**ATTACHMENT 1-20: Biological Information on Listed Species of Terrestrial Invertebrates and Model Parameterization for Pesticide Effects Determinations**

1. **Introduction**

The purpose of this document is to summarize available information for currently listed, proposed and candidate terrestrial invertebrate species from the US Fish and Wildlife Service. The focus of this effort is to capture information that may be used in ecological risk assessments of pesticides to make species-specific effects determinations. This report focuses on defining parameters, such as diet, which may be used to estimate pesticide exposures to listed terrestrial invertebrates. This report also focuses on defining species characteristics that may be used to assess potential indirect effects to the species (*e.g.,* diet and habitat).

A formal quality assurance and quality control plan was implemented in the collection of species specific data. The instructions for extracting information are included in **SUPPLEMENTAL INFORMATION 1**. A template for the worksheet used to record relevant biological information for each species is provided in **SUPPLEMENTAL INFORMATION 2**. **SUPPLEMENTAL INFORMATION 3** contains the completed worksheets containing biological information on each listed terrestrial invertebrate species.

At this time, there are a total of 141 federally listed as endangered and threatened (listed) species, subspecies or populations of terrestrial invertebrates that are listed under the Endangered Species Act (ESA) and occur in the United States. In addition, there are 11 species that are proposed for listing and 11 candidate species (**Table A 1-20.1**). This assessment does not consider species listed as “foreign”. This is because they occur outside of the action area for pesticide registrations in the US.

**Table A 1-20.1. Number of Listed Terrestrial Invertebrates by Status.**

|  |  |
| --- | --- |
| **Status** | **Number of listings** |
| Endangered | 126 |
| Threatened | 15 |
| Proposed | 11 |
| Candidate | 11 |
| Non-essential, experimental population | 1 |
| Total | 164 |

1. **No Effect Determinations**

“No Effect” determinations are made for 9 terrestrial invertebrate species. These species were excluded if they are presumed by the Fish and Wildlife Service to be extinct and if they have no designated critical habitat. Specific species that will be excluded from pesticide effects determinations because they are considered extinct are provided in **Table A 1-20.2**.

**Table A 1-20.2. Species for which “No Effect” determinations are made.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Scientific Name** | **Common Name** | **Listing1** | **Rational for “No Effect” determination** |
| *Achatinella buddii* | Oahu tree snail | E | Presumed by USFWS to be ‘almost certainly extinct’2 |
| *Achatinella caesia* | Oahu tree snail | E | Presumed by USFWS to be ‘almost certainly extinct’2 |
| *Achatinella casta* | Oahu tree snail | E | Presumed by USFWS to be ‘almost certainly extinct’2 |
| *Achatinella decora* | Oahu tree snail | E | Presumed by USFWS to be ‘almost certainly extinct’2 |
| *Achatinella lehiensis* | Oahu tree snail | E | Presumed by USFWS to be ‘almost certainly extinct’2 |
| *Achatinella papyracea* | Oahu tree snail | E | Presumed by USFWS to be ‘almost certainly extinct’2 |
| *Achatinella spaldingi* | Oahu tree snail | E | Presumed by USFWS to be ‘almost certainly extinct’2 |
| *Achatinella thaahumi* | Oahu tree snail | E | Presumed by USFWS to be ‘almost certainly extinct’2 |
| *Achatinella vittata* | Oahu tree snail | E | Presumed by USFWS to be ‘almost certainly extinct’2 |

1 E = endangered

2 US FWS, Recovery Plan for the Oahu Tree Snails of the Genus Achatinella (1992) (http://ecos.fws.gov/docs/recovery\_plan/920630.pdf)

1. **Species considered in National Level Effects Determinations**

There are a total of 155 listings for terrestrial invertebrates that will be discussed further in this report and included in pesticide risk assessments. Of these species, 51 have designated critical habitats. The majority of the listed species or subspecies are in the orders Stylommatophora (N = 49), Lepidoptera (N = 37), and Coleoptera (N = 22). Other orders that include listed species or subspecies of terrestrial invertebrates include Amphipoda (N = 1), Araneae (N = 8), Architaenioglossa (N = 1), Diptera (N = 15), Hymenoptera (N = 7), Odonata (N = 8), Opiliones (N = 3), Orthopotera (N = 1), Plecoptera (N = 2), and Pseudoscorpiones (N = 1). **Table A 1-20.3** contains a list of the number of listed species or subspecies that are represented by each order. **Table A 1-20.4** includes the full list of species that will be considered further in these assessments. There are some aquatic invertebrates that may have a terrestrial life-history stage (*e.g*., cyst stages of some listed vernal pool crustaceans) – they are addressed in **ATTACHMENT 1-12** (the aquatic invertebrate report).

**Table A 1-20.3. Orders of Terrestrial Invertebrates that have Listed Species or Subspecies and the Number of Species or Subspecies in Each Order.**

|  |  |  |
| --- | --- | --- |
| **Order** | **Common names of species within order** | **Number of listed species/subspecies** |
| Amphipoda | Amphipod | 1 |
| Araneae | Spiders, meshweavers | 8 |
| Architaenioglossa | Snails | 1 |
| Coleoptera | Beetles | 22 |
| Diptera | Flies | 15 |
| Hymenoptera | Bees | 7 |
| Lepidoptera | Butterflies, moths | 37 |
| Odonata | Dragonflies, damselflies | 8 |
| Opiliones | Harvestmen | 3 |
| Orthopotera | Grasshoppers | 1 |
| Plecoptera | Stoneflies, snowflies | 2 |
| Pseudoscorpiones | Pseudoscorpions | 1 |
| Stylommatophora | Snails | 49 |

