, it is a 'greater than' value), it will not be used to calculate RQs.

The dietary-based RQs calculated for chronic exposure from the pome fruit use (the use with the highest EECs reported in **Table** 7 based on 4 applications of 0.084 lbs a.i./A with a 3-day reapplicaiton interval) range from 0.02 (fruits/pods/seeds/large insects) to 0.27 (short grass) using upper 90th percentile Kenaga values. None of the dose-based chronic RQs exceed the Agency's LOC for the proposed fruiting vegetable use based on 4 applications of 0.021 lbs a.i./A with a 7-day reapplication rate; RQs range from <0.01 (>15-g mammals that eats seeds) to 0.42 (15-g mammal that eats short grass)].

For the proposed pome fruit use with 4 applications of 0.84 lbs a.i./A and a 3-day reapllicaton interval , the dose-based chronic RQs for mammals (all size classes) that eat short grass exceed the Agency's chronic risk LOC (RQs range from 1.1 to 2.3) (see **Table 15**). The LOC is also exceeded for 15-g mammals that eat tall grass and/or broadleaf plants/small insects and 35-g mammals that eat broadleaf plants/small insects (dose-based chronic RQs for all size and dietary categories for the proposed use on pome fruits range from 0.01 to 2.3). Regarding the proposed walnut use with its proposed 4 applications of 0.84 lbs a.i./A and a 14-day reapplication interval, the chronic dose-based RQs for 15-g mammals that eat short grass and/or broadleaf plants/small insects and 35-g mammals that eat short grass exceed the Agency's LOC for chronic risk (RQs range from 0.01 to 1.8). Therefore, some of the mammalian RQs calculated for chronic exposure from the proposed pome fruit and walnut uses exceed the Agency's chronic risk LOC.

Table 15 Mammal Dose-Based RQ Values for Chronic Exposure to Kasugamycin.

DIETARY CATEGORY	RQ (Upper 90th Percentile Kenaga)					
	Pome Fruits[1]			Walnuts[2]		
	15 g	35 g	1000 g	15 g	35 g	1000 g
Short Grass	**2.3**	**2.0**	**1.1**	**1.8**	**1.5**	0.81
Tall Grass	**1.1**	0.92	0.49	0.81	0.69	0.37
Broadleaf Plants/Small Insects	**1.3**	**1.1**	0.60	**1.0**	0.85	0.46
Fruits/Pods/Seeds/Large Insects	0.15	0.12	0.07	0.11	0.09	0.05
Seeds (granivore)	0.03	0.03	0.01	0.02	0.02	0.01

[1]Based on application rate of 0.084 lbs a.i./A, 4 applications with 3-day reapplicaiton interval.
[2] Based on application rate of 0.084 lbs a.i/A, 4 applications with 14-day reapplication interval.
Bolded RQs exceed the chronic risk LOC (1).

Drinking Water and Inhalation

The Screening Imbibition Program (SIP) and the Screening Tool for Inhalation Risk (STIR) were used to determine if drinking water and/or inhalation, respectively, are potentially significant routes of concern for terrestrial animals.

SIP (v. 1.0) was used to calculate the upper bound estimate of exposure using kasugamycin's solubility limit (228 g/L), the most sensitive acute and chronic avian toxicity endpoints [bobwhite quail (*Colinus virginianus*) LD_{50} and NOAEC of >2,000 mg a.i./kg-bw (MRID 47945732) and 450 mg a.i./kg-diet (MRID 47945737), respectively]

and the most sensitive acute and chronic mammalian toxicity endpoints [rat (*Rattus Norvegicus*) LD_{50} and NOAEL of >5,000 mg a.i./kg-bw (MRID 45910012) and 13.7 mg a.i./kg-bw (MRID 45910023), respectively]. Although, kasugamycin is classified as practically non-toxic on an acute exposure basis, because of the high aquatic solubility limit, drinking water alone could not be excluded as a potential pathway of concern for avian and mammalian species on an acute and chronic basis (see **APPENDIX B**).

STIR (v. 1.0) was used to calculate an upper bound estimate of exposure using kasugamycin's vapor pressure and molecular weight for vapor phase exposure as well as the maximum application rate and method of application for spray drift. STIR incorporates results from several toxicity studies including acute oral and inhalation rat toxicity endpoints [rat (*R. Norvegicus*) LD_{50} (oral) and LD_{50} (inhalation; 4-hr exposure) of >5,000 mg a.i./kg-bw (MRID 45910012) and >4.9 mg a.i./L (MRID 45910018), respectively] as well as the most sensitive acute oral avian toxicity endpoint [bobwhite quail (*C. virginianus*) LD_{50} of >2,000 mg a.i./kg-bw (MRID 47945732)]. Based on the results of the STIR model, inhalation exposure alone was determined not to be a potential pathway of concern for avian or mammalian species on an acute basis (see **APPENDIX C**).

Terrestrial Invertebrates

Kasugamycin is classified as 'practically nontoxic' to non-target terrestrial invertebrates on an acute exposure basis. Potential risk to terrestrial invertebrates from acute or chronic exposure to kasugamycin could not be assessed due to a lack of exposure data. Screening-level risk assessments do not typically evaluate risks to terrestrial invertebrates; however, toxicity information for beneficial insects is used to develop precautionary label language where necessary. Based on the available data, precautionary label language for bees does not appear necessary.

3. Non-target Terrestrial and Semi-aquatic Plants

For dicots, none of the RQs for kasugamycin exceed the Agency's listed species LOC (RQ>1.0) for terrestrial plants based on results from the TerrPlant v. 1.2.1 (RQs range from <0.1 to 0.46). For monocots, onion and wheat had inhibitions in dry weight of 26% and 37%, respectively, in the seedling emergence study (corn also had a statistically significant inhibition of 18%). These effects were seen at a limit concentration rate (0.0925 lb a.i./acre) above the currently proposed maximum application rate (0.084 lb a.i./acre). Off the site of application, TerrPlant assumes exposure levels to non-target plants via runoff is roughly 50% of the application rate. If effects are linear (which is an assumption since there is no dose-response information from the Tier I plant study), the effects in non-target plants found adjacent to the site of application would be below the 20% effect level. Under these assumptions, risks to non-listed monocots would not be expected. However, because definitive no-effect values were not established for monocots in the seedling emergence study, risk to listed monocots from the proposed use of kasugamycin is an uncertainty.

B. Risk Description

Based on the results of this assessment, kasugamycin is characterized as mobile to moderately mobile. Although the parent compound is subject to both biotic and abiotic routes of degradation, its degradates (kasuganobiosamine and kasugamycinic acid) are less subject to degradation. Since the two degradates are similar in structure to the parent and there are no data to indicate whether they have similar toxicity, they are presumed to be as toxic and are considered in the exposure assessment of total toxic residue. Based on total toxic residues, kasugamycin is characterized as persistent. Given that the compound is both persistent and mobile, it is likely to move into both surface and ground water. Although the compound is expected to move into surface water via runoff and spray drift, it not considered likely to bioaccumulate. Kasugamycin is also not considered likely to volatilize.

Kasugamycin is practically non-toxic to aquatic and terrestrial animals on an acute expsoure basis. Chronic exposure resulted in no effects at the highest concentration tested (9.5 mg a.i./L) for freshwater fish; however, there are no chronic toxicity data available for aquatic invertebrates. Chronic exposure to birds resulted in reduced survival in 14-day chicks (NOAEC=450 mg a.i./kg diet) while chronic exposure in mammals resulted in reduced growth (NOAEL=13.7 mg a.i./kg bw). The most sensitive nonvascular aquatic plant is cyanobacteria (EC_{50}=0.65 mg a.i./L) while the aquatic vascular plant is several orders of magnitude less sensitive with an EC_{50} value of 86 mg a.i./L. For terrestrial plants, the Tier 1 studies indicate that the EC_{25} values are less than the highest proposed application rates for monocots and dicots (however, there is some uncertainty with this regarding monocots in the available seedling emergence study).

The results of this screening-level risk assessment indicate the proposed kasugamycin pome fruit and walnut uses have the potential for direct adverse effects to listed and non-listed mammals from chronic exposure. Additionally risk to listed terrestrial plants (monocots) is an uncertainty. Therefore, the risk hypothesis from the Problem Formulation, *i.e., based on mode of action, the proposed use patterns, and the sensitivity of non-target aquatic and terrestrial species, the proposed uses of kysugamycin have the potential to reduce survival, reproduction, and/or growth in terrestrial and aquatic animals and plants through direct application, spray drift and/or runoff*] is partially supported. Although direct adverse effects to birds (and, thus, reptiles and terrestrial-phase amphibians), fish (and, thus, aquatic-phase amphibians), aquatic invertebrates, aquatic plants and non-listed terrestrial plants from the proposed kasugamycin uses are not expected, given the potential for effects on mammals, and listed plants (monocots), indirect effects to other organisms are possible. Since plantsand mammals are vital components of most habitats and ecosystems, alterations in their abundance or in their composition could result in adverse effects to other species.

The use of antibiotics on crops, although minor relative to total antibiotic use, can result in situations that impact the buildup of resistant bacteria. For example, antibiotics used as agricultural pesticides, such as kasugamycin, can be applied over large areas of land to densely vegetated fields and orchards. This can lead to the proliferation and rapid spread

of resistant genes in the bacterial population. Although, kasugamycin may be most active against bacteria or fungi that cause adverse effects to plants, there is evidence to suggest that resistance established in one type of bacteria can be spread to other strains or species of bacteria (via plasmids) (O'Brien, 2002). Although the probability is low, there is a potential for bacterial resistance to cross between plant bacteria and human bacteria (McManus and Stockwell, 2001). This possibility is highlighted here due to the seriousness of the public health threat associated with antibiotic resistance.

Additionally, bacteria serve an essential role in cycling nutrients and energy in the environment (*e.g.*, through decomposition of organic materials and Nitrogen-fixation). The effects of the potential reduction or alteration of the microorganism community from the proposed kasugaycin uses are unknown and are beyond the scope of this risk assessment. Therefore, the potential risks to the environment from the potential impacts to non-target microorganisms from the use of kasugamycin represent an uncertainty in this risk assessment.

1. Risks to Aquatic Organisms

a. Animals

Kasugamycin is practically nontoxic for fish on an acute exposure basis and all of the endpoints are indefinite, *i.e*, LC_{50}> highest concentration tested, therefore, no RQ values were calculated. The only RQ that could be calculated for aquatic animals was the chronic RQ for freshwater fish. The highest calculated chronic exposure RQ for freshwater fish is <0.001. Thus, risks to freshwater fish from chronic exposure to kasugamycin are not considered likely. Although chronic exposure data are not available for estuarine/marine fish, estuarine/marine fish do not appear to be more sensitive to kasugamycin than freshwater fish on an acute exposure basis. Therefore, freshwater fish are used as a surrogate for estuarine/marine fish in the absence of additional data. Additionally, the hydrolysis study showed that kasugamycin tends to break down much faster in neutral to alkaline environments. The more basic the environment, the faster kasugamycin breaks down. Since estuarine/marine environments tend to be more alkaline (in general) than freshwater (in general), kasugamycin might be expected to undergo hydrolysis more rapidly in the estuarine/marine environment. Therefore, based on available information, the likelihood of risks to fish from chronic exposure from the proposed kasugamycin uses is considered low.

There are currently no chronic data available for aquatic invertebrates. Aquatic invertebrates would need to be significantly more sensitive on a chronic exposure basis than an acute exposure basis for a chronic risk LOC to be exceeded (*i.e.*, >11,885 times more sensitive). Since this is unlikely given the toxicity profile for this chemical, risk to aquatic invertebrates from chronic exposure to kasugamycin is not expected.

Because there was no mortality or sublethal effects at the highest treatment levels tested in most of the acute aquatic animal studies submitted (with the exception of estuarine/marine mollusk), RQ values for acute exposure were not calculated for aquatic

animals in the Risk Estimation section of this assessment. In order to gain a better understanding of how the peak EEC for the maximum proposed kasugamycin application rates relate to the acute toxicity data currently available for fish and aquatic invertebrates, a ratio of the EEC/acute endpoint was calculated using the conservative assumption that the highest level tested is the endpoint value [*i.e.*, peak EEC = 6.53 µg a.i./L (FL Pepper scenario; **Table 6**); EC_{50}/LC_{50} = 66,200 µg a.i./L (freshwater invertebrate) to 120,000 µg a.i./L (freshwater fish)]. In this exercise the ratios calculated are < 0.001 for all aquatic animals. Actual RQs would likely be much lower than these since no effects were actually identified at the approximately100 mg a.i./L in any of the studies with the exception of the Eastern oyster study.

As with the other aquatic animal studies, the Eastern oyster study (MRID 47945724) resulted in an EC_{50} value greater than the highest concentration tested (>110 mg a.i./L); however, there were effects on oyster shell growth that resulted in a NOAEC value of 8.7 mg a.i./L. Shell growth inhibition was 47% in the 33 mg a.i./L (mean measured concentration) treatment group (the middle concentration tested), while the shell growth inhibitions were 42 and 37% for the highest two concentrations tested (55 and 110 mg a.i./L, respectively). However, even if the EC_{50} was 33 mg a.i./L (the concentrations where effects on shell growth were observed) in the mollusk study, the resulting RQ [*i.e.*, <0.001 (6.53 µg a.i./L (peak EEC)/33,000 µg a.i./L)] is less than the Agency's acute risk LOC for aquatic animals. Therefore, the likelihood of direct risk to aquatic animals from acute exposure to kasugamycin from the proposed uses is considered low.

Therefore, adverse effects to fish (acute or chronic exposure) and aquatic invertebrates (acute exposure) are not considered likely from the proposed kasugamycin uses based on the available toxicity data. Risk to aquatic invertebrates from chronic exposure, however, cannot be precluded at this time. Thus, risk to aquatic invertebrates is assumed in the absence of data.

a. Plants

All of the RQs for aquatic vascular and non-vascular plants are below Agency LOCs for risk to listed and non-listed species. Therefore, likelihood of direct risk to aquatic plants from the proposed kasugamycin uses is considered low.

2. Risks to Terrestrial Organisms

a. Animals

Birds

None of the avian RQs calculated for chronic exposure exceed the Agency's LOC for risk to listed and non-listed species. Therefore, risks to birds from the proposed kasugamycin uses are not expected.

There were no mortalities in any of the avian acute or sub-acute studies at the highest treatment levels tested (*i.e.*, all of the LD_{50} and LC_{50} endpoints are 'greater than' values), therefore, these endpoints are not used to calculate RQ values. Although frank sublethal effects (reduced feed consumption and/or reduced weight gain) were noted in some of the avian acute oral and sub-acute dietary studies, the highest concentrations tested are > 10x the terrestrial EECs. Therefore, a definitive LD_{50} value is not needed at this time to fully assess risks to birds (including federally listed and non-listed species).

In order to gain a better understanding of how the EECs for the maximum proposed kasugamycin application rates relate to the toxicity data currently available for birds, T-REX was used to calculate a ratio of the EEC/endpoint using the conservative assumption that the highest level tested is the endpoint value (*i.e.*, acute: LD_{50} = 2,000 mg a.i./kg-bw; sub-acute: LC_{50} = 4,858 mg a.i./kg-diet). In this exercise all of the acute and sub-acute ratios calculated using upper-bound Kenaga values (**Table 7**) were between <0.01 and 0.06 for all size and dietary classes. Actual RQs would be lower than these since there were no mortalities noted at the 2,000 mg a.i./kg-bw and the 4,858 mg a.i./kg-diet levels. Therefore, the likelihood of direct risk to birds from acute, sub-acute, or chronic exposure to kasugamycin is considered low.

Mammals

There were no mortalities or sublethal effects in the acute oral mammal study at the highest treatment level tested (*i.e.*, the LD_{50} endpoint is a 'greater than' value), therefore, this endpoint is not used to calculate RQ values. In order to gain a better understanding of how the EECs for the maximum proposed kasugamycin application rates relate to the acute toxicity data currently available for mammals, T-REX was used to calculate RQs using the conservative assumption that the highest value tested in the acute mammal study represents a definitive endpoint (*i.e.*, acute: LD_{50} = 5,000 mg a.i./kg-bw). In this exercise all of the acute dose-based RQs calculated using upper bound Kenaga values (**Table 7**) were between <0.01 and 0.01 for all size and dietary classes. The actual RQs would be lower than these since there were no mortalities or sublethal effects noted at the 5,000 mg a.i./kg-bw level. Therefore, the likelihood of direct risk to mammals from acute exposure to kasugamycin is considered low.

None of the mammalian RQs calculated for chronic exposure from the proposed fruiting vegetable use exceed the Agency's LOC for chronic risk to listed and non-listed species. Therefore, the likelihood of risks to mammals from the proposed kasugamycin use on fruiting vegetables is considered low.

For the proposed pome fruit use, the dose-based chronic RQs for mammals that eat short grass (all size classes); 15-g mammals that eat tall grass and/or broadleaf plants/small insects; and 35-g mammals that eat broadleaf plants/small insects exceed the Agency's chronic risk LOC. Regarding the proposed walnut use, the chronic dose-based RQs for 15-g mammals that eat short grass and/or broadleaf plants/small insects and 35-g mammals that eat short grass exceed the Agency's LOC for chronic risk. Therefore, there is a potential for risk to some listed and non-listed mammals from chronic exposure

resulting from the proposed pome fruit and walnut uses of kasugamycin. However, a single application at the 0.084 lbs a.i./A rate would result in a chronic RQ of 0.64 for the most sensitive mammals, *i.e.*, 15-g mammals feeding on short grass, and would fall below the chronic risk LOC.

Terrestrial Invertebrates

Toxicity information for beneficial insects in screening-level risk assessments is used to develop precautionary label language where necessary. Based on the available data, precautionary label language for bees is not necessary.

b. Plants

The LOC for non-listed terrestrial plants was not exceeded for monocots or dicots. However, there is some uncertainty regarding this result for monocots since onion and wheat had inhibitions in dry weight of 26 and 37%, respectively, in the seedling emergence study.

For listed terrestrial plants, none of the RQs for kasugamycin and dicots exceed the LOC for terrestrial plants. For listed monocots, because a definitive NOAEC value was not established for monocots in the Tier I seedling emergence study (*i.e.*, there were effects noted at the concentration tested), risk to listed monocots from potential exposure via runoff and spray drift is an uncertainty.

3. Review of Incident Data

Reviews of the Ecological Incident Information System (EIIS, version 2.1) and the Avian Incident Monitoring System (AIMS)[6] were conducted on May 20, 2011. There are no reported incidents for kasugamycin in the EIIS or AIMS databases. In addition to the incidents recorded in EIIS and AIMS, additional pesticide incidents are reported to the Agency in aggregated incident reports. Ecological incidents reported in aggregate reports include those categorized as 'minor fish and wildlife' (W-B), 'minor plant' (P-B), and 'other non-target' (ONT) incidents. 'Other non-target' incidents include reports of adverse effects to insects and other terrestrial invertebrates. As of May 20, 2011, there have been no aggregate kasugamycin ecological incidents reported to the Agency. Because this is a new chemical that has not been registered for use in the United States (with the exception of Section 18 registrations), the existence of ecological incident reports would be unlikely.

4. Federally Threatened and Endangered (Listed) Species Concerns

a. Action Area

For listed species assessment purposes, the action area is considered to be the area affected directly or indirectly by the Federal action and not merely the immediate area

[6] http://www.abcbirds.org/abcprograms/policy/pesticides/aims/aims/index.cfm

involved in the action. At the initial screening-level, the risk assessment considers broadly described taxonomic groups and conservatively assumes that listed species within those broad groups are located on or adjacent to the treated site and aquatic organisms are assumed to be located in a surface water body adjacent to the treated site. The assessment also assumes that the listed species are located within an assumed area that has the relatively highest potential exposure to the pesticide, and that exposures are likely to decrease with distance from the treatment area.

If the assumptions associated with the screening-level action area result in RQs that are below the listed species LOCs, a "no effect" determination conclusion is made with respect to listed species in that taxa, and no further refinement of the action area is necessary. Furthermore, RQs below the listed species LOCs for a given taxonomic group indicate no concern for indirect effects upon listed species that depend upon the taxonomic group covered by the RQ as a resource. However, in situations where the screening assumptions lead to RQs in excess of the listed species LOCs for a given taxonomic group, a potential for a "may affect" conclusion exists and may be associated with direct effects on listed species belonging to that taxonomic group or may extend to indirect effects upon listed species that depend upon that taxonomic group as a resource. In such cases, additional information on the biology of listed species, the locations of these species, and the locations of use sites could be considered to determine the extent to which screening assumptions regarding an action area apply to a particular listed organism. These subsequent refinement steps could consider how this information would impact the action area for a particular listed organism and may potentially include areas of exposure that are downwind and downstream of the pesticide use site.

b. Taxonomic Groups Potentially at Risk

The Level I screening assessment process for listed species uses the generic taxonomic group-based process to make inferences on direct effect concerns for listed species. The first iteration of reporting the results of the Level I screening is a listing of pesticide use sites and taxonomic groups for which RQ calculations reveal values that meet or exceed the listed species LOCs (for more information see, USEPA 2004).

(1). Discussion of Risk Quotients

The results of this screening-level risk assessment indicate that the proposed pome fruit and walnut uses have the potential for direct adverse effects to listed and non-listed mammals from chronic exposure. Additionally risks to listed terrestrial plants (monocots) from any of the proposed uses cannot be precluded based on available data. This indicates a potential risk for direct adverse effects to federally-listed monocots, and mammals and indirect adverse effects to any listed species that rely on these taxa as resources critical to their life cycle.

(2). Probit Dose Response Relationship

The probit slope response relationship can be used to calculate the chance of an individual event corresponding to the listed species acute LOCs and/or RQs. The analysis uses the Environmental Fate and Effects Division spreadsheet IECv1.1.xls.

If information is unavailable to estimate a slope from a study, a default slope assumption of 4.5 is used. Slopes were not available for the acute toxicity studies. Therefore, probit-dose analyses were done based on the taxon-specific acute listed species LOCs and a default slope of 4.5 to estimate an individual effects probability for all taxa. This resulted in a chance of ~1 in 418,000,000 for effects to fish and aquatic invertebrates, and a ~1 in 1 in 294,000 chance of effects for birds and mammals. To explore possible bounds to such an estimate, slopes of 2 and 9 were used to calculate upper and lower estimates of the effects probability associated with the listed species LOC. The chance of individual effects with these slopes ranged from ~1 in 44 to ~1 in 1 in 1.75E+31 for the various taxa (see **Table 16**).

Table 16 Chance of an Individual Effect Corresponding to the Listed Species Acute LOCs Using a Probit Slope Response Relationship.

TAXA	LISTED SPECIES LOC	PROBIT SLOPE		CHANCE OF AN INDIVIDUAL EFFECT
- Freshwater Fish **- Freshwater Invertebrates** **- Estuarine/Marine Fish** **- Estuarine/Marine Invertebrates**	0.05	**Slope**	4.5[1]	~1 in 418,000,000
		Upper Bound	2	~1 in 216
		Lower Bound	9	~1 in 1.75E+31
- Birds **- Mammals**	0.1	**Slope**	4.5[1]	~1 in 294,000
		Upper Bound	2	~1 in 44
		Lower Bound	9	~1 in 8.86E+18

[1] This is the default slope.