**Table A 1-20.4. Listed Species of Terrestrial Invertebrates Included in Pesticide Effects Determinations.**

| **Scientific Name** | **Common Name** | **Order** | **Listing Status\*** | **Critical Habitat?** | **USFWS Species ID (ENTITY\_ID)** |
| --- | --- | --- | --- | --- | --- |
| *Achatinella abbreviata* | Oahu tree snail | Stylommatophora | E | No | 9459 |
| *Achatinella apexfulva* | Oahu tree snail | Stylommatophora | E | No | 9401 |
| *Achatinella bellula* | Oahu tree snail | Stylommatophora | E | No | 9461 |
| *Achatinella bulimoides* | Oahu tree snail | Stylommatophora | E | No | 9421 |
| *Achatinella byronii* | Oahu tree snail | Stylommatophora | E | No | 9423 |
| *Achatinella cestus* | Oahu tree snail | Stylommatophora | E | No | 9465 |
| *Achatinella concavospira* | Oahu tree snail | Stylommatophora | E | No | 9405 |
| *Achatinella curta* | Oahu tree snail | Stylommatophora | E | No | 9419 |
| *Achatinella decipiens* | Oahu tree snail | Stylommatophora | E | No | 9409 |
| *Achatinella dimorpha* | Oahu tree snail | Stylommatophora | E | No | 9439 |
| *Achatinella elegans* | Oahu tree snail | Stylommatophora | E | No | 9441 |
| *Achatinella fulgens* | Oahu tree snail | Stylommatophora | E | No | 9403 |
| *Achatinella fuscobasis* | Oahu tree snail | Stylommatophora | E | No | 9413 |
| *Achatinella juddi* | Oahu tree snail | Stylommatophora | E | No | 9467 |
| *Achatinella juncea* | Oahu tree snail | Stylommatophora | E | No | 9443 |
| *Achatinella leucorraphe* | Oahu tree snail | Stylommatophora | E | No | 9417 |
| *Achatinella lila* | Oahu tree snail | Stylommatophora | E | No | 9415 |
| *Achatinella livida* | Oahu tree snail | Stylommatophora | E | No | 9397 |
| *Achatinella lorata* | Oahu tree snail | Stylommatophora | E | No | 9469 |
| *Achatinella mustelina* | Oahu tree snail | Stylommatophora | E | No | 9399 |
| *Achatinella phaeozona* | Oahu tree snail | Stylommatophora | E | No | 9471 |
| *Achatinella pulcherrima* | Oahu tree snail | Stylommatophora | E | No | 9411 |
| *Achatinella pupukanioe* | Oahu tree snail | Stylommatophora | E | No | 9473 |
| *Achatinella rosea* | Oahu tree snail | Stylommatophora | E | No | 9449 |
| *Achatinella sowerbyana* | Oahu tree snail | Stylommatophora | E | No | 9395 |
| *Achatinella stewartii* | Oahu tree snail | Stylommatophora | E | No | 9407 |
| *Achatinella swiftii* | Oahu tree snail | Stylommatophora | E | No | 9453 |
| *Achatinella taeniolata* | Oahu tree snail | Stylommatophora | E | No | 9475 |
| *Achatinella turgida* | Oahu tree snail | Stylommatophora | E | No | 9477 |
| *Achatinella valida* | Oahu tree snail | Stylommatophora | E | No | 9457 |
| *Achatinella viridans* | Oahu tree snail | Stylommatophora | E | No | 9479 |
| *Achatinella vulpina* | Oahu tree snail | Stylommatophora | E | No | 9483 |
| *Adelocosa anops* | Spider, Kauai cave wolf or pe'e pe'e maka 'ole | Araneae | E | Yes | 463 |
| *Anaea troglodyta floridalis* | Florida Leafwing Butterfly | Lepidoptera | E | Yes | 8083 |
| *Anguispira picta* | Snail, painted snake coiled forest | Stylommatophora | T | No | 393 |
| *Apodemia mormo langei* | Butterfly, Lange's metalmark | Lepidoptera | E | No | 421 |
| *Atlantea tulita* | Puerto Rico harlequin butterfly | Lepidoptera | C | No | 10007 |
| *Batrisodes texanus* | Beetle, Coffin Cave mold | Coleoptera | E | No | 447 |
| *Batrisodes venyivi* | Beetle, Helotes mold | Coleoptera | E | Yes | 460 |
| *Boloria acrocnema* | Butterfly, Uncompahgre fritillary | Lepidoptera | E | No | 437 |
| *Callophrys mossii bayensis* | Butterfly, San Bruno elfin | Lepidoptera | E | No | 427 |
| *Arsapnia arapahoe* | Arapahoe snowfly | Plecoptera | C | No | 10130 |
| *Cicindela dorsalis dorsalis* | Tiger beetle, Northeastern beach | Coleoptera | T | No | 442 |
| *Cicindelidia floridana* | Beetle, Miami tiger | Coleoptera | P | No | 10909 |
| *Cicindelidia highlandensis* | Highlands tiger beetle | Coleoptera | C | No | 1450 |
| *Cicindela nevadica lincolniana* | Tiger beetle, Salt Creek | Coleoptera | E | Yes | 4910 |
| *Cicindela ohlone* | Tiger beetle, Ohlone | Coleoptera | E | No | 457 |
| *Cicindela puritana* | Tiger beetle, Puritan | Coleoptera | T | No | 443 |
| *Cicurina baronia* | Meshweaver, Robber Baron Cave | Araneae | E | Yes | 472 |
| *Cicurina madla* | Meshweaver, Madla's Cave | Araneae | E | Yes | 471 |
| *Cicurina venii* | Meshweaver, Braken Bat Cave | Araneae | E | Yes | 474 |
| *Cicurina vespera* | Meshweaver, Government Canyon Bat Cave | Araneae | E | Yes | 473 |
| *Cyclargus (=Hemiargus) thomasi bethunebakeri* | Butterfly, Miami Blue | Lepidoptera | E | No | 4508 |
| *Desmocerus californicus dimorphus* | Beetle, valley elderberry longhorn | Coleoptera | T | Yes | 436 |
| *Dinacoma caseyi* | June Beetle, Caseys | Coleoptera | E | Yes | 8503 |
| *Discus macclintocki* | Snail, Iowa Pleistocene | Stylommatophora | E | No | 391 |
| *Drosophila aglaia* | Pomace fly, [unnamed] | Diptera | E | Yes | 1248 |
| *Drosophila differens* | Fly, Hawaiian picture-wing | Diptera | E | Yes | 1259 |
| *Drosophila digressa* | Fly, Hawaiian picture-wing | Diptera | E | No | 4000 |
| *Drosophila hemipeza* | Pomace fly, [unnamed] | Diptera | E | Yes | 1257 |
| *Drosophila heteroneura* | Pomace fly, [unnamed] | Diptera | E | Yes | 1249 |
| *Drosophila montgomeryi* | Pomace fly, [unnamed] | Diptera | E | Yes | 1250 |
| *Drosophila mulli* | Pomace fly, [unnamed] | Diptera | T | Yes | 1251 |
| *Drosophila musaphilia* | Pomace fly, [unnamed] | Diptera | E | Yes | 1252 |
| *Drosophila neoclavisetae* | Fly, Hawaiian picture-wing | Diptera | E | Yes | 1253 |
| *Drosophila obatai* | Pomace fly, [unnamed] | Diptera | E | Yes | 1254 |
| *Drosophila ochrobasis* | Pomace fly, [unnamed] | Diptera | E | Yes | 1258 |
| *Drosophila sharpi* | Fly, Hawaiian picture-wing | Diptera | E | Yes | 7261 |
| *Drosophila substenoptera* | Pomace fly, [unnamed] | Diptera | E | Yes | 1255 |
| *Drosophila tarphytrichia* | Pomace fly, [unnamed] | Diptera | E | Yes | 1256 |
| *Elaphrus viridis* | Beetle, delta green ground | Coleoptera | T | Yes | 435 |
| *Eua zebrina* | No common name | Stylommatophora | P | No | 7918 |
| *Euchloe ausonides insulanus* | Butterfly, island marble | Lepidoptera | C | No | 5610 |
| *Euphilotes battoides allyni* | Butterfly, El Segundo blue | Lepidoptera | E | No | 419 |
| *Euphilotes enoptes smithi* | Butterfly, Smith's blue | Lepidoptera | E | No | 428 |
| *Euphydryas editha bayensis* | Butterfly, bay checkerspot | Lepidoptera | T | Yes | 438 |
| *Euphydryas editha quino (=E. e. wrighti)* | Butterfly, Quino checkerspot | Lepidoptera | E | Yes | 426 |
| *Euphydryas editha taylori* | Checkerspot, Taylor's (=whulge) | Lepidoptera | E | Yes | 7495 |
| *Euproserpinus euterpe* | Moth, Kern primrose sphinx | Lepidoptera | T | No | 433 |
| *Glaucopsyche lygdamus palosverdesensis* | Butterfly, Palos Verdes blue | Lepidoptera | E | Yes | 432 |
| *Helminthoglypta walkeriana* | Snail, Morro shoulderband (=Banded dune) | Stylommatophora | E | Yes | 387 |
| *Heraclides aristodemus ponceanus* | Butterfly, Schaus swallowtail | Lepidoptera | E | No | 429 |
| *Hesperia dacotae* | Dakota Skipper | Lepidoptera | T | Yes | 3412 |
| *Hesperia leonardus montana* | Skipper, Pawnee montane | Lepidoptera | T | No | 434 |
| *Hylaeus anthracinus* | Anthricinan yellow-faced bee | Hymenoptera | P | No | 5580 |
| *Hylaeus assimulans* | Assimulans yellow-faced bee | Hymenoptera | P | No | 4413 |
| *Hylaeus facilis* | Easy yellow-faced bee | Hymenoptera | P | No | 6747 |
| *Hylaeus hilaris* | Hilaris yellow-faced bee | Hymenoptera | P | No | 7955 |
| *Hylaeus kuakea* | Hawaiian yellow-faced bee | Hymenoptera | P | No | 10009 |
| *Hylaeus longiceps* | Hawaiian yellow-faced bee | Hymenoptera | P | No | 5333 |
| *Hylaeus mana* | Hawaiian yellow-faced bee | Hymenoptera | P | No | 10008 |
| *Hypolimnas octocula mariannensis* | Mariana eight-spot butterfly | Lepidoptera | E | No | 4308 |
| *Icaricia icarioides fenderi* | Butterfly, Fender's blue | Lepidoptera | E | Yes | 450 |
| *Icaricia icarioides missionensis* | Butterfly, mission blue | Lepidoptera | E | No | 423 |
| *Ischnura luta* | Rota blue damselfly | Odonata | E | No | 9282 |
| *Lednia tumana* | Meltwater lednian stonefly | Plecoptera | C | No | 1849 |
| *Lycaeides argyrognomon lotis* | Butterfly, lotis blue | Lepidoptera | E | No | 422 |
| *Lycaeides melissa samuelis* | Butterfly, Karner blue | Lepidoptera | E | No | 420 |
| *Lycaena hermes* | Hermes copper butterfly | Lepidoptera | C | No | 1984 |
| *Manduca blackburni* | Moth, Blackburn's sphinx | Lepidoptera | E | Yes | 446 |
| *Megalagrion leptodemas* | Damselfly, crimson Hawaiian | Odonata | E | Yes | 4326 |
| *Megalagrion nesiotes* | Damselfly, flying earwig Hawaiian | Odonata | E | No | 2144 |
| *Megalagrion nigrohamatum nigrolineatum* | Damselfly, blackline Hawaiian | Odonata | E | Yes | 1361 |
| *Megalagrion oceanicum* | Damselfly, oceanic Hawaiian | Odonata | E | Yes | 6231 |
| *Megalagrion pacificum* | Damselfly, Pacific Hawaiian | Odonata | E | No | 1953 |
| *Megalagrion xanthomelas* | Orangeblack Hawaiian damselfly | Odonata | P | No | 6867 |
| *Microhexura montivaga* | Spider, spruce-fir moss | Araneae | E | Yes | 468 |
| *Neoleptoneta microps* | Spider, Government Canyon Bat Cave | Araneae | E | Yes | 470 |
| *Neoleptoneta myopica* | Spider, Tooth Cave | Araneae | E | No | 467 |
| *Neonympha mitchellii francisci* | Butterfly, Saint Francis' satyr | Lepidoptera | E | No | 455 |
| *Neonympha mitchellii mitchellii* | Butterfly, Mitchell's satyr | Lepidoptera | E | No | 424 |
| *Newcombia cumingi* | Tree snail, Newcomb's | Stylommatophora | E | Yes | 3876 |
| *Nicrophorus americanus* | Beetle, American burying | Coleoptera | E | No | 440 |
| *Nicrophorus americanus* | Beetle, American burying | Coleoptera | Exp | No | 10161 |
| *Oarisma poweshiek* | Poweshiek Skipperling | Lepidoptera | E | Yes | 10147 |
| *Orthalicus reses (not incl. nesodryas)* | Snail, Stock Island tree | Stylommatophora | T | No | 394 |
| *Ostodes strigatus* | No common name | Architaenioglossa | P | No | 3224 |
| *Oxyloma haydeni kanabensis* | Ambersnail, Kanab | Stylommatophora | E | No | 400 |
| *Papaipema eryngii* | Rattlesnake-master borer moth | Lepidoptera | C | No | 3670 |
| *Partula gibba* | Humped tree snail | Stylommatophora | E | No | 2364 |
| *Partula langfordi* | Langford's tree snail | Stylommatophora | E | No | 7731 |
| *Partula radiolata* | Guam tree snail | Stylommatophora | E | No | 7907 |
| *Partulina semicarinata* | Snail, Lanai tree | Stylommatophora | E | Yes | 1989 |
| *Partulina variabilis* | Snail, Lanai tree | Stylommatophora | E | Yes | 3385 |
| *Patera clarki nantahala* | globe, noonday | Stylommatophora | T | No | 392 |
| *Plebejus shasta charlestonensis* | Butterfly, Mount Charleston blue | Lepidoptera | E | Yes | 9001 |
| *Polygyriscus virginianus* | Snail, Virginia fringed mountain | Stylommatophora | E | No | 395 |
| *Polyphylla barbata* | June Beetle, Mount Hermon | Coleoptera | E | No | 456 |
| *Pseudanophthalmus caecus* | Clifton Cave beetle | Coleoptera | C | No | 5064 |
| *Pseudanophthalmus frigidus* | Icebox Cave beetle | Coleoptera | C | No | 2862 |
| *Pseudanophthalmus parvus* | Tatum Cave beetle | Coleoptera | C | No | 7134 |
| *Pseudanophthalmus troglodytes* | Louisville Cave beetle | Coleoptera | C | No | 3379 |
| *Pseudocopaeodes eunus obscurus* | Skipper, Carson wandering | Lepidoptera | E | No | 462 |
| *Pyrgus ruralis lagunae* | Skipper, Laguna Mountains | Lepidoptera | E | Yes | 451 |
| *Rhadine exilis* | Ground beetle, [unnamed] | Coleoptera | E | Yes | 461 |
| *Rhadine infernalis* | Ground beetle, [unnamed] | Coleoptera | E | Yes | 459 |
| *Rhadine persephone* | Beetle, Tooth Cave ground | Coleoptera | E | No | 449 |
| *Rhaphiomidas terminatus abdominalis* | Fly, Delhi Sands flower-loving | Diptera | E | No | 452 |
| *Samoana fragilis* | Fragile tree snail | Stylommatophora | E | No | 1862 |
| *Somatochlora hineana* | Dragonfly, Hine's emerald | Odonata | E | Yes | 445 |
| *Spelaeorchestia koloana* | Kauai cave amphipod | Amphipoda | E | Yes | 485 |
| *Speyeria callippe callippe* | Butterfly, callippe silverspot | Lepidoptera | E | No | 430 |
| *Speyeria zerene behrensii* | Butterfly, Behren's silverspot | Lepidoptera | E | No | 444 |
| *Speyeria zerene hippolyta* | Butterfly, Oregon silverspot | Lepidoptera | T | Yes | 431 |
| *Speyeria zerene myrtleae* | Butterfly, Myrtle's silverspot | Lepidoptera | E | No | 425 |
| *Strymon acis bartrami* | Bartram's Scrub-Hairsterak Butterfly | Lepidoptera | E | Yes | 5067 |
| *Succinea chittenangoensis* | Snail, Chittenango ovate amber | Stylommatophora | T | No | 389 |
| *Tartarocreagris texana* | Pseudoscorpion, Tooth Cave | Pseudoscorpiones | E | No | 466 |
| *Texamaurops reddelli* | Beetle, Kretschmarr Cave mold | Coleoptera | E | No | 448 |
| *Texella cokendolpheri* | Harvestman, Cokendolpher Cave | Opiliones | E | Yes | 469 |
| *Texella reddelli* | Harvestman, Bee Creek Cave | Opiliones | E | No | 464 |
| *Texella reyesi* | Harvestman, Bone Cave | Opiliones | E | No | 465 |
| *Trimerotropis infantilis* | Grasshopper, Zayante band-winged | Orthopotera | E | Yes | 458 |
| *Triodopsis platysayoides* | Snail, flat-spired three-toothed | Stylommatophora | T | No | 390 |
| *Vagrans egistina* | Mariana wandering butterfly | Lepidoptera | E | No | 5168 |