(3). Indirect Effects Analysis

The Agency acknowledges that pesticides have the potential to exert indirect effects upon listed organisms by, for example, perturbing forage or prey availability, altering the extent of nesting habitat, and creating gaps in the food chain. In conducting a screen for indirect effects, direct effect LOCs for each taxonomic group are used to make inferences concerning the potential for indirect effects upon listed species that rely upon non-listed organisms in these taxonomic groups as resources critical to their life cycle.

The Agency's chronic risk LOC for listed and non-listed mammals was exceeded for the proposed pome fruit and walnut uses. Risks to listed terrestrial plants (monocots) cannot be precluded based on available data. This indicates a potential risk for direct adverse effects to federally-listed monocots, and mammals and indirect adverse effects to any listed species that rely on these taxa as resources critical to their life cycle. Therefore, at this time, no federally-listed taxa can be excluded from the potential for direct and/or indirect effects from the proposed uses of kasugamycin (see **Table 17**). Species-specific concerns for indirect effects to listed organisms will require a determination of the

coincidence of kasugamycin use with locations of listed species and the biologically based resources upon which they depend.

Table 17 Screening Level Listed Species Risks Associated with Potential Direct or Indirect Effects Due to the Proposed Applications of Kasugamycin.

LISTED TAXON	POTENTIAL DIRECT EFFECTS	POTENTIAL INDIRECT EFFECTS
Terrestrial and semi-aquatic plants - monocots	Yes[1] (all uses)	Yes[2]
Terrestrial and semi-aquatic plants - dicots	No	Yes[2]
Birds	No	Yes[2]
Terrestrial-phase amphibians	No	Yes[2]
Reptiles	No	Yes[2]
Mammals	Yes (chronic; pome fruit and walnut uses)	Yes[2]
Aquatic plants	No	Yes[2]
Freshwater fish	No	Yes[2]
Aquatic-phase amphibians	No	Yes[2]
Freshwater crustaceans	No	Yes[2]
Mollusks	No	Yes[2]
Marine/estuarine fish	No	Yes[2]
Marine/estuarine crustaceans	No	Yes[2]

[1] Risk to this taxon is an uncertainty due to that fact that a NOAEC could not be established in the available data.
[2] The potential for adverse effects to those species that rely on mammals or those obligated to monocots cannot be precluded. Indirect effects may include general habitat modification, host plant loss, and food supply disruption.

(4). Critical Habitat

In the evaluation of pesticide effects on designated critical habitat, consideration is given to the physical and biological features (constituent elements) of a critical habitat identified by the U. S. Fish and Wildlife and National Marine Fisheries Services (the Services) as essential to the conservation of a listed species and which may require special management considerations or protection. The evaluation of impacts for a screening-level pesticide risk assessment focuses on the biological features that are constituent elements and is accomplished using the screening-level taxonomic analysis

(RQs) and levels of concern (LOCs) that are used to evaluate direct and indirect effects to listed organisms.

The screening-level risk assessment has identified potential concerns for indirect effects on listed species for those organisms dependant upon plants (monocots) and some animals (mammals). In light of the potential for indirect effects, the next step for EPA and the Services is to identify which listed species and their designated critical habitat(s), if applicable, are potentially implicated. Analytically, the identification of such species and their critical habitat can occur by determining whether the action area overlaps designated critical habitat or the occupied range of any listed species. If so, EPA would examine whether the pesticide's potential impacts on non-listed species would affect the listed species indirectly, or directly affect a constituent element of the critical habitats. At present, the information reviewed by EPA does not permit use of this analytical approach to make a definitive identification of species that are potentially impacted indirectly or designated critical habitats that are potentially impacted directly by the proposed uses of kasugamycin.

This screening-level risk assessment for critical habitats provides a listing of potential biological features that, if they are constituent elements of one or more critical habitats, would be of potential concern. These correspond to the taxa identified above (*i.e.*, monocots and mammals) as being of potential concern for adverse effects. This should serve as an initial step in problem formulation for further assessment of designated critical habitat impacts outlined above, should additional work be necessary.

(5). Co-occurrence Analysis

The goal of the analysis for co-location is to determine whether sites of pesticide use are geographically associated with known locations of listed species. At the screening level, this analysis is accomplished using the LOCATES (version 2.13) database. The database uses location information for listed species at the county level and compares it to agricultural census data (from 2002) for crop production at the same county level of resolution. The product is a listing of federally-listed species that are located within counties known to produce the crops upon which the pesticide will be used, in this case fruiting vegetables (tomatoes and peppers), pome fruits (apples and pears), and walnuts. For potential direct effects, only listed monocots (all uses) and mammals (apple, pear, and walnut uses only) will be considered, since they were the only taxa to have RQs above the listed species LOC or risks to the taxon could not be precluded based on available information. For indirect effects, all other taxa will be considered since there is a potential for indirect effects to taxa that might rely on plants and/or animals for some stage of their life-cycle.

LOCATES identified a total of 1,223 listed species that overlap at the county-level with areas where tomatoes, peppers, apples, pears, and walnuts are grown (see **APPENDIX G** for a complete species list). This preliminary analysis indicates that there is a potential for kasugamycin use to overlap with listed species and that a more refined assessment is warranted. The more refined assessment should involve clear delineation of the action

area associated with proposed uses of kasugamycin and best available information on the temporal and spatial co-location of listed species with respect to the action area. This analysis has not been conducted for this assessment.

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Ecotoxicity Studies:

MRID	Citation Reference
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459100-23	Henwood, S. (1993) Two-Generation Reproduction Study with Kasugamycin in Rats: Lab Project Number: TMN-0126: HWI 6434-102: TP2025. Unpublished study prepared by Hazleton Wisconsin, Inc. 1349 p.
479457-23	Mattock, S. (2002) Kasugamycin: Acute Toxicity to *Daphnia magna*. Project Number: 1442/16/D2149, 1442/16/D2149/OCR, 1442/16. Unpublished study prepared by Covance Laboratories, Ltd. 25 p.
479457-24	York, D. (2009) Kasugamycin Technical - Acute Toxicity to Eastern Oyster (*Crassostrea virginica*) Under Flow-Through Conditions. Project Number:

13917/6116, 13917/6116/OCR. Unpublished study prepared by Springborn Smithers Laboratories. 65 p.

479457-25 Fournier, A. (2009) Kasugamycin Technical - Acute Toxicity to Mysids (*Americamysis bahia*), Under Static Conditions. Project Number: 13917/6115, 1391/6115/OCR. Unpublished study prepared by Springborn Smithers Laboratories. 55 p.

479457-26 Fournier, A. (2009) Kasugamycin Technical - Acute Toxicity to Rainbow Trout (*Oncorhynchus mykiss*) Under Static Conditions. Project Number: 13917/6114, 13917/6114/OCR. Unpublished study prepared by Springborn Smithers Laboratories. 52 p.

479457-27 Fournier, A. (2009) Kasugamycin Technical - Acute Toxicity to Fathead Minnow (*Pimephales promelas*) Under Static Conditions. Project Number: 13917/6113, 13917/6113/OCR. Unpublished study prepared by Springborn Smithers Laboratories. 54 p.

479457-28 Fournier, A. (2009) Kasugamycin Technical - Acute Toxicity to Sheepshead Minnow (*Cyprinodon variegatus*) Under Static Conditions. Project Number: 13917/6112, 13917/6112/OCR. Unpublished study prepared by Springborn Smithers Laboratories. 52 p.

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479457-33 Redmond, C. (2009) Kasugamycin Technical - Acute Oral Toxicity Test (LD50) with Zebra Finch (*Taeniopygia guttata*). Project Number: 13917/4102, 13917/4102/OCR. Unpublished study prepared by Springborn Smithers Laboratories. 43 p.

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479457-38 Porch, J.; Krueger, H. (2009) Kasugamycin Technical: An Acute Contact Toxicity Study with the Honey Bee: Final Report. Project Number: 443/113, 443/113/OCR, 443/051309/BEECONT/SUB443. Unpublished study prepared by Wildlife International, Ltd. 38 p.

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479457-43 Softcheck, K. (2009) Kasugamycin Technical - 7-Day Toxicity Test with Duckweed (*Lemna gibba*). Project Number: 13917/6107, 13917/6107/OCR, 080108/OPPTS/SA/LEMNA. Unpublished study prepared by Springborn Smithers Laboratories. 87 p.

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479457-45 Softcheck, K. (2009) Kasugamycin Technical - 96-Hour Acute Toxicity Test with Freshwater Green Alga, *Pseudokirchneriella subcapitata*. Project Number: 13917/6108, 13917/6108/OCR, 0711408OPPTS/SA/PSS. Unpublished study prepared by Springborn Smithers Laboratories. 88 p.

479457-46 Softcheck, K. (2009) Kasugamycin Technical - 96-Hour Toxicity Test with the Marine Diatom, *Skeletonema costatum*. Project Number: 13917/6110, 13917/6110/OCR, 072808OPPTS/SA/SKEL. Unpublished study prepared by Springborn Smithers Laboratories. 75 p.

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464855-01 Swales, S. (2003) (Carbon 14) Kasugamycin: Hydrolytic Stability. Project Number: 1442/21. Unpublished study prepared by Covance Laboratories, Ltd. 123 p.

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482817-01 Orr, G. (2010) Kasugamycin Technical: Request for Waiver of Fish Bioconcentration Factor Data Requirement. Project Number: ARY/413/2455485. Unpublished study prepared by Arysta LifeScience North America, LLC . 5 p.

Appendix A: Open Literature Studies Available from the Public Version of ECOTOX (Available at: http://cfpub.epa.gov/ecotox/quick_query.htm)

Reference Number:	6905
Author(s):	Kobayashi, S.I.
Publication Year:	1978
Title:	Synergism in Pesticide Toxicity (2) Acute Oral Toxicity of Anti-ChE Pesticides in Mice
Source:	Toho Igakkai Zasshi (J. Med. Soc. Toho, Jpn.) 25(4): 635-649

This study is in Japanese and is, therefore, not considered for use in the risk assessment.

Reference Number:	5761
Author(s):	Hashimoto, Y., and Y. Nishiuchi
Publication Year:	1981
Title:	Establishment of Bioassay Methods for the Evaluation of Acute Toxicity of Pesticides to Aquatic Organisms
Source:	J. Pestic. Sci.6(2): 257-264

This study is in Japanese and is, therefore, not considered for use in the risk assessment.

Reference Number:	8589
Author(s):	Nishiuchi, Y.
Publication Year:	1989
Title:	Toxicity of Pesticides to Some Aquatic Animals. XI. Toxicity of Some Pesticides to Tadpoles
Source:	C. A. Sel. -Environ. Pollut. 18:3-72754Y (1990) / Aquat. Ecol. Chem. (Seitai Kaguku)9(4): 23-26

This study is in Japanese and is, therefore, not considered for use in the risk assessment.

Reference Number:	9158
Author(s):	Nishiuchi, Y., and K. Yoshida
Publication Year:	1972
Title:	Toxicities of Pesticides to Some Fresh Water Snails
Source:	Bull.Agric.Chem.Insp.Stn.(Tokyo)12(): 86-92

This study was translated from Japanese to English; specific data for kysugamycin could not be identified in the study.

Appendix B Screening Imbibition Program (SIP v. 1.0) Inputs and Outputs for the Proposed Uses of Kasugamycin

Table 1. Inputs

PARAMETER	VALUE
Chemical name	Kasugamycin
Solubility (in water at 25°C; mg/L)	228,000
Mammalian LD_{50} (mg/kg-bw)	5000
Mammalian test species	laboratory rat
Mammalian NOAEL (mg/kg-bw)	13.7
Mammalian test species	laboratory rat
Avian LD_{50} (mg/kg-bw)	2000
Avian test species	northern bobwhite quail
Mineau scaling factor	1.15
Bobwhite quail NOAEC (mg/kg-diet)	450

Table 2. Mammalian Results

PARAMETER	ACUTE	CHRONIC
Upper bound exposure (mg/kg-bw)	39216.0000	39216.0000
Adjusted toxicity value (mg/kg-bw)	3845.8028	10.5375
Ratio of exposure to toxicity	10.1971	3721.5659
Conclusion*	**Exposure through drinking water alone is a potential concern for mammals**	**Exposure through drinking water alone is a potential concern for mammals**

Table 3. Avian Results

PARAMETER	ACUTE	CHRONIC
Upper bound exposure (mg/kg-bw)	184680.0000	184680.0000
Adjusted toxicity value (mg/kg-bw)	1440.8590	47.8342
Ratio of exposure to acute toxicity	128.1735	3860.8324
Conclusion*	**Exposure through drinking water alone is a potential concern for birds**	**Exposure through drinking water alone is a potential concern for birds**

*Conclusion is for drinking water exposure alone. This does not combine all routes of exposure. Therefore, when aggregated with other routes (*i.e.*, diet, inhalation, dermal), pesticide exposure through drinking water may contribute to a total exposure that has potential for effects to non-target animals.

Appendix C Sample Screening Tool for Inhalation Risk (STIR v. 1.0) Inputs and Outputs for the Proposed Uses of Kasugamycin.

Table 1. Inputs

APPLICATION AND CHEMICAL INFORMATION	
Enter Chemical Name	Kasugamycin
Enter Chemical Use	Pome fruit
Is the Application a Spray? (enter y or n)	y
If Spray What Type (enter ground or air)	ground
Enter Chemical Molecular Weight (g/mole)	433.8
Enter Chemical Vapor Pressure (mmHg)	9.80E-08
Enter Application Rate (lb a.i./acre)	0.084
TOXICITY PROPERTIES	
Bird	
Enter Lowest Bird Oral LD_{50} (mg/kg bw)	2000
Enter Mineau Scaling Factor	1.15
Enter Tested Bird Weight (kg)	0.178
Mammal	
Enter Lowest Rat Oral LD_{50} (mg/kg bw)	5000
Enter Lowest Rat Inhalation LC_{50} (mg/L)	4.9
Duration of Rat Inhalation Study (hrs)	4
Enter Rat Weight (kg)	0.35

Table 2. Outputs

RESULTS Avian (0.020 kg)		**CONCLUSIONS**
Maximum Vapor Concentration in Air at Saturation (mg/m^3)	2.29E-03	
Maximum 1-hour Vapor Inhalation Dose (mg/kg)	2.88E-04	
Adjusted Inhalation LD_{50}	1.09E+01	
Ratio of Vapor Dose to Adjusted Inhalation LD_{50}	2.63E-05	**Exposure not Likely Significant**
Maximum Post-treatment Spray Inhalation Dose (mg/kg)	8.88E-03	
Ratio of Droplet Inhalation Dose to Adjusted Inhalation LD_{50}	8.12E-04	**Exposure not Likely Significant**
RESULTS Mammalian (0.015 kg)		
Maximum Vapor Concentration in Air at Saturation (mg/m^3)	2.29E-03	
Maximum 1-hour Vapor Inhalation Dose (mg/kg)	3.62E-04	
Adjusted Inhalation LD_{50}	2.92E+02	
Ratio of Vapor Dose to Adjusted Inhalation LD_{50}	1.24E-06	**Exposure not Likely Significant**
Maximum Post-treatment Spray Inhalation Dose (mg/kg)	1.12E-02	
Ratio of Droplet Inhalation Dose to Adjusted Inhalation LD_{50}	3.82E-05	**Exposure not Likely Significant**

Appendix D Example PRZM/EXAMS Output Data for highest Peak EECs

FL Pepper:

stored as FLPepper.out
Chemical: kasugamycin
PRZM environment: FLpeppersSTD.txt modified Tueday, 26 August 2008 at 06:16:38
EXAMS environment: pond298.exv modified Tueday, 26 August 2008 at 06:14:08
Metfile: w12844.dvf modified Tueday, 26 August 2008 at 06:14:22
Water segment concentrations (ppb)

Year	Peak	96 hr	21 Day	60 Day	90 Day	Yearly
1961	0.1924	0.1861	0.167	0.0988	0.06587	0.01624
1962	1.213	1.18	0.506	0.2981	0.2933	0.1687
1963	4.44	2.61	1.466	0.8275	0.7419	0.365
1964	5.417	5.242	4.937	3.139	2.722	1.464
1965	3.64	3.554	3.218	2.613	2.247	0.8803
1966	3.748	3.644	3.4	2.775	2.388	0.9022
1967	0.9341	0.907	0.8229	0.7176	0.6365	0.2695
1968	0.4972	0.4823	0.4303	0.2936	0.2615	0.1487
1969	2.722	2.645	2.417	2.081	1.863	0.8855
1970	3.093	3.021	2.76	2.32	2.092	0.7896
1971	0.887	0.8565	0.4626	0.2527	0.2245	0.1475
1972	1.098	1.061	0.9302	0.7445	0.64	0.271
1973	0.9985	0.9687	0.9008	0.7848	0.6878	0.2955
1974	2.502	2.429	2.028	1.407	1.186	0.6071
1975	1.953	1.892	1.664	1.287	1.089	0.4347
1976	1.467	1.424	1.293	0.7429	0.6236	0.3716
1977	3.971	3.855	3.615	2.356	1.587	0.7749
1978	3.501	3.387	3.054	2.281	1.997	0.9165
1979	3.277	3.219	2.91	2.361	2.042	0.9086
1980	2.388	2.328	2.119	1.864	1.711	0.764
1981	3.319	1.726	0.8291	0.7383	0.675	0.286
1982	3.343	3.245	2.97	2.358	2.01	0.8104
1983	2.588	2.508	2.096	1.199	1.046	0.5223
1984	14.34	13.87	12.21	7.109	4.761	1.65
1985	7.628	7.468	6.848	5.654	4.944	1.91
1986	6.652	6.423	5.639	2.791	2.313	1.273
1987	4.695	4.576	4.127	3.32	2.845	1.138
1988	1.308	1.274	1.194	1.003	0.8741	0.344
1989	2.005	1.951	0.9319	0.3709	0.3306	0.1897
1990	1.778	1.719	1.579	1.228	1.067	0.4036

Sorted results

Prob.	Peak	96 hr	21 Day	60 Day	90 Day	Yearly	
0.032258064516129	14.34	13.87	12.21	7.109	4.944	1.91	
0.0645161290322581	7.628	7.468	6.848	5.654	4.761	1.65	
0.0967741935483871	6.652	6.423	5.639	3.32	2.845	1.464	
0.129032258064516	5.417	5.242	4.937	3.139	2.722	1.273	
0.161290322580645	4.695	4.576	4.127	2.791	2.388	1.138	
0.193548387096774	4.44	3.855	3.615	2.775	2.313	0.9165	
0.225806451612903	3.971	3.644	3.4	2.613	2.247	0.9086	
0.258064516129032	3.748	3.554	3.218	2.361	2.092	0.9022	
0.290322580645161	3.64	3.387	3.054	2.358	2.042	0.8855	
0.32258064516129	3.501	3.245	2.97	2.356	2.01	0.8803	
0.354838709677419	3.343	3.219	2.91	2.32	1.997	0.8104	
0.387096774193548	3.319	3.021	2.76	2.281	1.863	0.7896	
0.419354838709677	3.277	2.645	2.417	2.081	1.711	0.7749	
0.451612903225806	3.093	2.61	2.119	1.864	1.587	0.764	
0.483870967741936	2.722	2.508	2.096	1.407	1.186	0.6071	
0.516129032258065	2.588	2.429	2.028	1.287	1.089	0.5223	
0.548387096774194	2.502	2.328	1.664	1.228	1.067	0.4347	
0.580645161290323	2.388	1.951	1.579	1.199	1.046	0.4036	
0.612903225806452	2.005	1.892	1.466	1.003	0.8741	0.3716	
0.645161290322581	1.953	1.726	1.293	0.8275	0.7419	0.365	
0.67741935483871	1.778	1.719	1.194	0.7848	0.6878	0.344	
0.709677419354839	1.467	1.424	0.9319	0.7445	0.675	0.2955	
0.741935483870968	1.308	1.274	0.9302	0.7429	0.64	0.286	

0.774193548387097		1.213	1.18	0.9008	0.7383	0.6365	0.271
0.806451612903226		1.098	1.061	0.8291	0.7176	0.6236	0.2695
0.838709677419355		0.9985	0.9687	0.8229	0.3709	0.3306	0.1897
0.870967741935484		0.9341	0.907	0.506	0.2981	0.2933	0.1687
0.903225806451613		0.887	0.8565	0.4626	0.2936	0.2615	0.1487
0.935483870967742		0.4972	0.4823	0.4303	0.2527	0.2245	0.1475
0.967741935483871		0.1924	0.1861	0.167	0.0988	0.06587	0.01624
0.1	6.5285	6.3049	5.5688	3.3019	2.8327	1.4449	
					Average of yearly averages:		0.663604666666667

Inputs generated by pe5.pl - Novemeber 2006

Data used for this run:
Output File: FLPepper
Metfile: w12844.dvf
PRZM scenario: FLpeppersSTD.txt
EXAMS environment file: pond298.exv
Chemical Name: kasugamycin

Description	Variable Name	Value	Units	Comments
Molecular weight	mwt	433.84	g/mol	
Henry's Law Const.	henry		atm-m^3/mol	
Vapor Pressure	vapr	9.83E-08	torr	
Solubility sol	228000	mg/L		
Kd Kd		mg/L		
Koc Koc	217.5	mg/L		
Photolysis half-life	kdp	0	days	Half-life
Aerobic Aquatic Metabolism	kbacw	43	days	Halfife
Anaerobic Aquatic Metabolism	kbacs	434	days	Halfife
Aerobic Soil Metabolism	asm	219	days	Halfife
Hydrolysis:	pH 5	630	days	Half-life
Hydrolysis:	pH 7	1155	days	Half-life
Hydrolysis:	pH 9	6932	days	Half-life
Method: CAM	2	integer	See PRZM manual	
Incorporation Depth:	DEPI		cm	
Application Rate:	TAPP	0.09	kg/ha	
Application Efficiency:		APPEFF	0.99	fraction
Spray Drift	DRFT	0.01	fraction of application rate applied to pond	
Application Date	Date	15-11	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	0.09	kg/ha		
Interval 2 interval	7	days	Set to 0 or delete line for single app.	
app. rate 2 apprate	0.09	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)	

Appendix E Sample T-REX Inputs and Outputs for the Proposed Uses of Kasugamycin.

INPUTS:

Chemical Name:	Kasugamycin
Use	Fruiting vegetables
Formulation	0
Application Rate	0.084 lbs a.i./acre
Half-life	35 days
Application Interval	3 days
Maximum # Apps./Year	4
Length of Simulation	1 year

Endpoints			
Avian	**Bobwhite quail**	**LD50 (mg/kg-bw)**	**2000.00**
	Bobwhite quail	**LC50 (mg/kg-diet)**	**4858.00**
	Mallard duck	**NOAEL(mg/kg-bw)**	**0.00**
	Bobwhite quail	**NOAEC (mg/kg-diet)**	**450.00**
Mammals		**LD50 (mg/kg-bw)**	**5000.00**
		LC50 (mg/kg-diet)	**0.00**
		NOAEL (mg/kg-bw)	**13.70**
		NOAEC (mg/kg-diet)	**274.00**

Dietary-based EECs (ppm)	**Kenaga Values**
Short Grass	**73.93**
Tall Grass	**33.88**
Broadleaf plants/sm Insects	**41.58**
Fruits/pods/seeds/lg insects	**4.62**

OUTPUTS:
Summary of Risk Quotient Calculations Based on Upper Bound Kenaga EECs.

Table 1. 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	1440.86	84.20	0.06	38.59	0.03	47.36	0.03	5.26	0.00	1.17	0.00
100	1834.29	48.01	0.03	22.01	0.01	27.01	0.01	3.00	0.00	0.67	0.00
1000	2591.00	21.50	0.01	9.85	0.00	12.09	0.00	1.34	0.00	0.30	0.00

Table 2. 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
4858	73.93	0.02	33.88	0.01	41.58	0.01	4.62	0.00

Size class not used for dietary risk quotients

Table 3. Upper Bound Kenaga, Chronic Avian Dietary Based Risk Quotients.

	EECs and RQs							
	Short Grass		Tall Grass		Broadleaf Plants/ Small Insects		Fruits/Pods/ Seeds/ Large Insects	
NOAEC (ppm)	EEC	RQ	EEC	RQ	EEC	RQ	EEC	RQ
450	73.93	0.16	33.88	0.08	41.58	0.09	4.62	0.01

Size class not used for dietary risk quotients

Table 4. 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	10989.15	70.48	0.01	32.31	0.00	39.65	0.00	4.41	0.00	0.98	0.00
35	8891.40	48.71	0.01	22.33	0.00	27.40	0.00	3.04	0.00	0.68	0.00
1000	3845.80	11.29	0.00	5.18	0.00	6.35	0.00	0.71	0.00	0.16	0.00

Table 5. 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
274	73.93	0.27	33.88	0.12	41.58	0.15	4.62	0.02

Size class not used for dietary risk quotients

Table 6. 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	30.11	70.48	2.34	32.31	1.07	39.65	1.32	4.41	0.15	0.98	0.03
35	24.36	48.71	2.00	22.33	0.92	27.40	1.12	3.04	0.12	0.68	0.03
1000	10.54	11.29	1.07	5.18	0.49	6.35	0.60	0.71	0.07	0.16	0.01

Appendix F SAMPLE TerrPlant Inputs and Outputs for the Proposed Kasugamycin Uses.

Table 1. Chemical Identity.

Chemical Name	Kasugamycin
PC code	230001
Use	Walnuts
Application Method	Ground
Application Form	Liquid
Solubility in Water (ppm)	>100

Table 2. Input parameters used to derive EECs.

Input Parameter	Symbol	Value	Units
Application Rate	A	0.084	lb a.i./acre
Incorporation	I	1	none
Runoff Fraction	R	0.05	none
Drift Fraction	D	0.01	none

Table 3. EECs for Kasugamycin. Units in lb a.i./acre.

Description	Equation	EEC
Runoff to dry areas	(A/I)*R	0.0042
Runoff to semi-aquatic areas	(A/I)*R*10	0.042
Spray drift	A*D	0.00084
Total for dry areas	((A/I)*R)+(A*D)	0.00504
Total for semi-aquatic areas	((A/I)*R*10)+(A*D)	0.04284

Table 4. Plant survival and growth data used for RQ derivation. Units are in lb a.i./acre.

	Seedling Emergence		Vegetative Vigor	
Plant type	**EC25**	**NOAEC**	**EC25**	**NOAEC**
Monocot	0.0925	<0.0925	0.0964	0.0964
Dicot	0.0925	0.0925	0.0964	0.0964

Table 5. RQ values for plants in dry and semi-aquatic areas exposed to through runoff and/or spray drift.*

Plant Type	Listed Status	Dry	Semi-Aquatic	Spray Drift
Monocot	**non-listed**	<0.1	0.46	<0.1
Monocot	**listed**	N/A	N/A	N/A
Dicot	**non-listed**	<0.1	0.46	<0.1
Dicot	**listed**	<0.1	0.46	<0.1

*If RQ > 1.0, the LOC is exceeded, resulting in potential for risk to that plant group.

Appendix G LOCATES RUN: County Occurrence List by State and Taxa for the Following Proposed Kasugamycin Uses: Walnuts (English), Tomatoes (in the open), Peppers (harvested), Peppers (other than bell, including chili), Peppers (bell, excluding pimientos), Pears (all), Apples

Total: 1223 Species

Inverse Name	Species	Taxon	Medium	
Abalone, White	*Haliotis sorenseni*	Gastropod	Saltwater	
Abutilon sandwicense (ncn)	*Abutilon sandwicense*	Dicot	Terrestrial	
Achyranthes mutica (ncn)	*Achyranthes mutica*	Dicot	Terrestrial	
Achyranthes splendens var. rotundata (ncn)	*Achyranthes splendens var. rotundata*	Dicot	Terrestrial	
Adobe Sunburst, San Joaquin	*Pseudobahia peirsonii*	Dicot	Terrestrial	
A'e (Zanthoxylum dipetalum var. tomentosum)	*Zanthoxylum dipetalum var. tomentosum*	Dicot	Terrestrial	
A'e (Zanthoxylum hawaiiense)	*Zanthoxylum hawaiiense*	Dicot	Terrestrial	
'Aiea (Nothocestrum breviflorum)	*Nothocestrum breviflorum*	Dicot	Terrestrial	
'Aiea (Nothocestrum peltatum)	*Nothocestrum peltatum*	Dicot	Terrestrial	
'Akepa, Hawaii	*Loxops coccineus coccineus*	Bird	Terrestrial	
'Akepa, Maui	*Loxops coccineus ochraceus*	Bird	Terrestrial	
'Akia Loa, Kauai (Hemignathus procerus)	*Hemignathus procerus*	Bird	Terrestrial	
'Akia Pola'au (Hemignathus	*Hemignathus munroi*	Bird	Terrestrial	
'Akoko (Chamaesyce celastroides var. kaenana)	*Chamaesyce celastroides var. kaenana*	Dicot	Terrestrial	
'Akoko (Chamaesyce deppeana)	*Chamaesyce deppeana*	Dicot	Terrestrial	
'Akoko (Chamaesyce herbstii)	*Chamaesyce herbstii*	Dicot	Terrestrial	
'Akoko (Chamaesyce kuwaleana)	*Chamaesyce kuwaleana*	Dicot	Terrestrial	
'Akoko (Chamaesyce rockii)	*Chamaesyce rockii*	Dicot	Terrestrial	
'Akoko (Chamaesyce skottsbergii var. skottsbe	*Chamaesyce skottsbergii var. kalaeloana*	Dicot	Terrestrial	
'Akoko (Euphorbia haeleeleana)	*Euphorbia haeleeleana*	Dicot	Terrestrial	
Alani (Melicope adscendens)	*Melicope adscendens*	Dicot	Terrestrial	
Alani (Melicope balloui)	*Melicope balloui*	Dicot	Terrestrial	
Alani (Melicope haupuensis)	*Melicope haupuensis*	Dicot	Terrestrial	
Alani (Melicope knudsenii)	*Melicope knudsenii*	Dicot	Terrestrial	
Alani (Melicope lydgatei)	*Melicope lydgatei*	Dicot	Terrestrial	
Alani (Melicope mucronulata)	*Melicope mucronulata*	Dicot	Terrestrial	
Alani (Melicope ovalis)	*Melicope ovalis*	Dicot	Terrestrial	
Alani (Melicope pallida)	*Melicope pallida*	Dicot	Terrestrial	
Alani (Melicope quadrangularis)	*Melicope quadrangularis*	Dicot	Terrestrial	
Alani (Melicope saint-johnii)	*Melicope saint-johnii*	Dicot	Terrestrial	
Alani (Melicope zahlbruckneri)	*Melicope zahlbruckneri*	Dicot	Terrestrial	
Albatross, Short-tailed	*Phoebastria (=Diomedea) albatrus*	Bird	Terrestrial, Saltwater	
Alligator, American	*Alligator mississippiensis*	Reptile	Terrestrial, Freshwater, Brackish	
Allocarya, Calistoga	*Plagiobothrys strictus*	Dicot	Vernal pool	
Alopecurus, Sonoma	*Alopecurus aequalis var.*	Monocot	Terrestrial	
Alsinidendron obovatum (ncn)	*Alsinidendron obovatum*	Dicot	Terrestrial	
Alsinidendron trinerve (ncn)	*Alsinidendron trinerve*	Dicot	Terrestrial	
Alsinidendron viscosum (ncn)	*Alsinidendron viscosum*	Dicot	Terrestrial	
Amaranth, Seabeach	*Amaranthus pumilus*	Dicot	Coastal	
Ambersnail, Kanab	*Oxyloma haydeni kanabensis*	Gastropod	Terrestrial, Freshwater	
Ambrosia, San Diego	*Ambrosia pumila*	Dicot	Terrestrial	
Ambrosia, South Texas	*Ambrosia cheiranthifolia*	Dicot	Terrestrial	
Amole, Cammatta Canyon	*Chlorogalum purpureum var. reductum*	Monocot	Terrestrial	
Amole, Purple	*Chlorogalum purpureum var. purpureum*	Monocot	Terrestrial	
Amphianthus, Little	*Amphianthus pusillus*	Dicot	Freshwater	
Amphipod, Illinois Cave	*Gammarus acherondytes*	Crustacean	Freshwater, Subterraneous	
Amphipod, Kauai Cave	*Spelaeorchestia koloana*	Crustacean	Freshwater, Subterraneous	
Amphipod, Noel's	*Gammarus desperatus*	Crustacean	Freshwater	
Amphipod, Peck's Cave	*Stygobromus (=Stygonectes) pecki*	Crustacean	Freshwater, Subterraneous	
'Anaunau (Lepidium arbuscula)	*Lepidium arbuscula*	Dicot	Terrestrial	
'Anunu (Sicyos alba)	*Sicyos alba*	Dicot	Terrestrial	
Aristida chaseae (ncn)	*Aristida chaseae*	Monocot	Terrestrial	

Arrowhead, Bunched	*Sagittaria fasciculata*	Monocot	Freshwater
Aster, Decurrent False	*Boltonia decurrens*	Dicot	Terrestrial, Freshwater
Aster, Florida Golden	*Chrysopsis floridana*	Dicot	Terrestrial
Aster, Ruth's Golden	*Pityopsis ruthii*	Dicot	Terrestrial
Auerodendron pauciflorum (ncn)	*Auerodendron pauciflorum*	Dicot	Terrestrial
Aupaka (Isodendrion hosakae)	*Isodendrion hosakae*	Dicot	Terrestrial
Aupaka (Isodendrion laurifolium)	*Isodendrion laurifolium*	Dicot	Terrestrial
Aupaka (Isodendrion longifolium)	*Isodendrion longifolium*	Dicot	Terrestrial
Avens, Spreading	*Geum radiatum*	Dicot	Terrestrial
'Awiwi (Centaurium sebaeoides)	*Centaurium sebaeoides*	Dicot	Terrestrial
'Awiwi (Hedyotis cookiana)	*Hedyotis cookiana*	Dicot	Terrestrial
Ayenia, Texas	*Ayenia limitaris*	Dicot	Terrestrial
Baccharis, Encinitas	*Baccharis vanessae*	Dicot	Terrestrial
Bankclimber, Purple	*Elliptoideus sloatianus*	Bivalve	Freshwater
Barbara Buttons, Mohr's	*Marshallia mohrii*	Dicot	Terrestrial
Barberry, Island	*Berberis pinnata ssp. insularis*	Dicot	Terrestrial
Barberry, Nevin's	*Berberis nevinii*	Dicot	Terrestrial
Bariaco	*Trichilia triacantha*	Dicot	Terrestrial
Bat, Gray	*Myotis grisescens*	Mammal	Terrestrial, Subterraneous
Bat, Hawaiian Hoary	*Lasiurus cinereus semotus*	Mammal	Terrestrial, Subterraneous
Bat, Indiana	*Myotis sodalis*	Mammal	Terrestrial, Subterraneous
Bat, Lesser (=Sanborn's) Long-nosed	*Leptonycteris curasoae yerbabuenae*	Mammal	Terrestrial, Subterraneous
Bat, Mexican Long-nosed	*Leptonycteris nivalis*	Mammal	Terrestrial, Subterraneous
Bat, Ozark Big-eared	*Corynorhinus (=Plecotus) townsendii ingens*	Mammal	Terrestrial, Subterraneous
Bat, Virginia Big-eared	*Corynorhinus (=Plecotus) townsendii virginianus*	Mammal	Terrestrial, Subterraneous
Beaked-rush, Knieskern's	*Rhynchospora knieskernii*	Monocot	Terrestrial
Bear, American Black	*Ursus americanus*	Mammal	Terrestrial
Bear, Grizzly	*Ursus arctos horribilis*	Mammal	Terrestrial
Bear, Louisiana Black	*Ursus americanus luteolus*	Mammal	Terrestrial
Bearclaw poppy, Dwarf	*Arctomecon humilis*	Dicot	Terrestrial
Beardtongue, Penland	*Penstemon penlandii*	Dicot	Terrestrial
Beargrass, Britton's	*Nolina brittoniana*	Monocot	Terrestrial
Beauty, Harper's	*Harperocallis flava*	Monocot	Terrestrial, Freshwater
Bedstraw, El Dorado	*Galium californicum ssp. sierrae*	Dicot	Terrestrial
Bedstraw, Island	*Galium buxifolium*	Dicot	Terrestrial
Beetle, American Burying	*Nicrophorus americanus*	Insect	Terrestrial
Beetle, Coffin Cave Mold	*Batrisodes texanus*	Insect	Subterraneous
Beetle, Comal Springs Dryopid	*Stygoparnus comalensis*	Insect	Freshwater, Subterraneous
Beetle, Comal Springs Riffle	*Heterelmis comalensis*	Insect	Freshwater, Subterraneous
Beetle, Delta Green Ground	*Elaphrus viridis*	Insect	Terrestrial, Vernal pool
Beetle, Helotes Mold	*Batrisodes venyivi*	Insect	Subterraneous
Beetle, Hungerford's Crawling Water	*Brychius hungerfordi*	Insect	Freshwater
Beetle, Kretschmarr Cave Mold	*Texamaurops reddelli*	Insect	Subterraneous
Beetle, Mount Hermon June	*Polyphylla barbata*	Insect	Terrestrial, Subterraneous
Beetle, Northeastern Beach Tiger	*Cicindela dorsalis dorsalis*	Insect	Terrestrial
Beetle, Ohlone Tiger	*Cicindela ohlone*	Insect	Terrestrial
Beetle, Puritan Tiger	*Cicindela puritana*	Insect	Terrestrial, Coastal
Beetle, Salt Creek Tiger	*Cicindela nevadica lincolniana*	Insect	Terrestrial
Beetle, Tooth Cave Ground	*Rhadine persephone*	Insect	Subterraneous
Beetle, Valley Elderberry Longhorn	*Desmocerus californicus dimorphus*	Insect	Terrestrial
Bellflower, Brooksville	*Campanula robinsiae*	Dicot	Terrestrial
Birch, Virginia Round-leaf	*Betula uber*	Dicot	Floodplain
Bird's-beak, Palmate-bracted	*Cordylanthus palmatus*	Dicot	Terrestrial
Bird's-beak, Pennell's	*Cordylanthus tenuis ssp. capillaris*	Dicot	Terrestrial
Bird's-beak, salt marsh	*Cordylanthus maritimus ssp. maritimus*	Dicot	Saltwater
Bird's-beak, Soft	*Cordylanthus mollis ssp. mollis*	Dicot	Brackish, Saltwater
Birds-in-a-nest, White	*Macbridea alba*	Dicot	Terrestrial
Bittercress, Small-anthered	*Cardamine micranthera*	Dicot	Terrestrial
Blackbird, Yellow-shouldered	*Agelaius xanthomus*	Bird	Terrestrial
Bladderpod, Dudley Bluffs	*Lesquerella congesta*	Dicot	Terrestrial
Bladderpod, Kodachrome	*Lesquerella tumulosa*	Dicot	Terrestrial
Bladderpod, Lyrate	*Lesquerella lyrata*	Dicot	Terrestrial
Bladderpod, Missouri	*Lesquerella filiformis*	Dicot	Terrestrial
Bladderpod, San Bernardino Mountains	*Lesquerella kingii ssp. bernardina*	Dicot	Terrestrial
Bladderpod, Spring Creek	*Lesquerella perforata*	Dicot	Floodplain
Bladderpod, White	*Lesquerella pallida*	Dicot	Terrestrial

Bladderpod, Zapata	*Lesquerella thamnophila*	Dicot	Terrestrial
Blazing Star, Ash Meadows	*Mentzelia leucophylla*	Dicot	Terrestrial
Blazing Star, Heller's	*Liatris helleri*	Dicot	Terrestrial
Blazing Star, Scrub	*Liatris ohlingerae*	Dicot	Terrestrial
Bluecurls, Hidden Lake	*Trichostema austromontanum ssp. compactum*	Dicot	Terrestrial
Bluegrass, Hawaiian	*Poa sandvicensis*	Monocot	Terrestrial
Bluegrass, Mann's (Poa mannii)	*Poa mannii*	Monocot	Terrestrial
Bluegrass, Napa	*Poa napensis*	Monocot	Terrestrial, Freshwater
Bluegrass, San Bernardino	*Poa atropurpurea*	Monocot	Terrestrial
Blue-star, Kearney's	*Amsonia kearneyana*	Dicot	Terrestrial
Bluet, Roan Mountain	*Hedyotis purpurea var. montana*	Dicot	Terrestrial
Boa, Puerto Rican	*Epicrates inornatus*	Reptile	Terrestrial
Boa, Virgin Islands Tree	*Epicrates monensis granti*	Reptile	Terrestrial
Bobwhite, Masked	*Colinus virginianus ridgwayi*	Bird	Terrestrial
Bonamia menziesii (ncn)	*Bonamia menziesii*	Dicot	Terrestrial
Bonamia, Florida	*Bonamia grandiflora*	Dicot	Terrestrial
Boxwood, Vahl's	*Buxus vahlii*	Dicot	Terrestrial
Brodiaea, Chinese Camp	*Brodiaea pallida*	Monocot	Terrestrial
Brodiaea, Thread-leaved	*Brodiaea filifolia*	Monocot	Terrestrial
Broom, San Clemente Island	*Lotus dendroideus ssp. traskiae*	Dicot	Terrestrial
Buckwheat, Cushenbury	*Eriogonum ovalifolium var. vineum*	Dicot	Terrestrial
Buckwheat, Ione (incl. Irish Hill)	*Eriogonum apricum (incl. var. prostratum)*	Dicot	Terrestrial
Buckwheat, Scrub	*Eriogonum longifolium var. gnaphalifolium*	Dicot	Terrestrial
Buckwheat, Southern Mountain Wild	*Eriogonum kennedyi var. austromontanum*	Dicot	Terrestrial
Buckwheat, Steamboat	*Eriogonum ovalifolium var. williamsiae*	Dicot	Terrestrial
Bulrush, Northeastern (=Barbed Bristle)	*Scirpus ancistrochaetus*	Monocot	Terrestrial, Freshwater
Bush-mallow, San Clemente Island	*Malacothamnus clementinus*	Dicot	Terrestrial
Bush-mallow, Santa Cruz Island	*Malacothamnus fasciculatus var. nesioticus*	Dicot	Terrestrial
Buttercup, Autumn	*Ranunculus aestivalis (=acriformis)*	Dicot	Terrestrial
Butterfly Plant, Colorado	*Gaura neomexicana var. coloradensis*	Dicot	Terrestrial
Butterfly, Bay Checkerspot (Wright's euphydryas)	*Euphydryas editha bayensis*	Insect	Terrestrial
Butterfly, Behren's Silverspot	*Speyeria zerene behrensii*	Insect	Terrestrial
Butterfly, Callippe Silverspot	*Speyeria callippe callippe*	Insect	Terrestrial
Butterfly, El Segundo Blue	*Euphilotes battoides allyni*	Insect	Terrestrial
Butterfly, Fender's Blue	*Icaricia icarioides fenderi*	Insect	Terrestrial
Butterfly, Karner Blue	*Lycaeides melissa samuelis*	Insect	Terrestrial
Butterfly, Lange's Metalmark	*Apodemia mormo langei*	Insect	Terrestrial
Butterfly, Lotis Blue	*Lycaeides argyrognomon lotis*	Insect	Terrestrial
Butterfly, Mission Blue	*Icaricia icarioides missionensis*	Insect	Terrestrial
Butterfly, Mitchell's Satyr	*Neonympha mitchellii mitchellii*	Insect	Terrestrial, Perm. wetland
Butterfly, Myrtle's Silverspot	*Speyeria zerene myrtleae*	Insect	Terrestrial
Butterfly, Oregon Silverspot	*Speyeria zerene hippolyta*	Insect	Terrestrial
Butterfly, Palos Verdes Blue	*Glaucopsyche lygdamus palosverdesensis*	Insect	Terrestrial
Butterfly, Quino Checkerspot	*Euphydryas editha quino (=E. e. wrighti)*	Insect	Terrestrial
Butterfly, Saint Francis' Satyr	*Neonympha mitchellii francisci*	Insect	Terrestrial
Butterfly, San Bruno Elfin	*Callophrys mossii bayensis*	Insect	Terrestrial
Butterfly, Smith's Blue	*Euphilotes enoptes smithi*	Insect	Terrestrial
Butterfly, Uncompahgre Fritillary	*Boloria acrocnema*	Insect	Terrestrial
Butterweed, Layne's	*Senecio layneae*	Dicot	Terrestrial
Butterwort, Godfrey's	*Pinguicula ionantha*	Dicot	Terrestrial, Freshwater
Button-celery, San Diego	*Eryngium aristulatum var. parishii*	Dicot	Terrestrial
Cactus, Arizona Hedgehog	*Echinocereus triglochidiatus var. arizonicus*	Dicot	Terrestrial
Cactus, Bakersfield	*Opuntia treleasei*	Dicot	Terrestrial
Cactus, Black Lace	*Echinocereus reichenbachii var. albertii*	Dicot	Terrestrial
Cactus, Brady Pincushion	*Pediocactus bradyi*	Dicot	Terrestrial
Cactus, Bunched Cory	*Coryphantha ramillosa*	Dicot	Terrestrial
Cactus, Chisos Mountain Hedgehog	*Echinocereus chisoensis var. chisoensis*	Dicot	Terrestrial