\*E=endangered; T=threatened, C = candidate, P = proposed, Exp = Experimental Population, Non-Essential

1. **Diets**

The diets of listed terrestrial invertebrates include a wide variety of aquatic and terrestrial animals and plants (**Table A 1-20.5**). Many listed terrestrial invertebrates (43%) consume leaves (broadleaf plants), fungus (25%), terrestrial invertebrates (23%), and/or nectar/pollen (31%). Many species have diets that include a variety of food items. **Tables A 1-20.6 and A 1-20.7** define the terrestrial plant parts and terrestrial animals, respectively, consumed by listed terrestrial invertebrates. **Table A 1-20.8** defines the aquatic animals consumed by each listed terrestrial invertebrate. Additional details and source information are provided in **SUPPLEMENTAL INFORMATION 3**.

**Table A 1-20.5. Number of listed terrestrial invertebrate species with each dietary item categories.**

|  |  |  |
| --- | --- | --- |
| **Dietary item** | | **Number of species1** |
| Plant matter | Algae | 1 |
| Aquatic plants | 3 |
| Broadleaf plants | 67 |
| Flowers | 8 |
| Fruit | 1 |
| Grass | 5 |
| Nectar/pollen | 48 |
| Seeds | 3 |
| Fungi | Fungus | 39 |
| Soil | Soil | 6 |
| Invertebrates | Freshwater | 8 |
| Saltwater | 0 |
| Terrestrial, above ground | 35 |
| Terrestrial, below ground | 8 |
| Vertebrates | Amphibians (terrestrial) | 0 |
| Birds (and chicks) | 0 |
| Carrion | 7 |
| Fish (freshwater) and amphibians | 9 |
| Fish (saltwater) | 0 |
| Mammals | 0 |
| Reptiles | 0 |

1 This adds up to more than the number of listed terrestrial invertebrates because a species may eat more than one type of dietary item.