Cactus, Cochise Pincushion	*Coryphantha robbinsorum*	Dicot	Terrestrial
Cactus, Knowlton	*Pediocactus knowltonii*	Dicot	Terrestrial
Cactus, Kuenzler Hedgehog	*Echinocereus fendleri var. kuenzleri*	Dicot	Terrestrial
Cactus, Lee Pincushion	*Coryphantha sneedii var. leei*	Dicot	Terrestrial
Cactus, Lloyd's Mariposa	*Echinomastus mariposensis*	Dicot	Terrestrial
Cactus, Mesa Verde	*Sclerocactus mesae-verdae*	Dicot	Terrestrial
Cactus, Nellie Cory	*Coryphantha minima*	Dicot	Terrestrial
Cactus, Nichol's Turk's Head	*Echinocactus horizonthalonius var. nicholii*	Dicot	Terrestrial
Cactus, Peebles Navajo	*Pediocactus peeblesianus peeblesianus*	Dicot	Terrestrial
Cactus, Pima Pineapple	*Coryphantha scheeri var. robustispina*	Dicot	Terrestrial
Cactus, San Rafael	*Pediocactus despainii*	Dicot	Terrestrial
Cactus, Siler Pincushion	*Pediocactus (=Echinocactus,=Utahia) sileri*	Dicot	Terrestrial
Cactus, Sneed Pincushion	*Coryphantha sneedii var. sneedii*	Dicot	Terrestrial
Cactus, Star	*Astrophytum asterias*	Dicot	Terrestrial
Cactus, Tobusch Fishhook	*Ancistrocactus tobuschii*	Dicot	Terrestrial
Cactus, Uinta Basin hookless	*Sclerocactus wetlandicus*	Dicot	Terrestrial
Cactus, Winkler	*Pediocactus winkleri*	Dicot	Terrestrial
Cactus, Wright Fishhook	*Sclerocactus wrightiae*	Dicot	Terrestrial
Campeloma, Slender	*Campeloma decampi*	Gastropod	Freshwater
Campion, Fringed	*Silene polypetala*	Dicot	Terrestrial
Capa Rosa	*Callicarpa ampla*	Dicot	Terrestrial
Caracara, Audubon's Crested	*Polyborus plancus audubonii*	Bird	Terrestrial
Caribou, Woodland	*Rangifer tarandus caribou*	Mammal	Terrestrial
Catchfly, Spalding's	*Silene spaldingii*	Dicot	Terrestrial
Catesbaea Melanocarpa (ncn)	*Catesbaea melanocarpa*	Dicot	Terrestrial
Catfish, Yaqui	*Ictalurus pricei*	Fish	Freshwater
Cat's-eye, Terlingua Creek	*Cryptantha crassipes*	Dicot	Terrestrial
Cavefish, Alabama	*Speoplatyrhinus poulsoni*	Fish	Freshwater
Cavefish, Ozark	*Amblyopsis rosae*	Fish	Freshwater
Cavesnail, Tumbling Creek	*Antrobia culveri*	Gastropod	Freshwater, Subterraneous
Ceanothus, Coyote	*Ceanothus ferrisae*	Dicot	Terrestrial
Ceanothus, Pine Hill	*Ceanothus roderickii*	Dicot	Terrestrial
Ceanothus, Vail Lake	*Ceanothus ophiochilus*	Dicot	Terrestrial
Centaury, Spring-loving	*Centaurium namophilum*	Dicot	Terrestrial
Chaffseed, American	*Schwalbea americana*	Dicot	Terrestrial
Chamaecrista glandulosa (ncn)	*Chamaecrista glandulosa var. mirabilis*	Dicot	Terrestrial
Chamaesyce Halemanui (ncn)	*Chamaesyce halemanui*	Dicot	Terrestrial
Checker-mallow, Keck's	*Sidalcea keckii*	Dicot	Terrestrial
Checker-mallow, Kenwood Marsh	*Sidalcea oregana ssp. valida*	Dicot	Terrestrial
Checker-mallow, Nelson's	*Sidalcea nelsoniana*	Dicot	Terrestrial
Checker-mallow, Pedate	*Sidalcea pedata*	Dicot	Terrestrial
Checker-mallow, Wenatchee Mountains	*Sidalcea oregana var. calva*	Dicot	Terrestrial
Chub, Bonytail	*Gila elegans*	Fish	Freshwater
Chub, Chihuahua	*Gila nigrescens*	Fish	Freshwater
Chub, Gila	*Gila intermedia*	Fish	Freshwater
Chub, Humpback	*Gila cypha*	Fish	Freshwater
Chub, Hutton Tui	*Gila bicolor ssp.*	Fish	Freshwater
Chub, Mohave Tui	*Gila bicolor mohavensis*	Fish	Freshwater
Chub, Oregon	*Oregonichthys crameri*	Fish	Freshwater
Chub, Owens Tui	*Gila bicolor snyderi*	Fish	Freshwater
Chub, Pahranagat Roundtail	*Gila robusta jordani*	Fish	Freshwater
Chub, Slender	*Erimystax cahni*	Fish	Freshwater
Chub, Sonora	*Gila ditaenia*	Fish	Freshwater
Chub, Spotfin	*Erimonax monachus*	Fish	Freshwater
Chub, Virgin River	*Gila seminuda (=robusta)*	Fish	Freshwater
Chub, Yaqui	*Gila purpurea*	Fish	Freshwater
Chumbo, Higo	*Harrisia portoricensis*	Dicot	Terrestrial
Chupacallos	*Pleodendron macranthum*	Dicot	Terrestrial
Cladonia, Florida Perforate	*Cladonia perforata*	Lichen	Terrestrial
Clarkia, Pismo	*Clarkia speciosa ssp. immaculata*	Dicot	Terrestrial
Clarkia, Presidio	*Clarkia franciscana*	Dicot	Terrestrial
Clarkia, Springville	*Clarkia springvillensis*	Dicot	Terrestrial
Clarkia, Vine Hill	*Clarkia imbricata*	Dicot	Terrestrial
Cliffrose, Arizona	*Purshia (=cowania) subintegra*	Dicot	Terrestrial

Clover, Fleshy Owl's	*Castilleja campestris ssp.*	Dicot	Vernal pool
Clover, Leafy Prairie	*Dalea foliosa*	Dicot	Terrestrial
Clover, Monterey	*Trifolium trichocalyx*	Dicot	Terrestrial
Clover, Prairie Bush	*Lespedeza leptostachya*	Dicot	Terrestrial
Clover, Running Buffalo	*Trifolium stoloniferum*	Dicot	Terrestrial
Clover, Showy Indian	*Trifolium amoenum*	Dicot	Terrestrial
Cobana Negra	*Stahlia monosperma*	Dicot	Terrestrial
Combshell, Southern (=Penitent mussel)	*Epioblasma penita*	Bivalve	Freshwater
Combshell, Upland	*Epioblasma metastriata*	Bivalve	Freshwater
Condor, California	*Gymnogyps californianus*	Bird	Terrestrial
Coneflower, Smooth	*Echinacea laevigata*	Dicot	Terrestrial
Coneflower, Tennessee Purple	*Echinacea tennesseensis*	Dicot	Terrestrial
Coot, Hawaiian (=Alae keo keo)	*Fulica americana alai*	Bird	Terrestrial
Coqui, Golden	*Eleutherodactylus jasperi*	Amphibian	Terrestrial, Freshwater
Cordia bellonis (ncn)	*Cordia bellonis*	Dicot	Terrestrial
Coyote-thistle, Loch Lomond	*Eryngium constancei*	Dicot	Terrestrial
Crane, Mississippi Sandhill	*Grus canadensis pulla*	Bird	Terrestrial, Freshwater
Crane, Whooping	*Grus americana*	Bird	Terrestrial, Freshwater
Cranichis Ricartii	*Cranichis ricartii*	Monocot	Terrestrial
Crayfish, Cave (Cambarus aculabrum)	*Cambarus aculabrum*	Crustacean	Freshwater
Crayfish, Nashville	*Orconectes shoupi*	Crustacean	Freshwater
Crayfish, Shasta	*Pacifastacus fortis*	Crustacean	Freshwater
Creeper, Hawaii	*Oreomystis mana*	Bird	Terrestrial
Creeper, Oahu (Alauwahio)	*Paroreomyza maculata*	Bird	Terrestrial
Crocodile, American	*Crocodylus acutus*	Reptile	Terrestrial, Freshwater
Crow, Hawaiian ('Alala)	*Corvus hawaiiensis*	Bird	Terrestrial
Crownbeard, Big-leaved	*Verbesina dissita*	Dicot	Terrestrial
Crownscale, San Jacinto Valley	*Atriplex coronata var. notatior*	Dicot	Terrestrial
Cui-ui	*Chasmistes cujus*	Fish	Freshwater
Curlew, Eskimo	*Numenius borealis*	Bird	Terrestrial
Cyanea undulata (ncn)	*Cyanea undulata*	Dicot	Terrestrial
Cycladenia, Jones	*Cycladenia jonesii (=humilis)*	Dicot	Terrestrial
Cypress, Gowen	*Cupressus goveniana ssp. goveniana*	Conf/cycds	Terrestrial
Cypress, Santa Cruz	*Cupressus abramsiana*	Conf/cycds	Terrestrial
Dace, Ash Meadows Speckled	*Rhinichthys osculus nevadensis*	Fish	Freshwater
Dace, Blackside	*Phoxinus cumberlandensis*	Fish	Freshwater
Dace, Clover Valley Speckled	*Rhinichthys osculus oligoporus*	Fish	Freshwater
Dace, Desert	*Eremichthys acros*	Fish	Freshwater
Dace, Foskett Speckled	*Rhinichthys osculus ssp.*	Fish	Freshwater
Dace, Independence Valley Speckled	*Rhinichthys osculus lethoporus*	Fish	Freshwater
Dace, Moapa	*Moapa coriacea*	Fish	Freshwater
Daisy, Lakeside	*Hymenoxys herbacea*	Dicot	Freshwater
Daisy, Maguire	*Erigeron maguirei*	Dicot	Freshwater
Daisy, Parish's	*Erigeron parishii*	Dicot	Freshwater
Daisy, Willamette	*Erigeron decumbens var. decumbens*	Dicot	Terrestrial
Daphnopsis hellerana (ncn)	*Daphnopsis hellerana*	Dicot	Terrestrial
Darter, Amber	*Percina antesella*	Fish	Freshwater
Darter, Bayou	*Etheostoma rubrum*	Fish	Freshwater
Darter, Bluemask (=jewel)	*Etheostoma sp.*	Fish	Freshwater
Darter, Boulder	*Etheostoma wapiti*	Fish	Freshwater
Darter, Cherokee	*Etheostoma scotti*	Fish	Freshwater
Darter, Duskytail	*Etheostoma percnurum*	Fish	Freshwater
Darter, Etowah	*Etheostoma etowahae*	Fish	Freshwater
Darter, Fountain	*Etheostoma fonticola*	Fish	Freshwater
Darter, Goldline	*Percina aurolineata*	Fish	Freshwater
Darter, Leopard	*Percina pantherina*	Fish	Freshwater
Darter, Maryland	*Etheostoma sellare*	Fish	Freshwater
Darter, Niangua	*Etheostoma nianguae*	Fish	Freshwater
Darter, Okaloosa	*Etheostoma okaloosae*	Fish	Freshwater
Darter, Relict	*Etheostoma chienense*	Fish	Freshwater
Darter, Slackwater	*Etheostoma boschungi*	Fish	Freshwater
Darter, Snail	*Percina tanasi*	Fish	Freshwater
Darter, Vermilion	*Etheostoma chermocki*	Fish	Freshwater
Darter, Watercress	*Etheostoma nuchale*	Fish	Freshwater
Dawn-flower, Texas Prairie (=Texas Bitterweed)	*Hymenoxys texana*	Dicot	Terrestrial
Deer, Columbian White-tailed	*Odocoileus virginianus leucurus*	Mammal	Terrestrial
Delissea rhytodisperma (ncn)	*Delissea rhytidosperma*	Dicot	Terrestrial

Diellia erecta (ncn)	*Diellia erecta*	Ferns	Terrestrial
Diellia falcata (ncn)	*Diellia falcata*	Ferns	Terrestrial
Diellia pallida (ncn)	*Diellia pallida*	Ferns	Terrestrial
Diellia unisora (ncn)	*Diellia unisora*	Ferns	Terrestrial
Diplazium molokaiense (ncn)	*Diplazium molokaiense*	Ferns	Terrestrial
Dogweed, Ashy	*Thymophylla tephroleuca*	Dicot	Terrestrial
Dragonfly, Hine's Emerald	*Somatochlora hineana*	Insect	Terrestrial, Freshwater
Dropwort, Canby's	*Oxypolis canbyi*	Dicot	Terrestrial, Freshwater
Dubautia latifolia (ncn)	*Dubautia latifolia*	Dicot	Terrestrial
Dubautia pauciflorula (ncn)	*Dubautia pauciflorula*	Dicot	Terrestrial
Duck, Hawaiian (Koloa)	*Anas wyvilliana*	Bird	Terrestrial, Freshwater
Dudleya, Conejo	*Dudleya abramsii ssp. parva*	Dicot	Terrestrial
Dudleya, Marcescent	*Dudleya cymosa ssp. marcescens*	Dicot	Terrestrial
Dudleya, Santa Clara Valley	*Dudleya setchellii*	Dicot	Terrestrial
Dudleya, Santa Cruz Island	*Dudleya nesiotica*	Dicot	Terrestrial
Dudleya, Santa Monica Mountains	*Dudleya cymosa ssp. ovatifolia*	Dicot	Terrestrial
Dudleya, Verity's	*Dudleya verityi*	Dicot	Terrestrial
Dwarf-flax, Marin	*Hesperolinon congestum*	Dicot	Terrestrial
Eagle, Bald	*Haliaeetus leucocephalus*	Bird	Terrestrial
Eider, Steller's	*Polysticta stelleri*	Bird	Terrestrial, Saltwater
Elepaio, Oahu	*Chasiempis sandwichensis ibidis*	Bird	Terrestrial
Elimia, Lacy	*Elimia crenatella*	Gastropod	Freshwater
Elktoe, Appalachian	*Alasmidonta raveneliana*	Bivalve	Freshwater
Erubia	*Solanum drymophilum*	Dicot	Terrestrial
Eugenia Woodburyana	*Eugenia woodburyana*	Dicot	Terrestrial
Evening-primrose, Antioch Dunes	*Oenothera deltoides ssp. howellii*	Dicot	Terrestrial
Evening-primrose, Eureka Valley	*Oenothera avita ssp. eurekensis*	Dicot	Terrestrial
Evening-primrose, San Benito	*Camissonia benitensis*	Dicot	Terrestrial
Fairy Shrimp, Conservancy Fairy	*Branchinecta conservatio*	Crustacean	Vernal pool
Fairy Shrimp, Longhorn	*Branchinecta longiantenna*	Crustacean	Vernal pool
Fairy Shrimp, Riverside	*Streptocephalus woottoni*	Crustacean	Vernal pool
Fairy Shrimp, San Diego	*Branchinecta sandiegonensis*	Crustacean	Vernal pool
Fairy Shrimp, Vernal Pool	*Branchinecta lynchi*	Crustacean	Vernal pool
Falcon, Northern Aplomado	*Falco femoralis septentrionalis*	Bird	Terrestrial
Fanshell	*Cyprogenia stegaria*	Bivalve	Freshwater
Fatmucket, Arkansas	*Lampsilis powelli*	Bivalve	Freshwater
Fern, Alabama Streak-sorus	*Thelypteris pilosa var. alabamensis*	Ferns	Terrestrial
Fern, American hart's-tongue	*Asplenium scolopendrium var. americanum*	Ferns	Terrestrial
Fern, Elaphoglossum serpens	*Elaphoglossum serpens*	Ferns	Terrestrial
Fern, Pendant Kihi (Adenophorus periens)	*Adenophorus periens*	Ferns	Terrestrial
Fern, Thelypteris inabonensis	*Thelypteris inabonensis*	Ferns	Terrestrial
Fern, Thelypteris verecunda	*Thelypteris verecunda*	Ferns	Terrestrial
Fern, Thelypteris yaucoensis	*Thelypteris yaucoensis*	Ferns	Terrestrial
Ferret, Black-footed	*Mustela nigripes*	Mammal	Terrestrial
Fiddleneck, Large-flowered	*Amsinckia grandiflora*	Dicot	Terrestrial
Flannelbush, Mexican	*Fremontodendron mexicanum*	Dicot	Terrestrial
Flannelbush, Pine Hill	*Fremontodendron californicum ssp. decumbens*	Dicot	Terrestrial
Fleabane, Zuni	*Erigeron rhizomatus*	Dicot	Terrestrial
Fly, Delhi Sands Flower-loving	*Rhaphiomidas terminatus abdominalis*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila aglaia*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila hemipeza*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila heteroneura*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila montgomeryi*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila mulli*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila musaphilia*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila neoclavisetae*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila obatai*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila ochrobasis*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila substenoptera*	Insect	Terrestrial
Fly, Hawaiian picture-wing	*Drosophila tarphytrichia*	Insect	Terrestrial
Flycatcher, Southwestern Willow	*Empidonax traillii extimus*	Bird	Terrestrial
Four-o'clock, Macfarlane's	*Mirabilis macfarlanei*	Dicot	Terrestrial
Fox, San Joaquin Kit	*Vulpes macrotis mutica*	Mammal	Terrestrial
Fox, San Miguel Island	*Urocyon littoralis littoralis*	Mammal	Terrestrial
Fox, Santa Catalina Island	*Urocyon littoralis catalinae*	Mammal	Terrestrial
Fox, Santa Cruz Island	*Urocyon littoralis santacruzae*	Mammal	Terrestrial

Fox, Santa Rosa Island	*Urocyon littoralis santarosae*	Mammal	Terrestrial
Frankenia, Johnston's	*Frankenia johnstonii*	Dicot	Terrestrial
Fringe Tree, Pygmy	*Chionanthus pygmaeus*	Dicot	Terrestrial
Fringepod, Santa Cruz Island	*Thysanocarpus conchuliferus*	Dicot	Terrestrial
Fritillary, Gentner's	*Fritillaria gentneri*	Monocot	Terrestrial
Frog, California Red-legged	*Rana aurora draytonii*	Amphibian	Terrestrial, Freshwater
Frog, Chiricahua Leopard	*Rana chiricahuensis*	Amphibian	Terrestrial, Freshwater
Frog, Dusky Gopher (Mississippi DPS)	*Rana capito sevosa*	Amphibian	Terrestrial, Freshwater
Frog, Mountain Yellow-legged	*Rana muscosa*	Amphibian	Terrestrial, Freshwater
Fruit, Earth (=geocarpon)	*Geocarpon minimum*	Dicot	Terrestrial
Gambusia, Big Bend	*Gambusia gaigei*	Fish	Freshwater
Gambusia, Clear Creek	*Gambusia heterochir*	Fish	Freshwater
Gambusia, Pecos	*Gambusia nobilis*	Fish	Freshwater
Gambusia, San Marcos	*Gambusia georgei*	Fish	Freshwater
Geranium, Hawaiian Red-flowered	*Geranium arboreum*	Dicot	Terrestrial
Gerardia, Sandplain	*Agalinis acuta*	Dicot	Terrestrial
Gesneria pauciflora (ncn)	*Gesneria pauciflora*	Dicot	Terrestrial
Gilia, Hoffmann's Slender-flowered	*Gilia tenuiflora ssp. hoffmannii*	Dicot	Terrestrial
Gilia, Monterey	*Gilia tenuiflora ssp. arenaria*	Dicot	Terrestrial
Gnatcatcher, Coastal California	*Polioptila californica californica*	Bird	Terrestrial
Goby, Tidewater	*Eucyclogobius newberryi*	Fish	Freshwater
Goetzea, Beautiful (Matabuey)	*Goetzea elegans*	Dicot	Terrestrial
Golden Sunburst, Hartweg's	*Pseudobahia bahiifolia*	Dicot	Terrestrial
Goldenrod, Blue Ridge	*Solidago spithamaea*	Dicot	Terrestrial
Goldenrod, Houghton's	*Solidago houghtonii*	Dicot	Terrestrial
Goldenrod, Short's	*Solidago shortii*	Dicot	Terrestrial
Goldenrod, White-haired	*Solidago albopilosa*	Dicot	Terrestrial
Goldfields, Burke's	*Lasthenia burkei*	Dicot	Terrestrial
Goldfields, Contra Costa	*Lasthenia conjugens*	Dicot	Terrestrial
Goose, Hawaiian (Nene)	*Branta (=Nesochen) sandvicensis*	Bird	Terrestrial, Freshwater
Gooseberry, Miccosukee	*Ribes echinellum*	Dicot	Terrestrial
Gouania hillebrandii (ncn)	*Gouania hillebrandii*	Dicot	Terrestrial
Gouania meyenii (ncn)	*Gouania meyenii*	Dicot	Terrestrial
Gouania vitifolia (ncn)	*Gouania vitifolia*	Dicot	Terrestrial
Gourd, Okeechobee	*Cucurbita okeechobeensis ssp. okeechobeensis*	Dicot	Terrestrial
Grass, California Orcutt	*Orcuttia californica*	Monocot	Terrestrial, Vernal pool
Grass, Colusa	*Neostapfia colusana*	Monocot	Vernal pool
Grass, Eureka Dune	*Swallenia alexandrae*	Monocot	Terrestrial
Grass, Fosberg's Love	*Eragrostis fosbergii*	Monocot	Terrestrial
Grass, Hairy Orcutt	*Orcuttia pilosa*	Dicot	Vernal pool
Grass, Sacramento Orcutt	*Orcuttia viscida*	Dicot	Vernal pool
Grass, San Joaquin Valley Orcutt	*Orcuttia inaequalis*	Monocot	Vernal pool
Grass, Slender Orcutt	*Orcuttia tenuis*	Dicot	Vernal pool
Grass, Solano	*Tuctoria mucronata*	Monocot	Terrestrial, Vernal pool
Grass, Tennessee Yellow-eyed	*Xyris tennesseensis*	Monocot	Terrestrial
Grasshopper, Zayante Band-winged	*Trimerotropis infantilis*	Insect	Terrestrial
Ground-plum, Guthrie's	*Astragalus bibullatus*	Dicot	Terrestrial
Groundsel, San Francisco Peaks	*Senecio franciscanus*	Dicot	Terrestrial
Guajon	*Eleutherodactylus cooki*	Amphibian	Terrestrial, Freshwater
Gumplant, Ash Meadows	*Grindelia fraxino-pratensis*	Dicot	Terrestrial
Haha (Cyanea acuminata)	*Cyanea acuminata*	Dicot	Terrestrial
Haha (Cyanea asarifolia)	*Cyanea asarifolia*	Dicot	Terrestrial
Haha (Cyanea copelandii ssp. copelandii)	*Cyanea copelandii ssp. copelandii*	Dicot	Terrestrial
Haha (Cyanea copelandii ssp. haleakalaensis)	*Cyanea copelandii ssp. haleakalaensis*	Dicot	Terrestrial
Haha (Cyanea Crispa) (=Rollandia crispa)	*Cyanea (=Rollandia) crispa*	Dicot	Terrestrial
Haha (Cyanea glabra)	*Cyanea glabra*	Dicot	Terrestrial
Haha (Cyanea grimesiana ssp. grimesiana)	*Cyanea grimesiana ssp. grimesiana*	Dicot	Terrestrial
Haha (Cyanea grimesiana ssp. obatae)	*Cyanea grimesiana ssp. obatae*	Dicot	Terrestrial
Haha (Cyanea hamatiflora ssp. carlsonii)	*Cyanea hamatiflora ssp. Carlsonii*	Dicot	Terrestrial
Haha (Cyanea hamatiflora ssp. hamatiflora)	*Cyanea hamatiflora ssp.*	Dicot	Terrestrial
Haha (Cyanea humboldtiana)	*Cyanea humboldtiana*	Dicot	Terrestrial

Haha (Cyanea koolauensis)	*Cyanea koolauensis*	Dicot	Terrestrial
Haha (Cyanea lobata)	*Cyanea lobata*	Dicot	Terrestrial
Haha (Cyanea longiflora)	*Cyanea longiflora*	Dicot	Terrestrial
Haha (Cyanea mceldowneyi)	*Cyanea mceldowneyi*	Dicot	Terrestrial
Haha (Cyanea pinnatifida)	*Cyanea pinnatifida*	Dicot	Terrestrial
Haha (Cyanea platyphylla)	*Cyanea platyphylla*	Dicot	Terrestrial
Haha (Cyanea recta)	*Cyanea recta*	Dicot	Terrestrial
Haha (Cyanea remyi)	*Cyanea remyi*	Dicot	Terrestrial
Haha (Cyanea shipmanii)	*Cyanea shipmannii*	Dicot	Terrestrial
Haha (Cyanea stictophylla)	*Cyanea stictophylla*	Dicot	Terrestrial
Haha (Cyanea St-Johnii) (=Rollandia St-Johnii)	*Cyanea st-johnii*	Dicot	Terrestrial
Haha (Cyanea superba)	*Cyanea superba*	Dicot	Terrestrial
Haha (Cyanea truncata)	*Cyanea truncata*	Dicot	Terrestrial
Ha'Iwale (Cyrtandra crenata)	*Cyrtandra crenata*	Dicot	Terrestrial
Ha'Iwale (Cyrtandra dentata)	*Cyrtandra dentata*	Dicot	Terrestrial
Ha'Iwale (Cyrtandra giffardii)	*Cyrtandra giffardii*	Dicot	Terrestrial
Ha'Iwale (Cyrtandra munroi)	*Cyrtandra munroi*	Dicot	Terrestrial
Ha'Iwale (Cyrtandra polyantha)	*Cyrtandra polyantha*	Dicot	Terrestrial
Ha'Iwale (Cyrtandra subumbellata)	*Cyrtandra subumbellata*	Dicot	Terrestrial
Ha'Iwale (Cyrtandra tintinnabula)	*Cyrtandra tintinnabula*	Dicot	Terrestrial
Ha'Iwale (Cyrtandra viridiflora)	*Cyrtandra viridiflora*	Dicot	Terrestrial
Hala Pepe (Pleomele hawaiiensis)	*Pleomele hawaiiensis*	Monocot	Terrestrial
Haplostachys Haplostachya (ncn)	*Haplostachys haplostachya*	Dicot	Terrestrial
Harebells, Avon Park	*Crotalaria avonensis*	Dicot	Terrestrial
Harperella	*Ptilimnium nodosum*	Dicot	Freshwater
Harvestman, Bee Creek Cave	*Texella reddelli*	Arachnid	Terrestrial, Subterraneous
Harvestman, Bone Cave	*Texella reyesi*	Arachnid	Terrestrial, Subterraneous
Harvestman, Cokendolpher Cave	*Texella cokendolpheri*	Arachnid	Terrestrial, Subterraneous
Hau Kauhiwi (Hibiscadelphus woodi)	*Hibiscadelphus woodii*	Dicot	Terrestrial
Hau Kuahiwi (Hibiscadelphus distans)	*Hibiscadelphus distans*	Dicot	Terrestrial
Hau Kuahiwi (Hibiscadelphus giffardianus)	*Hibiscadelphus giffardianus*	Dicot	Terrestrial
Hau Kuahiwi (Hibiscadelphus hualalaiensis)	*Hibiscadelphus hualalaiensis*	Dicot	Terrestrial
Hawk, Hawaiian (Io)	*Buteo solitarius*	Bird	Terrestrial
Hawk, Puerto Rican Broad-winged	*Buteo platypterus brunnescens*	Bird	Terrestrial
Hawk, Puerto Rican Sharp-shinned	*Accipiter striatus venator*	Bird	Terrestrial
Heartleaf, Dwarf-flowered	*Hexastylis naniflora*	Dicot	Terrestrial
Heather, Mountain Golden	*Hudsonia montana*	Dicot	Terrestrial
Heau (Exocarpos luteolus)	*Exocarpos luteolus*	Dicot	Terrestrial
Hedyotis degeneri (ncn)	*Hedyotis degeneri*	Dicot	Terrestrial
Hedyotis parvula (ncn)	*Hedyotis parvula*	Dicot	Terrestrial
Hedyotis St.-Johnii (ncn)	*Hedyotis st.-johnii*	Dicot	Terrestrial
Hesperomannia arborescens (ncn)	*Hesperomannia arborescens*	Dicot	Terrestrial
Hesperomannia arbuscula (ncn)	*Hesperomannia arbuscula*	Dicot	Terrestrial
Hesperomannia lydgatei (ncn)	*Hesperomannia lydgatei*	Dicot	Terrestrial
Hibiscus, Clay's	*Hibiscus clayi*	Dicot	Terrestrial
Higuero De Sierra	*Crescentia portoricensis*	Dicot	Terrestrial
Hilo Ischaemum (Ischaemum byrone)	*Ischaemum byrone*	Monocot	Terrestrial
Holei (Ochrosia kilaueaensis)	*Ochrosia kilaueaensis*	Dicot	Terrestrial
Holly, Cook's	*Ilex cookii*	Dicot	Terrestrial
Honeycreeper, Crested ('Akohekohe)	*Palmeria dolei*	Bird	Terrestrial
Howellia, Water	*Howellia aquatilis*	Dicot	Freshwater
Hypericum, Highlands Scrub	*Hypericum cumulicola*	Dicot	Terrestrial
'Ihi'Ihi (Marsilea villosa)	*Marsilea villosa*	Ferns	Terrestrial, Vernal pool
Ilex sintenisii (ncn)	*Ilex sintenisii*	Dicot	Terrestrial
Iliau (Wilkesia hobdyi)	*Wilkesia hobdyi*	Dicot	Terrestrial
Ipomopsis, Holy Ghost	*Ipomopsis sancti-spiritus*	Dicot	Terrestrial
Iris, Dwarf Lake	*Iris lacustris*	Monocot	Terrestrial
Irisette, White	*Sisyrinchium dichotomum*	Monocot	Terrestrial
Isopod, Lee County Cave	*Lirceus usdagalun*	Crustacean	Freshwater
Isopod, Madison Cave	*Antrolana lira*	Crustacean	Freshwater
Isopod, Socorro	*Thermosphaeroma thermophilus*	Crustacean	Freshwater
Ivesia, Ash Meadows	*Ivesia kingii var. eremica*	Dicot	Terrestrial
Jacquemontia, Beach	*Jacquemontia reclinata*	Dicot	Terrestrial, Coastal
Jaguar	*Panthera onca*	Mammal	Terrestrial

Jaguarundi, Gulf Coast	*Herpailurus (=Felis) yagouaroundi cacomitli*	Mammal	Terrestrial
Jewelflower, California	*Caulanthus californicus*	Dicot	Terrestrial
Jewelflower, Metcalf Canyon	*Streptanthus albidus ssp. albidus*	Dicot	Terrestrial
Jewelflower, Tiburon	*Streptanthus niger*	Dicot	Terrestrial
Joint-vetch, Sensitive	*Aeschynomene virginica*	Dicot	Terrestrial, Brackish
Kamakahala (Labordia cyrtandrae)	*Labordia cyrtandrae*	Dicot	Terrestrial
Kamakahala (Labordia lydgatei)	*Labordia lydgatei*	Dicot	Terrestrial
Kamakahala (Labordia tinifolia var. wahiawaen)	*Labordia tinifolia var. wahiawaensis*	Dicot	Terrestrial
Kamanomano (Cenchrus agrimonioides)	*Cenchrus agrimonioides*	Monocot	Terrestrial
Kangaroo Rat, Fresno	*Dipodomys nitratoides exilis*	Mammal	Terrestrial
Kangaroo Rat, Giant	*Dipodomys ingens*	Mammal	Terrestrial
Kangaroo Rat, Morro Bay	*Dipodomys heermanni morroensis*	Mammal	Terrestrial
Kangaroo Rat, San Bernardino Merriam's	*Dipodomys merriami parvus*	Mammal	Terrestrial
Kangaroo Rat, Stephens'	*Dipodomys stephensi (incl. D. cascus)*	Mammal	Terrestrial
Kangaroo Rat, Tipton	*Dipodomys nitratoides nitratoides*	Mammal	Terrestrial
Kauila (Colubrina oppositifolia)	*Colubrina oppositifolia*	Dicot	Terrestrial
Kaulu (Pteralyxia kauaiensis)	*Pteralyxia kauaiensis*	Dicot	Terrestrial
Kidneyshell, Triangular	*Ptychobranchus greenii*	Bivalve	Freshwater
Kio'Ele (Hedyotis coriacea)	*Hedyotis coriacea*	Dicot	Terrestrial
Kiponapona (Phyllostegia racemosa)	*Phyllostegia racemosa*	Dicot	Terrestrial
Kite, Everglades Snail	*Rostrhamus sociabilis plumbeus*	Bird	Terrestrial
Koki'o (Kokia drynarioides)	*Kokia drynarioides*	Dicot	Terrestrial
Koki'o (Kokia kauaiensis)	*Kokia kauaiensis*	Dicot	Terrestrial
Koki'o Ke'oke'o (Hibiscus waimeae ssp. hannerae)	*Hibiscus waimeae ssp. hannerae*	Dicot	Terrestrial
Kolea (Myrsine juddii)	*Myrsine juddii*	Dicot	Terrestrial
Kolea (Myrsine linearifolia)	*Myrsine linearifolia*	Dicot	Terrestrial
Ko'oko'olau (Bidens micrantha ssp. kalealaha)	*Bidens micrantha ssp. kalealaha*	Dicot	Terrestrial
Ko'oloa'ula (Abutilon menziesii)	*Abutilon menziesii*	Dicot	Terrestrial
Kuawawaenohu (Alsinidendron lychnoides)	*Alsinidendron lychnoides*	Dicot	Terrestrial
Kulu'I (Nototrichium humile)	*Nototrichium humile*	Dicot	Terrestrial
Ladies'-tresses, Canelo Hills	*Spiranthes delitescens*	Monocot	Terrestrial
Ladies'-tresses, Navasota	*Spiranthes parksii*	Monocot	Terrestrial
Ladies'-tresses, Ute	*Spiranthes diluvialis*	Monocot	Terrestrial
Larkspur, Baker's	*Delphinium bakeri*	Dicot	Terrestrial
Larkspur, San Clemente Island	*Delphinium variegatum ssp. kinkiense*	Dicot	Terrestrial
Larkspur, Yellow	*Delphinium luteum*	Dicot	Terrestrial
Lau'ehu (Panicum niihauense)	*Panicum niihauense*	Monocot	Terrestrial
Laukahi Kuahiwi (Plantago hawaiensis)	*Plantago hawaiensis*	Dicot	Terrestrial
Laukahi Kuahiwi (Plantago princeps)	*Plantago princeps*	Dicot	Terrestrial
Laulihilihi (Schiedea stellarioides)	*Schiedea stellarioides*	Dicot	Terrestrial
Layia, Beach	*Layia carnosa*	Dicot	Terrestrial, Coastal
Lead-plant, Crenulate	*Amorpha crenulata*	Dicot	Terrestrial
Leather-flower, Alabama	*Clematis socialis*	Dicot	Terrestrial
Leather-flower, Morefield's	*Clematis morefieldii*	Dicot	Terrestrial
Lepanthes eltorensis (ncn)	*Lepanthes eltoroensis*	Monocot	Terrestrial
Lessingia, San Francisco	*Lessingia germanorum (=L.g. var. germanorum)*	Dicot	Terrestrial
Lichen, Rock Gnome	*Gymnoderma lineare*	Lichen	Terrestrial
Liliwai (Acaena exigua)	*Acaena exigua*	Dicot	Terrestrial
Lily, Minnesota Trout	*Erythronium propullans*	Monocot	Terrestrial
Lily, Pitkin Marsh	*Lilium pardalinum ssp. pitkinense*	Monocot	Freshwater
Lily, Tiburon Mariposa	*Calochortus tiburonensis*	Monocot	Terrestrial
Lily, Western	*Lilium occidentale*	Monocot	Terrestrial
Limpet, Banbury Springs	*Lanx sp.*	Gastropod	Freshwater
Liveforever, Laguna Beach	*Dudleya stolonifera*	Dicot	Terrestrial
Liveforever, Santa Barbara Island	*Dudleya traskiae*	Dicot	Terrestrial
Lizard, Blunt-nosed Leopard	*Gambelia silus*	Reptile	Terrestrial
Lizard, Coachella Valley Fringe-	*Uma inornata*	Reptile	Terrestrial
Lizard, Island Night	*Xantusia riversiana*	Reptile	Terrestrial
Lizard, St. Croix Ground	*Ameiva polops*	Reptile	Terrestrial
Lo`ulu (Pritchardia affinis)	*Pritchardia affinis*	Monocot	Terrestrial

Lo`ulu (Pritchardia kaalae)	*Pritchardia kaalae*	Monocot	Terrestrial
Lo`ulu (Pritchardia napaliensis)	*Pritchardia napaliensis*	Monocot	Terrestrial
Lo`ulu (Pritchardia schattaueri)	*Pritchardia schattaueri*	Monocot	Terrestrial
Lo`ulu (Pritchardia viscosa)	*Pritchardia viscosa*	Monocot	Terrestrial
Lobelia monostachya (ncn)	*Lobelia monostachya*	Dicot	Terrestrial
Lobelia niihauensis (ncn)	*Lobelia niihauensis*	Dicot	Terrestrial
Lobelia oahuensis (ncn)	*Lobelia oahuensis*	Dicot	Terrestrial
Locoweed, Fassett's	*Oxytropis campestris var. chartacea*	Dicot	Terrestrial
Logperch, Conasauga	*Percina jenkinsi*	Fish	Freshwater
Logperch, Roanoke	*Percina rex*	Fish	Freshwater
Lomatium, Bradshaw's	*Lomatium bradshawii*	Dicot	Terrestrial, Freshwater
Lomatium, Cook's	*Lomatium cookii*	Dicot	Vernal pool
Loosestrife, Rough-leaved	*Lysimachia asperulaefolia*	Dicot	Terrestrial
Lousewort, Furbish	*Pedicularis furbishiae*	Dicot	Terrestrial
Lupine, Clover	*Lupinus tidestromii*	Dicot	Coastal
Lupine, Kincaid's	*Lupinus sulphureus (=oreganus) ssp. kincaidii (=var. kincaidii)*	Dicot	Terrestrial
Lupine, Nipomo Mesa	*Lupinus nipomensis*	Dicot	Coastal
Lupine, Scrub	*Lupinus aridorum*	Dicot	Terrestrial
Lynx, Canada	*Lynx canadensis*	Mammal	Terrestrial
Lyonia truncata var. proctorii (ncn)	*Lyonia truncata var. proctorii*	Dicot	Terrestrial
Lysimachia filifolia (ncn)	*Lysimachia filifolia*	Dicot	Terrestrial
Lysimachia lydgatei (ncn)	*Lysimachia lydgatei*	Dicot	Terrestrial
Madtom, Neosho	*Noturus placidus*	Fish	Freshwater
Madtom, Pygmy	*Noturus stanauli*	Fish	Freshwater
Madtom, Scioto	*Noturus trautmani*	Fish	Freshwater
Madtom, Smoky	*Noturus baileyi*	Fish	Freshwater
Madtom, Yellowfin	*Noturus flavipinnis*	Fish	Freshwater
Mahoe (Alectryon macrococcus)	*Alectryon macrococcus*	Dicot	Terrestrial
Makou (Peucedanum sandwicense)	*Peucedanum sandwicense*	Dicot	Terrestrial
Malacothrix, Island	*Malacothrix squalida*	Dicot	Terrestrial
Malacothrix, Santa Cruz Island	*Malacothrix indecora*	Dicot	Terrestrial
Mallow, Kern	*Eremalche kernensis*	Dicot	Terrestrial
Mallow, Peter's Mountain	*Iliamna corei*	Dicot	Terrestrial
Manaca, palma de	*Calyptronoma rivalis*	Monocot	Terrestrial
Manatee, West Indian	*Trichechus manatus*	Mammal	Saltwater
Manioc, Walker's	*Manihot walkerae*	Dicot	Terrestrial
Manzanita, Del Mar	*Arctostaphylos glandulosa ssp. crassifolia*	Dicot	Terrestrial
Manzanita, Ione	*Arctostaphylos myrtifolia*	Dicot	Terrestrial
Manzanita, Morro	*Arctostaphylos morroensis*	Dicot	Terrestrial
Manzanita, Pallid	*Arctostaphylos pallida*	Dicot	Terrestrial
Manzanita, Santa Rosa Island	*Arctostaphylos confertiflora*	Dicot	Terrestrial
Ma'oli'oli (Schiedea apokremnos)	*Schiedea apokremnos*	Dicot	Terrestrial
Ma'oli'oli (Schiedea kealiae)	*Schiedea kealiae*	Dicot	Terrestrial
Mapele (Cyrtandra cyaneoides)	*Cyrtandra cyaneoides*	Dicot	Terrestrial
Marstonia, Royal (=Royal Snail)	*Pyrgulopsis ogmorhaphe*	Gastropod	Terrestrial
Meadowfoam, Butte County	*Limnanthes floccosa ssp. californica*	Dicot	Vernal pool
Meadowfoam, Large-flowered Woolly	*Limnanthes floccosa ssp. Grandiflora*	Dicot	Vernal pool
Meadowfoam, Sebastopol	*Limnanthes vinculans*	Dicot	Terrestrial, Freshwater
Meadowrue, Cooley's	*Thalictrum cooleyi*	Dicot	Terrestrial
Mehamehame (Flueggea neowawraea)	*Flueggea neowawraea*	Dicot	Terrestrial
Meshweaver, Braken Bat Cave	*Cicurina venii*	Arachnid	Terrestrial, Subterraneous
Meshweaver, Government Canyon Bat Cave	*Cicurina vespera*	Arachnid	Terrestrial, Subterraneous
Meshweaver, Madla's Cave	*Cicurina madla*	Arachnid	Terrestrial, Subterraneous
Meshweaver, Robber Baron Cave	*Cicurina baronia*	Arachnid	Terrestrial, Subterraneous
Milkpea, Small's	*Galactia smallii*	Dicot	Terrestrial
Milk-vetch, Applegate's	*Astragalus applegatei*	Dicot	Terrestrial
Milk-vetch, Ash Meadows	*Astragalus phoenix*	Dicot	Terrestrial
Milk-vetch, Braunton's	*Astragalus brauntonii*	Dicot	Terrestrial
Milk-vetch, Clara Hunt's	*Astragalus clarianus*	Dicot	Terrestrial
Milk-vetch, Coachella Valley	*Astragalus lentiginosus var. coachellae*	Dicot	Terrestrial
Milk-vetch, Coastal Dunes	*Astragalus tener var. titi*	Dicot	Terrestrial
Milk-vetch, Cushenbury	*Astragalus albens*	Dicot	Terrestrial
Milk-vetch, Deseret	*Astragalus desereticus*	Dicot	Terrestrial
Milk-vetch, Fish Slough	*Astragalus lentiginosus var.*	Dicot	Terrestrial