**Table A 1-20.6. Diets of listed terrestrial invertebrates: terrestrial plants and fungi.**

| **Scientific Name** | **Common Name** | **Grass** | **Leaves1** | **Fungus** | **Fruit** | **Seeds** | **Flowers** | **Nectar/ pollen2** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Achatinella abbreviata* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella apexfulva* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella bellula* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella bulimoides* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella byronii* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella cestus* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella concavospira* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella curta* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella decipiens* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella dimorpha* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella elegans* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella fulgens* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella fuscobasis* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella juddi* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella juncea* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella leucorraphe* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella lila* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella livida* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella lorata* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella mustelina* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella phaeozona* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella pulcherrima* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella pupukanioe* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella rosea* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella sowerbyana* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella stewartii* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella swiftii* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella taeniolata* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella turgida* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella valida* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella viridans* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Achatinella vulpina* | Oahu tree snail | No | No | Yes3 | No | No | No | No |
| *Anaea troglodyta floridalis* | Florida Leafwing Butterfly | No | Yes | No | Yes4 | No | No | Yes |
| *Anguispira picta* | Snail, painted snake coiled forest | No | Yes | No | No | No | No | No |
| *Apodemia mormo langei* | Butterfly, Lange's metalmark | No | Yes | No | No | No | No | Yes |
| *Arsapnia arapahoe* | Snowfly, Arapahoe | No | Yes | No | No | No | No | Yes |
| *Atlantea tulita* | Butterfly, Puerto Rican harlequin | No | Yes | No | No | No | No | Yes |
| *Batrisodes texanus* | Beetle, Coffin Cave mold | No | Yes | No | No | No | No | No |
| *Boloria acrocnema* | Butterfly, Uncompahgre fritillary | No | Yes | No | No | No | No | Yes |
| *Callophrys mossii bayensis* | Butterfly, San Bruno elfin | No | Yes | No | No | No | Yes | Yes |
| *Cyclargus (=Hemiargus) thomasi bethunebakeri* | Butterfly, Miami Blue | No | Yes | No | No | No | No | Yes |
| *Desmocerus californicus dimorphus* | Beetle, valley elderberry longhorn | No | Yes | No | No | No | Yes | No |
| *Discus macclintocki* | Snail, Iowa Pleistocene | No | Yes | No | No | No | No | No |
| *Drosophila aglaia* | Pomace fly, [unnamed] | No | Yes | No | No | No | No | No |
| *Drosophila differens* | Fly, Hawaiian picture-wing | No | Yes | No | No | No | No | No |
| *Drosophila digressa* | Fly, Hawaiian picture-wing | No | Yes | No | No | No | No | No |
| *Drosophila hemipeza* | Pomace fly, [unnamed] | No | Yes | No | No | No | No | No |
| *Drosophila heteroneura* | Pomace fly, [unnamed] | No | Yes5 | No | No | No | No | No |
| *Drosophila montgomeryi* | Pomace fly, [unnamed] | No | Yes6 | No | No | No | No | No |
| *Drosophila mulli* | Pomace fly, [unnamed] | No | Yes | No | No | No | No | No |
| *Drosophila musaphilia* | Pomace fly, [unnamed] | No | Yes | No | No | No | No | Yes7 |
| *Drosophila neoclavisetae* | Fly, Hawaiian picture-wing | No | Yes | No | No | No | No | No |
| *Drosophila obatai* | Pomace fly, [unnamed] | No | Yes | No | No | No | No | No |
| *Drosophila ochrobasis* | Pomace fly, [unnamed] | No | Yes | No | No | No | No | No |
| *Drosophila sharpi* | Fly, Hawaiian picture-wing | No | Yes | No | No | No | No | No |
| *Drosophila substenoptera* | Pomace fly, [unnamed] | No | Yes | No | No | No | No | No |
| *Drosophila tarphytrichia* | Pomace fly, [unnamed] | No | Yes | No | No | No | No | No |
| *Eua zebrina* | Snail [unnamed] | No | Yes | No | No | No | No | No |
| *Euchloe ausanides insulanus* | Butterfly, island marble | No | Yes | No | No | No | No | Yes |
| *Euphilotes battoides allyni* | Butterfly, El Segundo blue | No | Yes | No | No | No | No | Yes |
| *Euphilotes enoptes smithi* | Butterfly, Smith's blue | No | No | No | No | Yes | Yes | Yes |
| *Euphydryas editha bayensis* | Butterfly, bay checkerspot | No | Yes | No | No | No | No | Yes |
| *Euphydryas editha quino (=E. e. wrighti)* | Butterfly, Quino checkerspot | No | Yes | No | No | No | No | Yes |