	piscinensis		
Milk-vetch, Heliotrope	*Astragalus montii*	Dicot	Terrestrial
Milk-vetch, Holmgren	*Astragalus holmgreniorum*	Dicot	Terrestrial
Milk-vetch, Jesup's	*Astragalus robbinsii var. jesupi*	Dicot	Terrestrial
Milk-vetch, Mancos	*Astragalus humillimus*	Dicot	Terrestrial
Milk-vetch, Osterhout	*Astragalus osterhoutii*	Dicot	Terrestrial
Milk-vetch, Pierson's	*Astragalus magdalenae var.*	Dicot	Terrestrial
Milk-vetch, Sentry	*Astragalus cremnophylax var. cremnophylax*	Dicot	Terrestrial
Milk-vetch, Triple-ribbed	*Astragalus tricarinatus*	Dicot	Terrestrial
Milk-vetch, Ventura Marsh	*Astragalus pycnostachyus var. lanosissimus*	Dicot	Terrestrial, Freshwater
Milkweed, Mead's	*Asclepias meadii*	Dicot	Terrestrial
Milkweed, Welsh's	*Asclepias welshii*	Dicot	Terrestrial
Minnow, Loach	*Tiaroga cobitis*	Fish	Freshwater
Minnow, Rio Grande Silvery	*Hybognathus amarus*	Fish	Freshwater
Mint, Garrett's	*Dicerandra christmanii*	Dicot	Terrestrial
Mint, Lakela's	*Dicerandra immaculata*	Dicot	Terrestrial
Mint, Longspurred	*Dicerandra cornutissima*	Dicot	Terrestrial
Mint, Otay Mesa	*Pogogyne nudiuscula*	Dicot	Terrestrial
Mint, San Diego Mesa	*Pogogyne abramsii*	Dicot	Terrestrial
Mint, Scrub	*Dicerandra frutescens*	Dicot	Terrestrial
Mitracarpus Maxwelliae	*Mitracarpus maxwelliae*	Dicot	Terrestrial
Mitracarpus Polycladus	*Mitracarpus polycladus*	Dicot	Terrestrial
Monardella, Willowy	*Monardella linoides ssp. viminea*	Dicot	Terrestrial
Monkey-flower, Michigan	*Mimulus glabratus var. michiganensis*	Dicot	Terrestrial, Freshwater
Monkshood, Northern Wild	*Aconitum noveboracense*	Dicot	Terrestrial
Moorhen, Hawaiian Common	*Gallinula chloropus sandvicensis*	Bird	Terrestrial
Morning-glory, Stebbins	*Calystegia stebbinsii*	Dicot	Terrestrial
Moth, Blackburn's Sphinx	*Manduca blackburni*	Insect	Terrestrial
Moth, Kern Primrose Sphinx	*Euproserpinus euterpe*	Insect	Terrestrial
Mountain Beaver, Point Arena	*Aplodontia rufa nigra*	Mammal	Terrestrial, Freshwater
Mountainbalm, Indian Knob	*Eriodictyon altissimum*	Dicot	Terrestrial
Mountain-mahogany, Catalina Island	*Cercocarpus traskiae*	Dicot	Terrestrial
Mouse, Alabama Beach	*Peromyscus polionotus ammobates*	Mammal	Terrestrial, Coastal
Mouse, Anastasia Island Beach	*Peromyscus polionotus phasma*	Mammal	Terrestrial, Coastal
Mouse, Choctawhatchee Beach	*Peromyscus polionotus allophrys*	Mammal	Terrestrial, Coastal
Mouse, Pacific Pocket	*Perognathus longimembris pacificus*	Mammal	Terrestrial
Mouse, Perdido Key Beach	*Peromyscus polionotus trissyllepsis*	Mammal	Coastal
Mouse, Preble's Meadow Jumping	*Zapus hudsonius preblei*	Mammal	Terrestrial
Mouse, Salt Marsh Harvest	*Reithrodontomys raviventris*	Mammal	Terrestrial
Mouse, Southeastern Beach	*Peromyscus polionotus niveiventris*	Mammal	Terrestrial, Coastal
Mouse, St. Andrew Beach	*Peromyscus polionotus peninsularis*	Mammal	Terrestrial, Coastal
Mucket, Orange-nacre	*Lampsilis perovalis*	Bivalve	Freshwater
Mucket, Pink (Pearlymussel)	*Lampsilis abrupta*	Bivalve	Freshwater
Munroidendron racemosum (ncn)	*Munroidendron racemosum*	Dicot	Terrestrial
Murrelet, Marbled	*Brachyramphus marmoratus*	Bird	Terrestrial, Freshwater, Saltwater
Mussel, Acornshell Southern	*Epioblasma othcaloogensis*	Bivalve	Freshwater
Mussel, Alabama Moccasinshell	*Medionidus acutissimus*	Bivalve	Freshwater
Mussel, Black (=Curtus' Mussel) Clubshell	*Pleurobema curtum*	Bivalve	Freshwater
Mussel, Clubshell	*Pleurobema clava*	Bivalve	Freshwater
Mussel, Coosa Moccasinshell	*Medionidus parvulus*	Bivalve	Freshwater
Mussel, Cumberland Combshell	*Epioblasma brevidens*	Bivalve	Freshwater
Mussel, Cumberland Elktoe	*Alasmidonta atropurpurea*	Bivalve	Freshwater
Mussel, Cumberland Pigtoe	*Pleurobema gibberum*	Bivalve	Freshwater
Mussel, Dark Pigtoe	*Pleurobema furvum*	Bivalve	Freshwater
Mussel, Dwarf Wedge	*Alasmidonta heterodon*	Bivalve	Freshwater
Mussel, Fat Threeridge	*Amblema neislerii*	Bivalve	Freshwater
Mussel, Fine-lined Pocketbook	*Lampsilis altilis*	Bivalve	Freshwater
Mussel, Fine-rayed Pigtoe	*Fusconaia cuneolus*	Bivalve	Freshwater
Mussel, Flat Pigtoe (=Marshall's Mussel)	*Pleurobema marshalli*	Bivalve	Freshwater
Mussel, Gulf Moccasinshell	*Medionidus penicillatus*	Bivalve	Freshwater
Mussel, Heavy Pigtoe (=Judge Tait's Mussel)	*Pleurobema taitianum*	Bivalve	Freshwater
Mussel, Heelsplitter Carolina	*Lasmigona decorata*	Bivalve	Freshwater
Mussel, Heelsplitter Inflated	*Potamilus inflatus*	Bivalve	Freshwater
Mussel, Ochlockonee Moccasinshell	*Medionidus simpsonianus*	Bivalve	Freshwater

Mussel, Oval Pigtoe	*Pleurobema pyriforme*	Bivalve	Freshwater
Mussel, Ovate Clubshell	*Pleurobema perovatum*	Bivalve	Freshwater
Mussel, Oyster	*Epioblasma capsaeformis*	Bivalve	Freshwater
Mussel, Ring Pink (=Golf Stick Pearly)	*Obovaria retusa*	Bivalve	Freshwater
Mussel, Rough Pigtoe	*Pleurobema plenum*	Bivalve	Freshwater
Mussel, Scaleshell	*Leptodea leptodon*	Bivalve	Freshwater
Mussel, Shiny Pigtoe	*Fusconaia cor*	Bivalve	Freshwater
Mussel, Shiny-rayed Pocketbook	*Lampsilis subangulata*	Bivalve	Freshwater
Mussel, Southern Clubshell	*Pleurobema decisum*	Bivalve	Freshwater
Mussel, Southern Pigtoe	*Pleurobema georgianum*	Bivalve	Freshwater
Mussel, Speckled Pocketbook	*Lampsilis streckeri*	Bivalve	Freshwater
Mussel, Winged Mapleleaf	*Quadrula fragosa*	Bivalve	Freshwater
Mustard, Carter's	*Warea carteri*	Dicot	Terrestrial
Mustard, Penland Alpine Fen	*Eutrema penlandii*	Dicot	Terrestrial, Freshwater
Mustard, Slender-petaled	*Thelypodium stenopetalum*	Dicot	Terrestrial
Myrcia Paganii	*Myrcia paganii*	Dicot	Terrestrial
Na'ena'e (Dubautia herbstobatae)	*Dubautia herbstobatae*	Dicot	Terrestrial
Na'ena'e (Dubautia plantaginea ssp. humilis)	*Dubautia plantaginea ssp. humilis*	Dicot	Terrestrial
Nani Wai'ale'ale (Viola kauaensis var. wahiawaensis)	*Viola kauaiensis var. wahiawaensis*	Dicot	Terrestrial
Nanu (Gardenia mannii)	*Gardenia mannii*	Dicot	Terrestrial
Na'u (Gardenia brighamii)	*Gardenia brighamii*	Dicot	Terrestrial
Naucorid, Ash Meadows	*Ambrysus amargosus*	Insect	Terrestrial
Naupaka, Dwarf (Scaevola coriacea)	*Scaevola coriacea*	Dicot	Terrestrial
Navarretia, Few-flowered	*Navarretia leucocephala ssp. Pauciflora*	Dicot	Terrestrial, Vernal pool
Navarretia, Many-flowered	*Navarretia leucocephala ssp. plieantha*	Dicot	Terrestrial, Vernal pool
Navarretia, Spreading	*Navarretia fossalis*	Dicot	Vernal pool
Nehe (Lipochaeta lobata var. leptophylla)	*Lipochaeta lobata var. leptophylla*	Dicot	Terrestrial
Neraudia angulata (ncn)	*Neraudia angulata*	Dicot	Terrestrial
Neraudia ovata (ncn)	*Neraudia ovata*	Dicot	Terrestrial
Neraudia sericea (ncn)	*Neraudia sericea*	Dicot	Terrestrial
Nightjar, Puerto Rico	*Caprimulgus noctitherus*	Bird	Terrestrial
Nioi (Eugenia koolauensis)	*Eugenia koolauensis*	Dicot	Terrestrial
Niterwort, Amargosa	*Nitrophila mohavensis*	Dicot	Terrestrial
Nohoanu (Geranium multiflorum)	*Geranium multiflorum*	Dicot	Terrestrial
Oak, Hinckley	*Quercus hinckleyi*	Dicot	Terrestrial
Ocelot	*Leopardus (=Felis) pardalis*	Mammal	Terrestrial
'Oha (Delissea rivularis)	*Delissea rivularis*	Dicot	Terrestrial
'Oha (Delissea subcordata)	*Delissea subcordata*	Dicot	Terrestrial
'Oha (Delissea undulata)	*Delissea undulata*	Dicot	Terrestrial
'Oha (Lobelia gaudichaudii koolauensis)	*Lobelia gaudichaudii ssp. koolauensis*	Dicot	Terrestrial
'Oha Wai (Clermontia drepanomorpha)	*Clermontia drepanomorpha*	Dicot	Terrestrial
'Oha Wai (Clermontia lindseyana)	*Clermontia lindseyana*	Dicot	Terrestrial
'Oha Wai (Clermontia oblongifolia ssp. mauiensis)	*Clermontia oblongifolia ssp. mauiensis*	Dicot	Terrestrial
'Oha Wai (Clermontia peleana)	*Clermontia peleana*	Dicot	Terrestrial
'Oha Wai (Clermontia pyrularia)	*Clermontia pyrularia*	Dicot	Terrestrial
'Oha Wai (Clermontia samuelii)	*Clermontia samuelii*	Dicot	Terrestrial
'Ohai (Sesbania tomentosa)	*Sesbania tomentosa*	Dicot	Terrestrial
'Ohe'ohe (Tetraplasandra gymnocarpa)	*Tetraplasandra gymnocarpa*	Dicot	Terrestrial
'Olulu (Brighamia insignis)	*Brighamia insignis*	Dicot	Terrestrial
Onion, Munz's	*Allium munzii*	Monocot	Terrestrial
'O'o, Kauai (='A'a)	*Moho braccatus*	Bird	Terrestrial
Opuhe (Urera kaalae)	*Urera kaalae*	Dicot	Terrestrial
Orchid, Eastern Prairie Fringed	*Platanthera leucophaea*	Monocot	Terrestrial
Orchid, Western Prairie Fringed	*Platanthera praeclara*	Monocot	Terrestrial
Otter, Northern Sea	*Enhydra lutris kenyoni*	Mammal	Saltwater
Otter, Southern Sea	*Enhydra lutris nereis*	Mammal	Saltwater
'O'u (Honeycreeper)	*Psittirostra psittacea*	Bird	Terrestrial
Owl, Mexican Spotted	*Strix occidentalis lucida*	Bird	Terrestrial
Owl, Northern Spotted	*Strix occidentalis caurina*	Bird	Terrestrial
Oxytheca, Cushenbury	*Oxytheca parishii var. goodmaniana*	Dicot	Terrestrial

Paintbrush, Ash-grey Indian	*Castilleja cinerea*	Dicot	Terrestrial
Paintbrush, Golden	*Castilleja levisecta*	Dicot	Terrestrial
Paintbrush, San Clemente Island Indian	*Castilleja grisea*	Dicot	Terrestrial
Paintbrush, Soft-leaved	*Castilleja mollis*	Dicot	Terrestrial
Paintbrush, Tiburon	*Castilleja affinis ssp. neglecta*	Dicot	Terrestrial
Palila	*Loxioides bailleui*	Bird	Terrestrial
Palo Colorado (Ternstroemia luquillensis)	*Ternstroemia luquillensis*	Dicot	Terrestrial
Palo de Jazmin	*Styrax portoricensis*	Dicot	Terrestrial
Palo de Nigua	*Cornutia obovata*	Dicot	Terrestrial
Palo de Ramon	*Banara vanderbiltii*	Dicot	Terrestrial
Palo de Rosa	*Ottoschulzia rhodoxylon*	Dicot	Terrestrial
Pamakani (Viola chamissoniana ssp. chamissoniana)	*Viola chamissoniana ssp. chamissoniana*	Dicot	Terrestrial
Panicgrass, Carter's (Panicum fauriei var.carteri)	*Panicum fauriei var. carteri*	Monocot	Terrestrial
Panther, Florida	*Puma (=Felis) concolor coryi*	Mammal	Terrestrial
Parrot, Puerto Rican	*Amazona vittata*	Bird	Terrestrial
Parrotbill, Maui	*Pseudonestor xanthophrys*	Bird	Terrestrial
Pauoa (Ctenitis squamigera)	*Ctenitis squamigera*	Ferns	Terrestrial
Pawpaw, Beautiful	*Deeringothamnus pulchellus*	Dicot	Terrestrial
Pawpaw, Four-petal	*Asimina tetramera*	Dicot	Terrestrial
Pawpaw, Rugel's	*Deeringothamnus rugelii*	Dicot	Terrestrial
Pearlshell, Louisiana	*Margaritifera hembeli*	Bivalve	Freshwater
Pearlymussel, Alabama Lamp	*Lampsilis virescens*	Bivalve	Freshwater
Pearlymussel, Appalachian Monkeyface	*Quadrula sparsa*	Bivalve	Freshwater
Pearlymussel, Birdwing	*Conradilla caelata*	Bivalve	Freshwater
Pearlymussel, Cracking	*Hemistena lata*	Bivalve	Freshwater
Pearlymussel, Cumberland Bean	*Villosa trabalis*	Bivalve	Freshwater
Pearlymussel, Cumberland Monkeyface	*Quadrula intermedia*	Bivalve	Freshwater
Pearlymussel, Curtis'	*Epioblasma florentina curtisii*	Bivalve	Freshwater
Pearlymussel, Dromedary	*Dromus dromas*	Bivalve	Freshwater
Pearlymussel, Fat Pocketbook	*Potamilus capax*	Bivalve	Freshwater
Pearlymussel, Green-blossom	*Epioblasma torulosa gubernaculum*	Bivalve	Freshwater
Pearlymussel, Higgins' Eye	*Lampsilis higginsii*	Bivalve	Freshwater
Pearlymussel, Little-wing	*Pegias fabula*	Bivalve	Freshwater
Pearlymussel, Orange-footed	*Plethobasus cooperianus*	Bivalve	Freshwater
Pearlymussel, Pale Lilliput	*Toxolasma cylindrellus*	Bivalve	Freshwater
Pearlymussel, Purple Cat's Paw	*Epioblasma obliquata obliquata*	Bivalve	Freshwater
Pearlymussel, Tubercled-blossom	*Epioblasma torulosa torulosa*	Bivalve	Freshwater
Pearlymussel, Turgid-blossom	*Epioblasma turgidula*	Bivalve	Freshwater
Pearlymussel, White Cat's Paw	*Epioblasma obliquata perobliqua*	Bivalve	Freshwater
Pearlymussel, White Wartyback	*Plethobasus cicatricosus*	Bivalve	Freshwater
Pearlymussel, Yellow-blossom	*Epioblasma florentina florentina*	Bivalve	Freshwater
Pebblesnail, Flat	*Lepyrium showalteri*	Gastropod	Freshwater
Pelos del Diablo	*Aristida portoricensis*	Monocot	Terrestrial
Penny-cress, Kneeland Prairie	*Thlaspi californicum*	Dicot	Terrestrial
Pennyroyal, Todsen's	*Hedeoma todsenii*	Dicot	Terrestrial
Penstemon, Blowout	*Penstemon haydenii*	Dicot	Terrestrial
Pentachaeta, Lyon's	*Pentachaeta lyonii*	Dicot	Terrestrial
Pentachaeta, White-rayed	*Pentachaeta bellidiflora*	Dicot	Terrestrial
Peperomia, Wheeler's	*Peperomia wheeleri*	Dicot	Terrestrial
Peppergrass, Slick Spot	*Lepidium papilliferum*	Dicot	Terrestrial, Floodplain
Petrel, Hawaiian Dark-rumped	*Pterodroma phaeopygia sandwichensis*	Bird	Terrestrial
Phacelia, Clay	*Phacelia argillacea*	Dicot	Terrestrial
Phacelia, Island	*Phacelia insularis ssp. insularis*	Dicot	Terrestrial
Phacelia, North Park	*Phacelia formosula*	Dicot	Terrestrial
Phlox, Texas Trailing	*Phlox nivalis ssp. texensis*	Dicot	Terrestrial
Phlox, Yreka	*Phlox hirsuta*	Dicot	Terrestrial
Phyllostegia hirsuta (ncn)	*Phyllostegia hirsuta*	Dicot	Terrestrial
Phyllostegia kaalaensis (ncn)	*Phyllostegia kaalaensis*	Dicot	Terrestrial
Phyllostegia knudsenii (ncn)	*Phyllostegia knudsenii*	Dicot	Terrestrial
Phyllostegia mannii (ncn)	*Phyllostegia mannii*	Dicot	Terrestrial
Phyllostegia mollis (ncn)	*Phyllostegia mollis*	Dicot	Terrestrial
Phyllostegia parviflora (ncn)	*Phyllostegia parviflora*	Dicot	Terrestrial
Phyllostegia velutina (ncn)	*Phyllostegia velutina*	Dicot	Terrestrial

Phyllostegia waimeae (ncn)	*Phyllostegia waimeae*	Dicot	Terrestrial
Phyllostegia warshaueri (ncn)	*Phyllostegia warshaueri*	Dicot	Terrestrial
Phyllostegia wawrana (ncn)	*Phyllostegia wawrana*	Dicot	Terrestrial
Pigeon, Puerto Rican Plain	*Columba inornata wetmorei*	Bird	Terrestrial
Pilo (Hedyotis mannii)	*Hedyotis mannii*	Dicot	Terrestrial
Pink, Swamp	*Helonias bullata*	Monocot	Terrestrial, Freshwater
Pinkroot, Gentian	*Spigelia gentianoides*	Dicot	Terrestrial
Piperia, Yadon's	*Piperia yadonii*	Monocot	Terrestrial
Pitaya, Davis' Green	*Echinocereus viridiflorus var. davisii*	Dicot	Terrestrial
Pitcher-plant, Alabama Canebrake	*Sarracenia rubra alabamensis*	Dicot	Terrestrial, Freshwater
Pitcher-plant, Green	*Sarracenia oreophila*	Dicot	Terrestrial, Freshwater
Pitcher-plant, Mountain Sweet	*Sarracenia rubra ssp. jonesii*	Dicot	Terrestrial, Freshwater
Platanthera holochila (ncn)	*Platanthera holochila*	Monocot	Terrestrial
Plover, Piping	*Charadrius melodus*	Bird	Terrestrial
Plover, Western Snowy	*Charadrius alexandrinus nivosus*	Bird	Terrestrial
Plum, Scrub	*Prunus geniculata*	Dicot	Terrestrial
Poa siphonoglossa (ncn)	*Poa siphonoglossa*	Monocot	Terrestrial
Po'e (Portulaca sclerocarpa)	*Portulaca sclerocarpa*	Dicot	Terrestrial
Pogonia, Small Whorled	*Isotria medeoloides*	Monocot	Terrestrial
Polygala, Lewton's	*Polygala lewtonii*	Dicot	Terrestrial
Polygala, Tiny	*Polygala smallii*	Dicot	Terrestrial
Polygonum, Scott's Valley	*Polygonum hickmanii*	Dicot	Terrestrial
Polystichum calderonense (ncn)	*Polystichum calderonense*	Ferns	Terrestrial
Pondberry	*Lindera melissifolia*	Dicot	Terrestrial
Pondweed, Little Aguja Creek	*Potamogeton clystocarpus*	Monocot	Freshwater
Poolfish, Pahrump (= Pahrump Killifish)	*Empetrichthys latos*	Dicot	Freshwater
Po'ouli	*Melamprosops phaeosoma*	Bird	Terrestrial
Popcornflower, Rough	*Plagiobothrys hirtus*	Dicot	Vernal pool
Popolo 'Aiakeakua (Solanum sandwicense)	*Solanum sandwicense*	Dicot	Terrestrial
Popolo Ku Mai (Solanum incompletum)	*Solanum incompletum*	Dicot	Terrestrial
Poppy, Sacramento Prickly	*Argemone pleiacantha ssp. pinnatisecta*	Dicot	Terrestrial
Poppy-mallow, Texas	*Callirhoe scabriuscula*	Dicot	Terrestrial
Potato-bean, Price's	*Apios priceana*	Dicot	Terrestrial
Potentilla, Hickman's	*Potentilla hickmanii*	Dicot	Terrestrial
Prairie Dog, Utah	*Cynomys parvidens*	Mammal	Terrestrial, Subterraneous
Prairie-chicken, Attwater's Greater	*Tympanuchus cupido attwateri*	Bird	Terrestrial
Prickly-apple, Fragrant	*Cereus eriophorus var. fragrans*	Dicot	Terrestrial
Prickly-ash, St. Thomas	*Zanthoxylum thomasianum*	Dicot	Terrestrial
Primrose, Maguire	*Primula maguirei*	Dicot	Terrestrial
Pronghorn, Sonoran	*Antilocapra americana sonoriensis*	Mammal	Terrestrial
Pseudoscorpion, Tooth Cave	*Tartarocreagris texana*	Arachnid	Terrestrial, Subterraneous
Pteris lidgatei (ncn)	*Pteris lidgatei*	Ferns	Terrestrial
Pua'ala (Brighamia rockii)	*Brighamia rockii*	Dicot	Terrestrial
Puma (=Cougar), Eastern	*Puma (=Felis) concolor (all subsp. except coryi)*	Mammal	Terrestrial
Pupfish, Ash Meadows Amargosa	*Cyprinodon nevadensis mionectes*	Fish	Freshwater
Pupfish, Comanche Springs	*Cyprinodon elegans*	Fish	Freshwater
Pupfish, Desert	*Cyprinodon macularius*	Fish	Freshwater
Pupfish, Devils Hole	*Cyprinodon diabolis*	Fish	Freshwater
Pupfish, Leon Springs	*Cyprinodon bovinus*	Fish	Freshwater
Pupfish, Owens	*Cyprinodon radiosus*	Fish	Freshwater
Pupfish, Warm Springs	*Cyprinodon nevadensis pectoralis*	Fish	Freshwater
Purple Bean	*Villosa perpurpurea*	Bivalve	Freshwater
Pussypaws, Mariposa	*Calyptridium pulchellum*	Dicot	Terrestrial
Pu'uka'a (Cyperus trachysanthos)	*Cyperus trachysanthos*	Monocot	Terrestrial
Quillwort, Black-spored	*Isoetes melanospora*	Ferns	Vernal pool
Quillwort, Louisiana	*Isoetes louisianensis*	Ferns	Terrestrial, Freshwater
Quillwort, Mat-forming	*Isoetes tegetiformans*	Ferns	Vernal pool
Rabbit, Pygmy	*Brachylagus idahoensis*	Mammal	Terrestrial
Rabbit, Riparian Brush	*Sylvilagus bachmani riparius*	Mammal	Terrestrial
Rabbitsfoot, Rough	*Quadrula cylindrica strigillata*	Bivalve	Freshwater
Rail, California Clapper	*Rallus longirostris obsoletus*	Bird	Terrestrial
Rail, Light-footed Clapper	*Rallus longirostris levipes*	Bird	Terrestrial
Rail, Yuma Clapper	*Rallus longirostris yumanensis*	Bird	Terrestrial
Rattlesnake, New Mexican Ridge-nosed	*Crotalus willardi obscurus*	Reptile	Terrestrial