| *Euphydryas editha taylori* | Checkerspot, Taylor's (=whulge) | No | Yes | No | No | No | No | Yes |
| *Euproserpinus euterpe* | Moth, Kern primrose sphinx | No | Yes | No | No | No | No | Yes |
| *Glaucopsyche lygdamus palosverdesensis* | Butterfly, Palos Verdes blue | No | No | No | No | Yes | No | Yes |
| *Helminthoglypta walkeriana* | Snail, Morro shoulderband (=Banded dune) | No | No | Yes | No | No | No | No |
| *Heraclides aristodemus ponceanus* | Butterfly, Schaus swallowtail | No | Yes | No | No | No | No | Yes |
| *Hesperia dacotae* | Dakota Skipper | Yes | No | No | No | No | No | Yes |
| *Hesperia leonardus montana* | Skipper, Pawnee montane | Yes | No | No | No | No | No | Yes |
| *Hylaeus anthracinus* | Bee, anthricinan yellow-faced | No | No | No | No | No | No | Yes |
| *Hylaeus assimulans* | Bee, assimulans yellow-faced | No | No | No | No | No | No | Yes |
| *Hylaeus faciliis* | Bee, easy yellow-faced | No | No | No | No | No | No | Yes |
| *Hylaeus hilaris* | Bee, hilaris yellow-faced | No | No | No | No | No | No | Yes |
| *Hylaeus kuakea* | Bee, Hawaiian yellow-faced | No | No | No | No | No | No | Yes |
| *Hylaeus longiceps* | Bee, Hawaiian yellow-faced | No | No | No | No | No | No | Yes |
| *Hylaeus mana* | Bee, Hawaiian yellow-faced | No | No | No | No | No | No | Yes |
| *Hypolimnas octocula mariannensis* | Butterfly, Mariana eight-spot | No | Yes | No | No | No | No | Yes |
| *Icaricia icarioides fenderi* | Butterfly, Fender's blue | No | Yes | No | No | No | No | Yes |
| *Icaricia icarioides missionensis* | Butterfly, mission blue | No | Yes | No | No | No | Yes | Yes |
| *Lednia tumana* | Stonefly, meltwater lednian | No | Yes | No | No | No | Yes | Yes |
| *Lycaeides argyrognomon lotis* | Butterfly, lotis blue | No | Yes | No | No | Yes | Yes | Yes |
| *Lycaeides melissa samuelis* | Butterfly, Karner blue | No | Yes | No | No | No | No | Yes |
| *Lycaena hermes* | Butterfly, hermes copper | No | Yes | No | No | No | No | Yes |
| *Manduca blackburni* | Moth, Blackburn's sphinx | No | Yes | No | No | No | Yes | Yes |
| *Neoleptoneta myopica* | Spider, Tooth Cave | No | Yes | No | No | No | No | No |
| *Neonympha mitchellii francisci* | Butterfly, Saint Francis' satyr | No | Yes | No | No | No | No | Yes |
| *Neonympha mitchellii mitchellii* | Butterfly, Mitchell's satyr | Yes | No | No | No | No | No | Yes |
| *Newcombia cumingi* | Tree snail, Newcomb's | No | Yes | Yes8 | No | No | No | No |
| *Oarisma poweshiek* | Poweshiek Skipperling | Yes | No | No | No | No | No | Yes |
| *Orthalicus reses (not incl. nesodryas)* | Snail, Stock Island tree | No | Yes | No | No | No | No | No |
| *Ostodes strigatus* | Snail [unnamed] | No | Yes | Yes | No | No | No | No |
| *Oxyloma haydeni kanabensis* | Ambersnail, Kanab | Yes | Yes | No | No | No | No | No |
| *Papaipema eryngii10* | Moth, rattlesnake master borer | No | Yes | No | No | No | No | Yes |
| *Partula gibba* | Snail, humped tree | No | Yes | No | No | No | No | No |
| *Partula langfordi* | Snail, Langford’s tree | No | Yes | No | No | No | No | No |
| *Partula radiolata* | Snail, Guam tree | No | Yes | No | No | No | No | No |
| *Partulina semicarinata* | Snail, Lanai tree | No | Yes | Yes8 | No | No | No | No |
| *Partulina variabilis* | Snail, Lanai tree | No | Yes | Yes8 | No | No | No | No |
| *Patera clarki nantahala* | globe, noonday | No | No | Yes | No | No | No | No |
| *Plebejus shasta charlestonensis* | Butterfly, Mount Charleston blue | No | Yes | No | No | No | No | Yes |
| *Polyphylla barbata*10 | Ground beetle, Mount Herman | No | No | No | No | No | No | No |
| *Pseudocopaeodes eunus obscurus* | Skipper, Carson wandering | Yes | No | No | No | No | No | Yes |
| *Pyrgus ruralis lagunae* | Skipper, Laguna Mountains | No | Yes | No | No | No | No | Yes |
| *Rhaphiomidas terminatus abdominalis* | Fly, Delhi Sands flower-loving | No | No | No | No | No | No | Yes |
| *Samoana fragilis* | Snail, fragile tree | No | Yes | No | No | No | No | No |
| *Spelaeorchestia koloana10* | Amphipod, Kauai cave | No | Yes | No | No | No | No | No |
| *Speyeria callippe callippe* | Butterfly, callippe silverspot | No | Yes | No | No | No | No | Yes |
| *Speyeria zerene behrensii* | Butterfly, Behren's silverspot | No | Yes | No | No | No | No | Yes |
| *Speyeria zerene hippolyta* | Butterfly, Oregon silverspot | No | Yes | No | No | No | No | Yes |
| *Speyeria zerene myrtleae* | Butterfly, Myrtle's silverspot | No | Yes | No | No | No | No | Yes |
| *Strymon acis bartrami* | Bartram's Scrub-Hairsterak Butterfly | No | Yes | No | No | No | No | Yes |
| *Succinea chittenangoensis* | Snail, Chittenango ovate amber | No | Yes | No | No | No | No | No |
| *Tartarocreagris texana* | Pseudoscorpion, Tooth Cave | No | Yes | No | No | No | No | No |
| *Texella reddelli* | Harvestman, Bee Creek Cave | No | Yes | No | No | No | No | No |
| *Texella reyesi* | Harvestman, Bone Cave | No | Yes | No | No | No | No | No |
| *Trimerotropis infantilis* | Grasshopper, Zayante band-winged | No | Yes | No | No | No | No | No |
| *Triodopsis platysayoides* | Snail, flat-spired three-toothed | No | Yes | Yes | No | No | Yes | No |
| *Vagrans egistina* | Butterfly, Mariana wandering | No | Yes | No | No | No | No | Yes |