Rattleweed, Hairy	*Baptisia arachnifera*	Dicot	Terrestrial
Reed-mustard, Barneby	*Schoenocrambe barnebyi*	Dicot	Terrestrial
Reed-mustard, Shrubby	*Schoenocrambe suffrutescens*	Dicot	Terrestrial
Remya kauaiensis (ncn)	*Remya kauaiensis*	Dicot	Terrestrial
Remya montgomeryi (ncn)	*Remya montgomeryi*	Dicot	Terrestrial
Remya, Maui	*Remya mauiensis*	Dicot	Terrestrial
Rhadine exilis (ncn)	*Rhadine exilis*	Insect	Terrestrial, Subterraneous
Rhadine infernalis (ncn)	*Rhadine infernalis*	Insect	Terrestrial, Subterraneous
Rhododendron, Chapman	*Rhododendron chapmanii*	Dicot	Terrestrial
Ridge-cress (=Pepper-cress), Barneby	*Lepidium barnebyanum*	Dicot	Terrestrial
Riffleshell, Northern	*Epioblasma torulosa rangiana*	Bivalve	Freshwater
Riffleshell, Tan	*Epioblasma florentina walkeri (=E. walkeri)*	Bivalve	Freshwater
Riversnail, Anthony's	*Athearnia anthonyi*	Gastropod	Freshwater
Rock-cress, Braun's	*Arabis perstellata E. L. Braun var. ampla Rollins*	Dicot	Terrestrial
Rock-cress, Hoffmann's	*Arabis hoffmannii*	Dicot	Terrestrial
Rock-cress, McDonald's	*Arabis mcdonaldiana*	Dicot	Terrestrial
Rock-cress, Santa Cruz Island	*Sibara filifolia*	Dicot	Terrestrial
Rock-cress, Shale Barren	*Arabis serotina*	Dicot	Terrestrial
Rock-cress, Small	*Arabis perstellata E. L. Braun var. perstellata Fernald*	Dicot	Terrestrial
Rock-pocketbook, Ouachita (=Wheeler's pm)	*Arkansia wheeleri*	Bivalve	Freshwater
Rocksnail, Painted	*Leptoxis taeniata*	Gastropod	Freshwater
Rocksnail, Plicate	*Leptoxis plicata*	Gastropod	Freshwater
Rocksnail, Round	*Leptoxis ampla*	Gastropod	Freshwater
Rosemary, Cumberland	*Conradina verticillata*	Dicot	Terrestrial
Rosemary, Etonia	*Conradina etonia*	Dicot	Terrestrial
Rosemary, Short-leaved	*Conradina brevifolia*	Dicot	Terrestrial
Roseroot, Leedy's	*Sedum integrifolium ssp. leedyi*	Dicot	Terrestrial
Rush-pea, Slender	*Hoffmannseggia tenella*	Dicot	Terrestrial
Rush-rose, Island	*Helianthemum greenei*	Dicot	Terrestrial
Salamander, Barton Springs	*Eurycea sosorum*	Amphibian	Terrestrial, Freshwater
Salamander, California Tiger	*Ambystoma californiense*	Amphibian	Terrestrial, Vernal pool
Salamander, Cheat Mountain	*Plethodon nettingi*	Amphibian	Terrestrial, Freshwater
Salamander, Desert Slender	*Batrachoseps aridus*	Amphibian	Terrestrial, Freshwater
Salamander, Frosted Flatwoods	*Ambystoma cingulatum*	Amphibian	Terrestrial, Freshwater, Vernal pool
Salamander, Red Hills	*Phaeognathus hubrichti*	Amphibian	Terrestrial, Freshwater
Salamander, San Marcos	*Eurycea nana*	Amphibian	Terrestrial, Freshwater
Salamander, Santa Cruz Long-toed	*Ambystoma macrodactylum croceum*	Amphibian	Terrestrial, Freshwater, Vernal pool
Salamander, Shenandoah	*Plethodon shenandoah*	Amphibian	Terrestrial, Freshwater
Salamander, Sonora Tiger	*Ambystoma tigrinum stebbinsi*	Amphibian	Terrestrial, Freshwater, Vernal pool
Salamander, Texas Blind	*Typhlomolge rathbuni*	Amphibian	Freshwater, Subterraneous
Salmon, Atlantic	*Salmo salar*	Fish	Freshwater, Brackish, Saltwater
Salmon, Chinook	*Oncorhynchus (=Salmo)*	Fish	Freshwater, Brackish, Saltwater
Salmon, Chum	*Oncorhynchus (=Salmo) keta*	Fish	Freshwater, Brackish, Saltwater
Salmon, Coho	*Oncorhynchus (=Salmo) kisutch*	Fish	Freshwater, Brackish, Saltwater
Salmon, Sockeye	*Oncorhynchus (=Salmo) nerka*	Fish	Freshwater, Brackish, Saltwater
Sandalwood, Lanai (='Iliahi)	*Santalum freycinetianum var. lanaiense*	Dicot	Terrestrial
Sandlace	*Polygonella myriophylla*	Dicot	Terrestrial
Sand-verbena, Large-fruited	*Abronia macrocarpa*	Dicot	Terrestrial
Sandwort, Bear Valley	*Arenaria ursina*	Dicot	Terrestrial
Sandwort, Cumberland	*Arenaria cumberlandensis*	Dicot	Terrestrial
Sandwort, Marsh	*Arenaria paludicola*	Dicot	Terrestrial, Freshwater
Sanicula mariversa (ncn)	*Sanicula mariversa*	Dicot	Terrestrial
Sanicula purpurea (ncn)	*Sanicula purpurea*	Dicot	Terrestrial
Sawfish, Smalltooth	*Pristis pectinata*	Fish	Freshwater, Brackish, Saltwater
Schiedea haleakalensis (ncn)	*Schiedea haleakalensis*	Dicot	Terrestrial
Schiedea helleri (ncn)	*Schiedea helleri*	Dicot	Terrestrial
Schiedea hookeri (ncn)	*Schiedea hookeri*	Dicot	Terrestrial
Schiedea kaalae (ncn)	*Schiedea kaalae*	Dicot	Terrestrial
Schiedea kauaiensis (ncn)	*Schiedea kauaiensis*	Dicot	Terrestrial
Schiedea membranacea (ncn)	*Schiedea membranacea*	Dicot	Terrestrial
Schiedea nuttallii (ncn)	*Schiedea nuttallii*	Dicot	Terrestrial
Schiedea spergulina var. leiopoda (ncn)	*Schiedea spergulina var. leiopoda*	Dicot	Terrestrial
Schiedea spergulina var. spergulina (ncn)	*Schiedea spergulina var. spergulina*	Dicot	Terrestrial

Schiedea, Diamond Head (Schiedea adamantis)	*Schiedea adamantis*	Dicot	Terrestrial
Schoepfia arenaria (ncn)	*Schoepfia arenaria*	Dicot	Terrestrial
Scrub-Jay, Florida	*Aphelocoma coerulescens*	Bird	Terrestrial
Sculpin, Pygmy	*Cottus paulus (=pygmaeus)*	Fish	Freshwater
Sea turtle, green	*Chelonia mydas*	Reptile	Saltwater
Sea turtle, hawksbill	*Eretmochelys imbricata*	Reptile	Saltwater, Coastal
Sea turtle, leatherback	*Dermochelys coriacea*	Reptile	Saltwater, Coastal
Sea turtle, loggerhead	*Caretta caretta*	Reptile	Saltwater, Coastal
Sea-blite, California	*Suaeda californica*	Dicot	Terrestrial
Seagrass, Johnson's	*Halophila johnsonii*	Monocot	Saltwater, Coastal
Seal, Guadalupe Fur	*Arctocephalus townsendi*	Mammal	Saltwater, Coastal
Seal, Hawaiian Monk	*Monachus schauinslandi*	Mammal	Saltwater, Coastal
Seal, spotted	*Phoca largha*	Mammal	Saltwater
Sea-lion, Steller	*Eumetopias jubatus*	Mammal	Saltwater, Coastal
Sedge, Golden	*Carex lutea*	Monocot	Terrestrial
Sedge, Navajo	*Carex specuicola*	Monocot	Terrestrial
Sedge, White	*Carex albida*	Monocot	Terrestrial, Freshwater
Shagreen, Magazine Mountain	*Mesodon magazinensis*	Gastropod	Terrestrial
Shearwater, Newell's Townsend's	*Puffinus auricularis newelli*	Bird	Terrestrial, Saltwater
Sheep, Peninsular Bighorn	*Ovis canadensis nelsoni*	Mammal	Terrestrial
Sheep, Sierra Nevada Bighorn	*Ovis canadensis sierrae*	Mammal	Terrestrial
Shiner, Arkansas River	*Notropis girardi*	Fish	Freshwater
Shiner, Beautiful	*Cyprinella formosa*	Fish	Freshwater
Shiner, Blue	*Cyprinella caerulea*	Fish	Freshwater
Shiner, Cahaba	*Notropis cahabae*	Fish	Freshwater
Shiner, Cape Fear	*Notropis mekistocholas*	Fish	Freshwater
Shiner, Palezone	*Notropis albizonatus*	Fish	Freshwater
Shiner, Pecos Bluntnose	*Notropis simus pecosensis*	Fish	Freshwater
Shiner, Topeka	*Notropis topeka (=tristis)*	Fish	Freshwater
Shrew, Buena Vista Lake Ornate	*Sorex ornatus relictus*	Mammal	Terrestrial
Shrike, San Clemente Loggerhead	*Lanius ludovicianus mearnsi*	Bird	Terrestrial
Shrimp, Alabama Cave	*Palaemonias alabamae*	Crustacean	Freshwater
Shrimp, California Freshwater	*Syncaris pacifica*	Crustacean	Freshwater
Shrimp, Kentucky Cave	*Palaemonias ganteri*	Crustacean	Freshwater
Shrimp, Squirrel Chimney Cave	*Palaemonetes cummingi*	Crustacean	Freshwater, Subterraneous
Silene hawaiiensis (ncn)	*Silene hawaiiensis*	Dicot	Terrestrial
Silene lanceolata (ncn)	*Silene lanceolata*	Dicot	Terrestrial
Silene perlmanii (ncn)	*Silene perlmanii*	Dicot	Terrestrial
Silverside, Waccamaw	*Menidia extensa*	Fish	Freshwater
Silversword, Haleakala ('Ahinahina)	*Argyroxiphium sandwicense ssp. macrocephalum*	Dicot	Terrestrial
Silversword, Ka'u (Argyroxiphium kauense)	*Argyroxiphium kauense*	Dicot	Terrestrial
Silversword, Mauna Kea ('Ahinahina)	*Argyroxiphium sandwicense ssp. sandwicense*	Dicot	Terrestrial
Skink, Blue-tailed Mole	*Eumeces egregius lividus*	Reptile	Terrestrial
Skink, Sand	*Neoseps reynoldsi*	Reptile	Terrestrial
Skipper, Carson Wandering	*Pseudocopaeodes eunus obscurus*	Insect	Terrestrial
Skipper, Laguna Mountain	*Pyrgus ruralis lagunae*	Insect	Terrestrial
Skipper, Pawnee Montane	*Hesperia leonardus montana*	Insect	Terrestrial
Skullcap, Florida	*Scutellaria floridana*	Dicot	Terrestrial
Skullcap, Large-flowered	*Scutellaria montana*	Dicot	Terrestrial
Slabshell, Chipola	*Elliptio chipolaensis*	Bivalve	Freshwater
Smelt, Delta	*Hypomesus transpacificus*	Fish	Freshwater, Brackish
Snail, Armored	*Pyrgulopsis (=Marstonia) pachyta*	Gastropod	Freshwater
Snail, Bliss Rapids	*Taylorconcha serpenticola*	Gastropod	Freshwater
Snail, Chittenango Ovate Amber	*Succinea chittenangoensis*	Gastropod	Terrestrial, Freshwater
Snail, Flat-spired Three-toothed	*Triodopsis platysayoides*	Gastropod	Terrestrial
Snail, Iowa Pleistocene	*Discus macclintocki*	Gastropod	Terrestrial
Snail, Lioplax Cylindrical	*Lioplax cyclostomaformis*	Gastropod	Freshwater
Snail, Morro Shoulderband	*Helminthoglypta walkeriana*	Gastropod	Terrestrial
Snail, Newcomb's	*Erinna newcombi*	Gastropod	Freshwater
Snail, Noonday	*Mesodon clarki nantahala*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella abbreviata)	*Achatinella abbreviata*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella apexfulva)	*Achatinella apexfulva*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella bellula)	*Achatinella bellula*	Gastropod	Terrestrial

Snail, O'ahu Tree (Achatinella buddii)	*Achatinella buddii*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella bulimoides)	*Achatinella bulimoides*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella byronii)	*Achatinella byronii*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella caesia)	*Achatinella caesia*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella casta)	*Achatinella casta*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella cestus)	*Achatinella cestus*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella concavospira)	*Achatinella concavospira*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella curta)	*Achatinella curta*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella decipiens)	*Achatinella decipiens*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella decora)	*Achatinella decora*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella dimorpha)	*Achatinella dimorpha*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella elegans)	*Achatinella elegans*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella fulgens)	*Achatinella fulgens*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella fuscobasis)	*Achatinella fuscobasis*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella juddii)	*Achatinella juddii*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella juncea)	*Achatinella juncea*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella lehuiensis)	*Achatinella lehuiensis*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella leucorraphe)	*Achatinella leucorraphe*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella lila)	*Achatinella lila*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella	*Achatinella livida*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella	*Achatinella lorata*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella mustelina)	*Achatinella mustelina*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella papyracea)	*Achatinella papyracea*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella phaeozona)	*Achatinella phaeozona*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella pulcherrima)	*Achatinella pulcherrima*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella pupukanioe)	*Achatinella pupukanioe*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella rosea)	*Achatinella rosea*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella sowerbyana)	*Achatinella sowerbyana*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella spaldingi)	*Achatinella spaldingi*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella stewartii)	*Achatinella stewartii*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella swiftii)	*Achatinella swiftii*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella taeniolata)	*Achatinella taeniolata*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella thaanumi)	*Achatinella thaahumi*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella turgida)	*Achatinella turgida*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella valida)	*Achatinella valida*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella viridans)	*Achatinella viridans*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella vittata)	*Achatinella vittata*	Gastropod	Terrestrial
Snail, O'ahu Tree (Achatinella vulpina)	*Achatinella vulpina*	Gastropod	Terrestrial

Snail, Painted Snake Coiled Forest	*Anguispira picta*	Gastropod	Terrestrial
Snail, Pecos Assiminea	*Assiminea pecos*	Gastropod	Freshwater
Snail, Snake River Physa	*Physa natricina*	Gastropod	Terrestrial
Snail, Tulotoma	*Tulotoma magnifica*	Gastropod	Terrestrial
Snail, Virginia Fringed Mountain	*Polygyriscus virginianus*	Gastropod	Terrestrial
Snake, Atlantic Salt Marsh	*Nerodia clarkii taeniata*	Reptile	Terrestrial, Brackish, Saltwater
Snake, Concho Water	*Nerodia paucimaculata*	Reptile	Terrestrial, Freshwater
Snake, Eastern Indigo	*Drymarchon corais couperi*	Reptile	Terrestrial
Snake, Giant Garter	*Thamnophis gigas*	Reptile	Terrestrial, Freshwater
Snake, Lake Erie Water	*Nerodia sipedon insularum*	Reptile	Terrestrial, Freshwater
Snake, Northern Copperbelly Water	*Nerodia erythrogaster neglecta*	Reptile	Terrestrial, Freshwater
Snake, San Francisco Garter	*Thamnophis sirtalis tetrataenia*	Reptile	Terrestrial, Freshwater
Snakeroot	*Eryngium cuneifolium*	Dicot	Terrestrial
Sneezeweed, Virginia	*Helenium virginicum*	Dicot	Vernal pool
Snowbells, Texas	*Styrax texanus*	Dicot	Terrestrial
Sparrow, Cape Sable Seaside	*Ammodramus maritimus mirabilis*	Bird	Terrestrial
Sparrow, Florida Grasshopper	*Ammodramus savannarum floridanus*	Bird	Terrestrial
Sparrow, San Clemente Sage	*Amphispiza belli clementeae*	Bird	Terrestrial
Spermolepis hawaiiensis (ncn)	*Spermolepis hawaiiensis*	Dicot	Terrestrial
Spider, Government Canyon Bat Cave	*Neoleptoneta microps*	Arachnid	Terrestrial, Subterraneous
Spider, Kauai Cave Wolf	*Adelocosa anops*	Arachnid	Terrestrial, Subterraneous
Spider, Spruce-fir Moss	*Microhexura montivaga*	Arachnid	Terrestrial
Spider, Tooth Cave	*Leptoneta myopica*	Arachnid	Terrestrial, Subterraneous
Spikedace	*Meda fulgida*	Fish	Freshwater
Spinedace, Big Spring	*Lepidomeda mollispinis pratensis*	Fish	Freshwater
Spinedace, Little Colorado	*Lepidomeda vittata*	Fish	Freshwater
Spinedace, White River	*Lepidomeda albivallis*	Fish	Freshwater
Spineflower, Ben Lomond	*Chorizanthe pungens var. hartwegiana*	Dicot	Terrestrial
Spineflower, Howell's	*Chorizanthe howellii*	Dicot	Terrestrial
Spineflower, Monterey	*Chorizanthe pungens var. pungens*	Dicot	Terrestrial
Spineflower, Orcutt's	*Chorizanthe orcuttiana*	Dicot	Terrestrial
Spineflower, Robust	*Chorizanthe robusta va r. robusta*	Dicot	Terrestrial
Spineflower, Scotts Valley	*Chorizanthe robusta var. hartwegii*	Dicot	Terrestrial
Spineflower, Slender-horned	*Dodecahema leptoceras*	Dicot	Terrestrial
Spineflower, Sonoma	*Chorizanthe valida*	Dicot	Terrestrial
Spinymussel, James River	*Pleurobema collina*	Bivalve	Freshwater
Spinymussel, Tar River	*Elliptio steinstansana*	Bivalve	Freshwater
Spiraea, Virginia	*Spiraea virginiana*	Dicot	Terrestrial
Springfish, Hiko White River	*Crenichthys baileyi grandis*	Fish	Freshwater
Springfish, Railroad Valley	*Crenichthys nevadae*	Fish	Freshwater
Springfish, White River	*Crenichthys baileyi baileyi*	Fish	Freshwater
Springsnail, Alamosa	*Tryonia alamosae*	Gastropod	Freshwater
Springsnail, Bruneau Hot	*Pyrgulopsis bruneauensis*	Gastropod	Freshwater
Springsnail, Koster's	*Juturnia kosteri*	Gastropod	Terrestrial
Springsnail, Roswell	*Pyrgulopsis roswellensis*	Gastropod	Freshwater
Spurge, Deltoid	*Chamaesyce deltoidea ssp. deltoidea*	Dicot	Terrestrial
Spurge, Garber's	*Chamaesyce garberi*	Dicot	Terrestrial
Spurge, Hoover's	*Chamaesyce hooveri*	Dicot	Vernal pool
Spurge, Telephus	*Euphorbia telephioides*	Dicot	Terrestrial
Squawfish, Colorado	*Ptychocheilus lucius*	Fish	Freshwater
Squirrel, Carolina Northern Flying	*Glaucomys sabrinus coloratus*	Mammal	Terrestrial
Squirrel, Delmarva Peninsula Fox	*Sciurus niger cinereus*	Mammal	Terrestrial
Squirrel, Mount Graham Red	*Tamiasciurus hudsonicus grahamensis*	Mammal	Terrestrial
Squirrel, Northern Idaho Ground	*Spermophilus brunneus brunneus*	Mammal	Terrestrial
Steelhead	*Oncorhynchus (=Salmo) mykiss*	Fish	Freshwater, Brackish, Saltwater
Stenogyne angustifolia (ncn)	*Stenogyne angustifolia var. angustifolia*	Dicot	Terrestrial
Stenogyne campanulata (ncn)	*Stenogyne campanulata*	Dicot	Terrestrial
Stenogyne kanehoana (ncn)	*Stenogyne kanehoana*	Dicot	Terrestrial
Stickleback, Unarmored Threespine	*Gasterosteus aculeatus williamsoni*	Fish	Freshwater
Stickseed, Showy	*Hackelia venusta*	Dicot	Terrestrial
Stickyseed, Baker's	*Blennosperma bakeri*	Dicot	Vernal pool
Stilt, Hawaiian (=Ae'o)	*Himantopus mexicanus knudseni*	Bird	Terrestrial
Stirrupshell	*Quadrula stapes*	Bivalve	Freshwater
Stonecrop, Lake County	*Parvisedum leiocarpum*	Dicot	Vernal pool
Stork, Wood	*Mycteria americana*	Bird	Terrestrial
Sturgeon, Alabama	*Scaphirhynchus suttkusi*	Fish	Freshwater