1 Also includes those that eat decaying leaves and/or leaf litter.

2 Also includes those that eat sap.

3 Eats fungus on leaves.

4 Occasionally eats rotten fruit and dung.

5 Also eats decomposing bark and stems.

6 Also feeds within decaying bark.

7 Eats moldy slime flux – sap seepage.

8 Eats fungus and algae from leaves.

10 Eats roots.

**Table A 1-20.7. Diets of listed terrestrial invertebrates: terrestrial animals or soil.**

| **Scientific Name** | **Common Name** | **Terrestrial Inverts** | **Soil dwelling inverts** | **Soil1** | **Mammals** | **Birds** | **Reptiles** | **Amphibians (terrestrial)** | **Carrion** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Anaea troglodyta floridalis* | Florida Leafwing Butterfly | No | No | Yes | No | No | No | No | No |
| *Batrisodes texanus* | Beetle, Coffin Cave mold | No | No | Yes | No | No | No | No | Yes |
| *Cicindela dorsalis dorsalis* | Tiger beetle, Northeastern beach | Yes | Yes | No | No | No | No | No | No |
| *Cicindela nevadica lincolniana* | Tiger beetle, Salt Creek | Yes | Yes | No | No | No | No | No | No |
| *Cicindela ohlone* | Tiger beetle, Ohlone | Yes | Yes | No | No | No | No | No | No |
| *Cicindela puritana* | Tiger beetle, Puritan | Yes | Yes | No | No | No | No | No | No |
| *Cincindelidia floridana* | Tiger beetle, Miami | Yes | No | No | No | No | No | No | No |
| *Cincindelidia highlandensis* | Tiger beetle, highlands | Yes | No | No | No | No | No | No | No |
| *Dinacoma caseyi* | June Beetle, Caseys | No | Yes | Yes | No | No | No | No | No |
| *Elaphrus viridis* | Beetle, delta green ground | Yes | Yes | No | No | No | No | No | No |
| *Ischnura luta* | Damselfly, Rota blue | Yes | No | No | No | No | No | No | No |
| *Megalagrian xanthomelos* | Damselfly, orangeblack Hawaiian | Yes | No | No | No | No | No | No | No |
| *Neoleptoneta myopica* | Spider, Tooth Cave | No | No | No | No | No | No | No | Yes |
| *Nicrophorus americanus* | Beetle, American burying | Yes | Yes | No | No | No | No | No | Yes |
| *Patera clarki nantahala* | globe, noonday | No | No | Yes | No | No | No | No | No |
| *Polygyriscus virginianus* | Snail, Virginia fringed mountain | No | No | Yes | No | No | No | No | No |
| *Pseudoanophthalmus caecus* | Beetle, Clifton Cave | Yes | No | No | No | No | No | No | No |
| *Pseudoanophthalmus frigidus* | Beetle, Ice Box Cave | Yes | No | No | No | No | No | No | No |
| *Pseudoanophthalmus parvus* | Beetle, Tatum Cave | Yes | No | No | No | No | No | No | No |
| *Pseudoanophthalmus troglodytes* | Beetle, Louisville Cave | Yes | No | No | No | No | No | No | No |
| *Rhaphiomidas terminatus abdominalis* | Fly, Delhi Sands flower-loving | No | Yes | No | No | No | No | No | No |
| *Tartarocreagris texana* | Pseudoscorpion, Tooth Cave | No | No | No | No | No | No | No | Yes |
| *Texamaurops reddelli* | Beetle, Kretschmarr Cave mold | No | No | Yes | No | No | No | No | Yes |
| *Texella reddelli* | Harvestman, Bee Creek Cave | No | No | No | No | No | No | No | Yes |
| *Texella reyesi* | Harvestman, Bone Cave | No | No | No | No | No | No | No | Yes |
| *Triodopsis platysayoides* | Snail, flat-spired three-toothed | Yes | No | No | No | No | No | No | No |

1 Includes those that eat detritus.

**Table A 1-20.8. Diets of listed terrestrial invertebrates: aquatic animals.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Scientific Name** | **Common Name** | **Algae** | **Aquatic plants** | **FW inverts** | **SW inverts** | **FW fish and amphibians** | **SW fish** |
| *Arsapnia arapahoe* | Snowfly, Arapahoe | No | Yes | No | No | No | No |
| *Cicindela dorsalis dorsalis* | Tiger beetle, Northeastern beach | No | No | No | No | Yes | No |
| *Ischnura luta* | Damselfly, Rota blue | No | No | Yes | No | Yes | No |
| *Lednia tumana* | Stonefly, meltwater lednian | Yes | Yes | No | No | No | No |
| *Megalagrion leptodemas* | Damselfly, crimson Hawaiian | No | No | Yes | No | Yes | No |
| *Megalagrion nesiotes* | Damselfly, flying earwig Hawaiian | No | No | Yes | No | Yes | No |
| *Megalagrion nigrohamatum nigrolineatum* | Damselfly, blackline Hawaiian | No | No | Yes | No | Yes | No |
| *Megalagrion oceanicum* | Damselfly, oceanic Hawaiian | No | No | Yes | No | Yes | No |
| *Megalagrion pacificum* | Damselfly, Pacific Hawaiian | No | No | Yes | No | Yes | No |
| *Megalagrian xanthomelos* | Damselfly, orangeblack Hawaiian | No | No | Yes | No | Yes | No |
| *Neoleptoneta myopica* | Spider, Tooth Cave | No | Yes | No | No | No | No |
| *Somatochlora hineana* | Dragonfly, Hine's emerald | No | No | Yes | No | Yes | No |

1. **Exposure models**

Potential exposure from direct contact and through consumption of pesticide-contaminated dietary items will be considered. These exposure routes will also be used to consider the potential of indirect effects. For direct effects, exposures to the pesticide through the diet and from direct exposure are assessed using T-REX and/or the earthworm fugacity model (see **ATTACHMENT 1-7**). For direct (contact) exposure, T-REX is used for estimating exposures to non-soil-dwelling invertebrates and the earthworm fugacity model is used to model exposures to soil-dwelling invertebrates. If the species consumes plants, fungus, non-soil-dwelling invertebrates or vertebrates (amphibians, reptiles, birds or mammals) that inhabit terrestrial areas, T-REX will be used. If the species consumes soil (including detritus) or soil-dwelling invertebrates, the earthworm fugacity model will be used. For any listed invertebrate that has an aquatic life-stage, PRZM5/VVWM will be used to estimate exposures in aquatic environments. **Table A 1-20. 9** lists the models that will be run for each species to evaluate the potential for direct effects. For indirect effects, T-REX and the earthworm fugacity model will be used to evaluate the potential for indirect effects related to a loss of terrestrial prey sprecies; TerrPlant will be used to assess the potential for loss of plant food items and habitat effects; and PRZM5/VVWM will be used to evaluate the potential for indirect effects related to the loss of aquatic prey items.