Sturgeon, Gulf	*Acipenser oxyrinchus desotoi*	Fish	Freshwater, Saltwater
Sturgeon, North American green	*Acipenser medirostris*	Fish	Freshwater, Saltwater
Sturgeon, Pallid	*Scaphirhynchus albus*	Fish	Freshwater
Sturgeon, Shortnose	*Acipenser brevirostrum*	Fish	Freshwater, Saltwater
Sturgeon, White	*Acipenser transmontanus*	Fish	Freshwater, Saltwater
Sucker, June	*Chasmistes liorus*	Fish	Freshwater
Sucker, Lost River	*Deltistes luxatus*	Fish	Freshwater
Sucker, Modoc	*Catostomus microps*	Fish	Freshwater
Sucker, Razorback	*Xyrauchen texanus*	Fish	Freshwater
Sucker, Santa Ana	*Catostomus santaanae*	Fish	Freshwater
Sucker, Shortnose	*Chasmistes brevirostris*	Fish	Freshwater
Sucker, Warner	*Catostomus warnerensis*	Fish	Freshwater
Sumac, Michaux's	*Rhus michauxii*	Dicot	Terrestrial
Sunflower, Pecos	*Helianthus paradoxus*	Dicot	Terrestrial, Perm. wetland
Sunflower, San Mateo Woolly	*Eriophyllum latilobum*	Dicot	Terrestrial
Sunflower, Schweinitz's	*Helianthus schweinitzii*	Dicot	Terrestrial
Sunray, Ash Meadows	*Enceliopsis nudicaulis var. corrugata*	Dicot	Terrestrial
Swiftlet, Mariana Gray (=Vanikoro)	*Aerodramus vanikorensis bartschi*	Bird	Terrestrial
Tadpole Shrimp, Vernal Pool	*Lepidurus packardi*	Crustacean	Vernal pool
Taraxacum, California	*Taraxacum californicum*	Dicot	Terrestrial
Tarplant, Gaviota	*Deinandra increscens ssp. villosa*	Dicot	Terrestrial
Tarplant, Otay	*Deinandra (=Hemizonia) conjugens*	Dicot	Terrestrial
Tarplant, Santa Cruz	*Holocarpha macradenia*	Dicot	Terrestrial
Tectaria Estremerana	*Tectaria estremerana*	Ferns	Terrestrial
Tern, California Least	*Sterna antillarum browni*	Bird	Terrestrial
Tern, Interior (population) Least	*Sterna antillarum*	Bird	Terrestrial
Tern, Roseate	*Sterna dougallii dougallii*	Bird	Terrestrial
Ternstroemia subsessilis (ncn)	*Ternstroemia subsessilis*	Dicot	Terrestrial
Tetramolopium arenarium (ncn)	*Tetramolopium arenarium*	Dicot	Terrestrial
Tetramolopium capillare (ncn)	*Tetramolopium capillare*	Dicot	Terrestrial
Tetramolopium filiforme (ncn)	*Tetramolopium filiforme*	Dicot	Terrestrial
Tetramolopium lepidotum ssp. lepidotum (ncn)	*Tetramolopium lepidotum ssp. lepidotum*	Dicot	Terrestrial
Tetramolopium remyi (ncn)	*Tetramolopium remyi*	Dicot	Terrestrial
Thelypody, Howell's Spectacular	*Thelypodium howellii spectabilis*	Dicot	Terrestrial
Thistle, Chorro creek Bog	*Cirsium fontinale var. obispoense*	Dicot	Terrestrial, Freshwater
Thistle, Fountain	*Cirsium fontinale var. fontinale*	Dicot	Terrestrial
Thistle, La Graciosa	*Cirsium loncholepis*	Dicot	Freshwater, Brackish, Coastal
Thistle, Pitcher's	*Cirsium pitcheri*	Dicot	Terrestrial
Thistle, Sacramento Mountains	*Cirsium vinaceum*	Dicot	Terrestrial
Thistle, Suisun	*Cirsium hydrophilum var. hydrophilum*	Dicot	Terrestrial, Brackish
Thornmint, San Diego	*Acanthomintha ilicifolia*	Dicot	Terrestrial
Thornmint, San Mateo	*Acanthomintha obovata ssp.*	Dicot	Terrestrial
Thrush, Large Kauai	*Myadestes myadestinus*	Bird	Terrestrial
Thrush, Small Kauai (Puaiohi)	*Myadestes palmeri*	Bird	Terrestrial
Toad, Arroyo Southwestern	*Bufo californicus (=microscaphus)*	Amphibian	Terrestrial, Freshwater
Toad, Houston	*Bufo houstonensis*	Amphibian	Terrestrial, Freshwater
Toad, Puerto Rican Crested	*Peltophryne lemur*	Amphibian	Terrestrial, Freshwater
Topminnow, Gila (Yaqui)	*Poeciliopsis occidentalis*	Fish	Freshwater
Torreya, Florida	*Torreya taxifolia*	Conf/cycds	Terrestrial
Tortoise, Desert	*Gopherus agassizii*	Reptile	Terrestrial
Tortoise, Gopher	*Gopherus polyphemus*	Reptile	Terrestrial
Towhee, Inyo Brown	*Pipilo crissalis eremophilus*	Bird	Terrestrial
Townsendia, Last Chance	*Townsendia aprica*	Dicot	Terrestrial
Tree Fern, Elfin	*Cyathea dryopteroides*	Ferns	Terrestrial
Trematolobelia singularis (ncn)	*Trematolobelia singularis*	Dicot	Terrestrial
Trillium, Persistent	*Trillium persistens*	Monocot	Terrestrial
Trillium, Relict	*Trillium reliquum*	Monocot	Terrestrial
Trout, Apache	*Oncorhynchus apache*	Fish	Freshwater
Trout, Bull	*Salvelinus confluentus*	Fish	Freshwater
Trout, Gila	*Oncorhynchus gilae*	Fish	Freshwater
Trout, Greenback Cutthroat	*Oncorhynchus clarki stomias*	Fish	Freshwater
Trout, Lahontan Cutthroat	*Oncorhynchus clarki henshawi*	Fish	Freshwater
Trout, Little Kern Golden	*Oncorhynchus aguabonita whitei*	Fish	Freshwater
Trout, Paiute Cutthroat	*Oncorhynchus clarki seleniris*	Fish	Freshwater
Tuctoria, Green's	*Tuctoria greenei*	Dicot	Vernal pool
Turtle, Alabama Red-bellied	*Pseudemys alabamensis*	Reptile	Terrestrial, Freshwater
Turtle, Bog	*Clemmys muhlenbergii*	Reptile	Terrestrial, Freshwater
Turtle, Flattened Musk	*Sternotherus depressus*	Reptile	Terrestrial, Freshwater

Turtle, Ringed Map	*Graptemys oculifera*	Reptile	Terrestrial, Freshwater
Turtle, Yellow-blotched Map	*Graptemys flavimaculata*	Reptile	Terrestrial, Freshwater
Twinpod, Dudley Bluffs	*Physaria obcordata*	Dicot	Terrestrial
Uhiuhi (Caesalpinia kavaiensis)	*Caesalpinia kavaiense*	Dicot	Terrestrial
Umbel, Huachuca Water	*Lilaeopsis schaffneriana var.*	Dicot	Terrestrial, Freshwater
Uvillo	*Eugenia haematocarpa*	Dicot	Terrestrial
Vernonia Proctorii (ncn)	*Vernonia proctorii*	Dicot	Terrestrial
Vervain, California	*Verbena californica*	Dicot	Terrestrial
Vetch, Hawaiian (Vicia menziesii)	*Vicia menziesii*	Dicot	Terrestrial
Vigna o-wahuensis (ncn)	*Vigna o-wahuensis*	Dicot	Terrestrial
Viola helenae (ncn)	*Viola helenae*	Dicot	Terrestrial
Viola oahuensis (ncn)	*Viola oahuensis*	Dicot	Terrestrial
Vireo, Black-capped	*Vireo atricapilla*	Bird	Terrestrial
Vireo, Least Bell's	*Vireo bellii pusillus*	Bird	Terrestrial
Vole, Amargosa	*Microtus californicus scirpensis*	Mammal	Terrestrial
Vole, Florida Salt Marsh	*Microtus pennsylvanicus dukecampbelli*	Mammal	Terrestrial, Brackish
Vole, Hualapai Mexican	*Microtus mexicanus hualpaiensis*	Mammal	Terrestrial
Wahine Noho Kula (Isodendrion pyrifolium)	*Isodendrion pyrifolium*	Dicot	Terrestrial
Wallflower, Ben Lomond	*Erysimum teretifolium*	Dicot	Terrestrial
Wallflower, Contra Costa	*Erysimum capitatum var.*	Dicot	Terrestrial
Wallflower, Menzie's	*Erysimum menziesii*	Dicot	Terrestrial
Walnut, Nogal	*Juglans jamaicensis*	Monocot	Terrestrial
Warbler (=Wood), Golden-cheeked	*Dendroica chrysoparia*	Bird	Terrestrial
Warbler (=Wood), Kirtland's	*Dendroica kirtlandii*	Bird	Terrestrial
Warbler, Bachman's	*Vermivora bachmanii*	Bird	Terrestrial
Warea, Wide-leaf	*Warea amplexifolia*	Dicot	Terrestrial
Watercress, Gambel's	*Rorippa gambellii*	Dicot	Terrestrial, Freshwater, Brackish
Water-plantain, Kral's	*Sagittaria secundifolia*	Monocot	Freshwater
Water-willow, Cooley's	*Justicia cooleyi*	Dicot	Terrestrial
Wawae'Iole (Phlegmariurus (=Huperzia) mannii)	*Huperzia mannii*	Ferns	Terrestrial
Whale, Finback	*Balaenoptera physalus*	Mammal	Saltwater
Whale, Humpback	*Megaptera novaeangliae*	Mammal	Saltwater
Whale, North Atlantic right	*Eubalaena glacialis (incl. australis)*	Mammal	Saltwater
Whale, Sei	*Balaenoptera borealis*	Mammal	Saltwater
Whale, Sperm	*Physeter catodon (=macrocephalus)*	Mammal	Saltwater
Whipsnake (=Striped Racer), Alameda	*Masticophis lateralis euryxanthus*	Reptile	Terrestrial
Whitlow-wort, Papery	*Paronychia chartacea*	Dicot	Terrestrial
Wild-buckwheat, Clay-loving	*Eriogonum pelinophilum*	Dicot	Terrestrial
Wild-buckwheat, Gypsum	*Eriogonum gypsophilum*	Dicot	Terrestrial
Wild-rice, Texas	*Zizania texana*	Monocot	Freshwater
Wings, Pigeon	*Clitoria fragrans*	Dicot	Terrestrial
Wireweed	*Polygonella basiramia*	Dicot	Terrestrial
Wolf, Red	*Canis rufus*	Mammal	Terrestrial
Woodland-star, San Clemente	*Lithophragma maximum*	Dicot	Terrestrial
Woodpecker, Ivory-billed	*Campephilus principalis*	Bird	Terrestrial
Woodpecker, Red-cockaded	*Picoides borealis*	Bird	Terrestrial
Woodrat, Riparian	*Neotoma fuscipes riparia*	Mammal	Terrestrial
Woolly-star, Santa Ana River	*Eriastrum densifolium ssp. sanctorum*	Dicot	Terrestrial
Woolly-threads, San Joaquin	*Monolopia (=Lembertia) congdonii*	Dicot	Terrestrial
Woundfin	*Plagopterus argentissimus*	Fish	Freshwater
Xylosma crenatum (ncn)	*Xylosma crenatum*	Dicot	Terrestrial
Yellowhead, Desert	*Yermo xanthocephalus*	Dicot	Terrestrial
Yerba Santa, Lompoc	*Eriodictyon capitatum*	Dicot	Terrestrial
Ziziphus, Florida	*Ziziphus celata*	Dicot	Terrestrial

Appendix H Fate data for Parent and Degradates

Table 1 Structure and Chemical Name of Residues of Concern

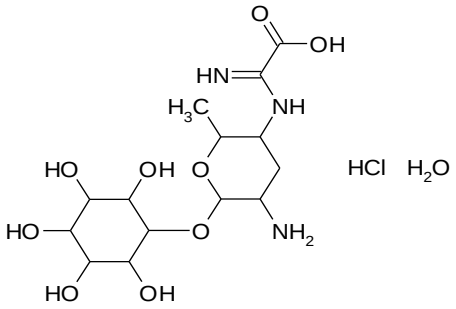
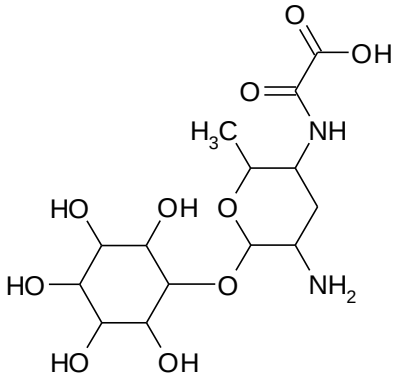
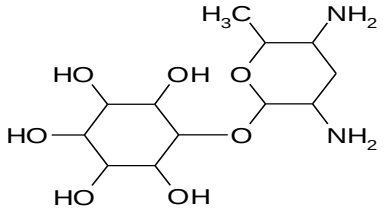
Common Name Chemical Name	Structure
a. Kasugamycin; *Pseudonyms*: Kasugamycin hydrochloride hydrate, Kasugamycin HCL×H2O, Kasumin 2L, Kasumin Cobre; Kasugamycin hydrochloride; KSM×HCl; Kasugamycin,3-O-[2-Amino-4-[(carboxyiminomethyl)amino]-2,3,4,6-tetradeoxy-α-D-arabino-hexopyranosyl]-D-chiro-inositol hydrochloride hydrate; *IUPAC Name*: 1L-1,3,4/2,5,6-1-Deoxy-2,3,4,5,6-penta-a-hydroxycyclohexyl 2-amino-2,3,4,6-tetradeoxy-4-(α-iminoglycino)-α-D-arabino-hexopyranoside hydrochloride hydrate *Cas #*: 19408-46-9 (for kasugamycin hydrochloride)	
b. Kasugamycinic acid; *Pseudonyms*: 3-O-[2-Amino-4-{(carboxycarbonyl)amino]-2,3,4,6-tetradeoxy-α-D-arabino-hexopyranosyl]-D-chiro-inositol; *IUPAC Name*: {5-Amino-2-methyl-6-[(2,3,4,5,6-pentahydroxycyclohexyl)oxy]tetrahydro-2H-pyran-3-yl}amino)(oxo)acetic acid *Cas#*: 6001-03-2	
c. Kasuganobiosamine; *Pseudonyms*: Kasuganobiosamine 2HCl [KB-3; kasuganobiosamine dihydrochloride; KSB; KB]; *IUPAC Name*: 6-[3,5-Diamino-6-methyltetrahydro-2H-pyran-2-yl)oxy]cyclohexane-1,2,3,4,5-pentol hydrochloride *Cas#*: 6189-93-1	

Table 2 Kasugamycin and all its transformation products

Name(s)	Maximum Percent of Applied Dose (interval)	% of applied dose at final sampling interval (study duration in days)	MRID	Study Type (OPPTS guideline)[1]	Comments
Kasugamycin; Pseudonyms: Kasugamycin hydrochloride hydrate, Kasugamycin HCL×H2O, Kasumin 2L, Kasumin Cobre; Kasugamycin hydrochloride; KSM×HCl; Kasugamycin,3-O-[2-Amino-4-[(carboxyiminomethyl)amino]-2,3,4,6-tetradeoxy-α-D-arabino-hexopyranosyl]-D-chiro-inositol hydrochloride hydrate; IUPAC Name: 1L-1,3,4/2,5,6-1-Deoxy-2,3,4,5,6-penta-a-hydroxycyclohexyl 2-amino-2,3,4,6-tetradeoxy-4-(α-iminoglycino)-α-D-arabino-hexopyranoside hydrochloride hydrate; Cas #: 19408-46-9 (for kasugamycin hydrochloride)	NA	silt loam soil-water system = 40.9% (180d); Sterile: silt loam soil = 69.1% (181d)	MRID 47945719	Aerobic/ Anaerobic soil metabolism (paddy) study	Linear $t_{1/2}$: 147.5 days* (r^2=0.8354) *half-life was only calculated in soil and assumed to be equivalent to the total system half-life since residues in water were 1.4% of the applied or less and therefore were not analyzed.
	NA	Lake water-loamy sand sediment system: total = 22.3% (100d): River water-clay loam sediment system: total = 21.8% (100d)	MRID 47945720	Aerobic aquatic metabolism (835.4300)	Lake water-loamy sand sediment system: total system $t_{1/2}$ = 45.4 days (r^2 = 0.7650; linear); River water-clay loam sediment system: total system $t_{1/2}$ = 44.2 days (r^2 =0.8242; linear)
	NA	Total System = 8% (368d)	MRID 47945721	Anaerobic aquatic metabolism (835.4400)	clay loam soil total system, $t_{1/2}$ = 105 days (r^2 = 0.8860; linear)
	NA	4.5% (366d)	MRID 47945718	Aerobic Soil metabolism (835.4100)	$t_{1/2}$ = 73 days (r^2 =0.9152; linear) in clay loam soil

Name(s)	Maximum Percent of Applied Dose (interval)	% of applied dose at final sampling interval (study duration in days)	MRID	Study Type (OPPTS guideline)[1]	Comments
	NA	<0.01 ppm (390d), <0.01 ppm (386d), <0.01 ppm (397d), <0.01 ppm (387d)	MRID 48132602	Terrestrial field dissipation (835.6100)	Could not calculate $t^{1/2}$ because residues were <LOQ and early sampling intervals (California, Loamy Sand); $t_{1/2}$ = 5.7d (r^2=0.8843, Washington, Loamy Sand/Sand) ; $t_{1/2}$ =12.3d (r^2=0.4591, New York, Loamy Sand/Sand); Could not calculate $t^{1/2}$ because residues were <LOQ and early sampling intervals (Georgia, Loamy Sand/Sandy Loam/Sandy Clay Loam)
	NA	pH5 buffer solution: 86.3% (18.9d), natural lake water: 17.6% (18.9%)	MRID 47945716	Aqueous Photolysis (835.2240)	pH5 buffer: adjusted $t_{1/2}$ = 630d, natural lake water: adjusted $t_{1/2}$ = 17.4d
	NA	pH 4=94.7% (30d), pH 5= 92.6% (30d), pH 7= 73.7% (30d), pH 9= 15.3% (30d)	MRID 46485501	Hydrolysis (835.2120)	pH 4 $t_{1/2}$ = 462d, pH 5 $t_{1/2}$ = 630d, pH 7 $t_{1/2}$ = 79.7d, pH 9 $t_{1/2}$ = 11.4d
	NA	100% (614 hrs-clay loam, 800 hrs-sandy loam, 725 hrs-Shizuoka sandy loam), 0% (leachate)	MRID 47945715	Soil column leaching (835.1240)	Supplemental Study
kasugamycinic acid[2]; Pseudonyms: 3-O-[2-Amino-4-{(carboxycarbonyl)amino]-2,3,4,6-tetradeoxy-α-D-arabino-hexopyranosyl]-D-chiro-inositol; IUPAC Name: {5-Amino-2-	non-sterile silt loam soil = 3.1% (180d), sterile: 11.9% (181d)	non-sterile silt loam soil = 3.1% (180d); sterile: silt loam soil = 11.9% (181d)	MRID 47945719	Aerobic/Anaerobic soil metabolism (paddy) study	NA

Name(s)	Maximum Percent of Applied Dose (interval)	% of applied dose at final sampling interval (study duration in days)	MRID	Study Type (OPPTS guideline)[1]	Comments
methyl-6-[(2,3,4,5,6-pentahydroxycyclohexyl)oxy]tetrahydro-2H-pyran-3-yl}amino)(oxo)acetic acid; Cas#: 6001-03-2	Lake water-loamy sand sediment system: total system = 30.7% (14d); River water-clay loam sediment system: total system = 16.3% (14d)	Lake water-loamy sand sediment system: total = 0.6% (100d); River water-clay loam sediment system: total = 0.2% (100d)	MRID 47945720	Aerobic aquatic metabolism (835.4300)	NA
	Total System = 35.9% (185d)	Total System = 28.7% (368d)	MRID 47945721	Anaerobic aquatic metabolism (835.4400)	NA
	pH 4=4.1% (30d), pH 5= 2.9% (30d), pH 7= 21.3% (30d), pH 9= 77.8% (30d)	pH 4=4.1% (30d), pH 5= 2.9% (30d), pH 7= 21.3% (30d), pH 9= 77.8% (30d)	MRID 46485501	Hydrolysis (835.2120)	NA
	pH5 buffer solution: 3.6% (18.9d), natural lake water: 55.6% (12.9d)	pH5 buffer solution: 3.6% (18.9d), natural lake water: 48.5% (18.9d)	MRID 47945716	Aqueous Photolysis (835.2240)	NA
	NA	Avg: 30.2% (30 hrs-clay loam), 0% (leachate)	MRID 47945715	Soil column leaching (835.1240)	Supplemental Study
Kasuganobiosamine[3]; Pseudonyms: Kasuganobiosamine 2HCl [KB-3; kasuganobiosamine dihydrochloride; KSB; KB]; IUPAC Name: 6-[3,5-Diamino-6-methyltetrahydro-2H-pyran-2-yl)oxy]cyclohexane-1,2,3,4,5-pentol hydrochloride; Cas#: 6189-93-1	Not quantified	Not quantified	MRID 47945720	Aerobic aquatic metabolism (835.4300)	NA
	Total System = 48.5% (277d)	Total System = 44.7% (368d)	MRID 47945721	Anaerobic aquatic metabolism (835.4400)	NA
	pH5 buffer solution: 1.1% (16d), natural lake water: 4.7% (12.9d)	pH5 buffer solution: 0.8%+/-<0.1% (18.9d), natural lake water: 3.2% (18.9%)	MRID 47945716	Aqueous Photolysis (835.2240)	NA

Name(s)	Maximum Percent of Applied Dose (interval)	% of applied dose at final sampling interval (study duration in days)	MRID	Study Type (OPPTS guideline)[1]	Comments
	NA	Avg: 100% (26 hrs-clay loam), 0% (leachate)	MRID 47945715	Soil column leaching (835.1240)	Supplemental study
M-1	Lake water-loamy sand sediment system: total system = 6.2% (63d); River water-clay loam sediment system: total system = 3.5% (63d)	Lake water-loamy sand sediment system: total = 1.5% (100d); River water-clay loam sediment system: total = 3.1% (100d)	MRID 47945720	Aerobic aquatic metabolism (835.4300)	NA
M-2	Lake water-loamy sand sediment system: total system = 2.2% (63d); River water-clay loam sediment system: total system = 1.2% (63d)	Lake water-loamy sand sediment system: total = 1.5% (100d); River water-clay loam sediment system: total = 0.4% (100d)	MRID 47945720	Aerobic aquatic metabolism (835.4300)	NA
CO2; Pseudonyms: Carbon dioxide; IUPAC Name: Carbon dioxide; Cas#: 124-38-9	Not quantified	Lake water-loamy sand sediment system: Total = 44.2% (100d); River water-clay loam sediment system: Total = 45.5% (100d)	MRID 47945720	Aerobic aquatic metabolism (835.4300)	NA

Name(s)	Maximum Percent of Applied Dose (interval)	% of applied dose at final sampling interval (study duration in days)	MRID	Study Type (OPPTS guideline)[1]	Comments
	Not quantified	55.4% (366d)	MRID 47945718	Aerobic Soil metbolism (835.4100)	NA
Area -1 (Intermediate)	Total System = 16.2% (63d)	Total System = 0% (368d)	MRID 47945721	Anaerobic aquatic metabolism (835.4400)	NA
Area -3 (Intermediate)	Total System = 5.5% (368d)	Total System = 5.5% (368d)	MRID 47945721	Anaerobic aquatic metabolism (835.4400)	NA
2'-N-Acetyl kasugamycin; Pseudonyms: KN-2; KN; IUPAC Name: ({5-Acetylamino-2-methyl-6-[(2,3,4,5,6-pentahydroxycyclohexyl)oxy]tetrahydro-2H-pyran-3-yl}amino)(imino)acetic acid ; Cas#: Unknown	Reference Compound used to identify the potential occurrence in the following studies: MRID 47945719, MRID 47945718; MRID 47945721, MRID 47945716. The compound was not observed in any studies.				
Deinositolyl 2'-N-acetyl kasugamycin; Pseudonyms: KE-3; KE; IUPAC Name: {[5-(Acetylamino)-6-Hydroxy-2-methyltetrahydro-2H-pyran-3-yl]amino}(imino)acetic acid; Cas#: Unknown	Reference Compound used to identify the potential occurrence in the following studies: MRID 47945719, MRID 47945718, MRID 47945721, MRID 47945716. The compound was not observed in any studies.				

Name(s)	Maximum Percent of Applied Dose (interval)	% of applied dose at final sampling interval (study duration in days)	MRID	Study Type (OPPTS guideline)[1]	Comments
D-Chiro-inositol ; Pseudonyms: IN-2; IN; IUPAC Name: Cyclohexane-1,2,3,4,5,6-hexol; Cas#: 643-12-9	Reference Compound used to identify the potential occurrence in the following studies: MRID 47945719, MRID 4794571, MRID 47945721, MRID 47945716. The compound was not observed in any studies.				

[1]Not all of the studies listed under the parent compound are listed under each degradate. Only when a degradate was detected in a particular study is that study listed under the degradate.

[2]: Kasugamycinic acid was looked for in the following studies: MRID 48132602, 47945716, 47945721, 47945718, 47945719, 47945720, and 47945715.

[3]: Kasuganobiosamine was looked for in the following studies: MRID 47945716, 47945721, 47945718, 47945719, and 479457