**Table A 1-20.9. Models used to estimate exposures to listed terrestrial invertebrates (direct effects).**

| **Scientific Name** | **Common Name** | **T-REX** | **Earth-worm Fugacity** | **PRZM5/ VVWM** |
| --- | --- | --- | --- | --- |
| *Achatinella abbreviata* | Oahu tree snail | Yes | No | No |
| *Achatinella apexfulva* | Oahu tree snail | Yes | No | No |
| *Achatinella bellula* | Oahu tree snail | Yes | No | No |
| *Achatinella bulimoides* | Oahu tree snail | Yes | No | No |
| *Achatinella byronii* | Oahu tree snail | Yes | No | No |
| *Achatinella cestus* | Oahu tree snail | Yes | No | No |
| *Achatinella concavospira* | Oahu tree snail | Yes | No | No |
| *Achatinella curta* | Oahu tree snail | Yes | No | No |
| *Achatinella decipiens* | Oahu tree snail | Yes | No | No |
| *Achatinella dimorpha* | Oahu tree snail | Yes | No | No |
| *Achatinella elegans* | Oahu tree snail | Yes | No | No |
| *Achatinella fulgens* | Oahu tree snail | Yes | No | No |
| *Achatinella fuscobasis* | Oahu tree snail | Yes | No | No |
| *Achatinella juddi* | Oahu tree snail | Yes | No | No |
| *Achatinella juncea* | Oahu tree snail | Yes | No | No |
| *Achatinella leucorraphe* | Oahu tree snail | Yes | No | No |
| *Achatinella lila* | Oahu tree snail | Yes | No | No |
| *Achatinella livida* | Oahu tree snail | Yes | No | No |
| *Achatinella lorata* | Oahu tree snail | Yes | No | No |
| *Achatinella mustelina* | Oahu tree snail | Yes | No | No |
| *Achatinella phaeozona* | Oahu tree snail | Yes | No | No |
| *Achatinella pulcherrima* | Oahu tree snail | Yes | No | No |
| *Achatinella pupukanioe* | Oahu tree snail | Yes | No | No |
| *Achatinella rosea* | Oahu tree snail | Yes | No | No |
| *Achatinella sowerbyana* | Oahu tree snail | Yes | No | No |
| *Achatinella stewartii* | Oahu tree snail | Yes | No | No |
| *Achatinella swiftii* | Oahu tree snail | Yes | No | No |
| *Achatinella taeniolata* | Oahu tree snail | Yes | No | No |
| *Achatinella turgida* | Oahu tree snail | Yes | No | No |
| *Achatinella valida* | Oahu tree snail | Yes | No | No |
| *Achatinella viridans* | Oahu tree snail | Yes | No | No |
| *Achatinella vulpina* | Oahu tree snail | Yes | No | No |
| *Adelocosa anops* | Spider, Kauai cave wolf or pe'e pe'e maka 'ole | No\* | No\* | No\* |
| *Anaea troglodyta floridalis* | Florida Leafwing Butterfly | Yes | Yes | No |
| *Anguispira picta* | Snail, painted snake coiled forest | Yes | No | No |
| *Apodemia mormo langei* | Butterfly, Lange's metalmark | Yes | No | No |
| *Arsapnia arapahoe* | Snowfly, Arapahoe | Yes | No | Yes |
| *Atlantea tulita* | Butterfly, Puerto Rican harlequin | Yes | No | No |
| *Batrisodes texanus* | Beetle, Coffin Cave mold | No\* | No\* | No\* |
| *Batrisodes venyivi* | Beetle, Helotes mold | No\* | No\* | No\* |
| *Boloria acrocnema* | Butterfly, Uncompahgre fritillary | Yes | No | No |
| *Callophrys mossii bayensis* | Butterfly, San Bruno elfin | Yes | No | No |
| *Cicindela dorsalis dorsalis* | Tiger beetle, Northeastern beach | Yes | Yes | No |
| *Cicindela nevadica lincolniana* | Tiger beetle, Salt Creek | Yes | Yes | Yes |
| *Cicindela ohlone* | Tiger beetle, Ohlone | Yes | Yes | No |
| *Cicindela puritana* | Tiger beetle, Puritan | Yes | Yes | No |
| *Cicidelidia floridana* | Tiger beetle, Miami | Yes | Yes | No |
| *Cicindelidia highlandensis* | Tiger beetle, highlands | Yes | Yes | No |
| *Cicurina baronia* | Meshweaver, Robber Baron Cave | No\* | No\* | No\* |
| *Cicurina madla* | Meshweaver, Madla's Cave | No\* | No\* | No\* |
| *Cicurina venii* | Meshweaver, Braken Bat Cave | No\* | No\* | No\* |
| *Cicurina vespera* | Meshweaver, Government Canyon Bat Cave | No\* | No\* | No\* |
| *Cyclargus (=Hemiargus) thomasi bethunebakeri* | Butterfly, Miami Blue | Yes | No | No |
| *Desmocerus californicus dimorphus* | Beetle, valley elderberry longhorn | Yes | No | No |
| *Dinacoma caseyi* | June Beetle, Caseys | No | Yes | No |
| *Discus macclintocki* | Snail, Iowa Pleistocene | Yes | No | No |
| *Drosophila aglaia* | Pomace fly, [unnamed] | Yes | No | No |
| *Drosophila differens* | Fly, Hawaiian picture-wing | Yes | No | No |
| *Drosophila digressa* | Fly, Hawaiian picture-wing | Yes | No | No |
| *Drosophila hemipeza* | Pomace fly, [unnamed] | Yes | No | No |
| *Drosophila heteroneura* | Pomace fly, [unnamed] | Yes | No | No |
| *Drosophila montgomeryi* | Pomace fly, [unnamed] | Yes | No | No |
| *Drosophila mulli* | Pomace fly, [unnamed] | Yes | No | No |
| *Drosophila musaphilia* | Pomace fly, [unnamed] | Yes | No | No |
| *Drosophila neoclavisetae* | Fly, Hawaiian picture-wing | Yes | No | No |
| *Drosophila obatai* | Pomace fly, [unnamed] | Yes | No | No |
| *Drosophila ochrobasis* | Pomace fly, [unnamed] | Yes | No | No |
| *Drosophila sharpi* | Fly, Hawaiian picture-wing | Yes | No | No |
| *Drosophila substenoptera* | Pomace fly, [unnamed] | Yes | No | No |
| *Drosophila tarphytrichia* | Pomace fly, [unnamed] | Yes | No | No |
| *Elaphrus viridis* | Beetle, delta green ground | Yes | Yes | Yes |
| *Eua zebrina* | Snail [unnamed] | Yes | No | No |
| *Euchloe ausonides insulanus* | Butterfly, island marble | Yes | No | No |
| *Euphilotes battoides allyni* | Butterfly, El Segundo blue | Yes | No | No |
| *Euphilotes enoptes smithi* | Butterfly, Smith's blue | Yes | No | No |
| *Euphydryas editha bayensis* | Butterfly, bay checkerspot | Yes | No | No |
| *Euphydryas editha quino (=E. e. wrighti)* | Butterfly, Quino checkerspot | Yes | No | No |
| *Euphydryas editha taylori* | Checkerspot, Taylor's (=whulge) | Yes | No | No |
| *Euproserpinus euterpe* | Moth, Kern primrose sphinx | Yes | No | No |
| *Glaucopsyche lygdamus palosverdesensis* | Butterfly, Palos Verdes blue | Yes | No | No |
| *Helminthoglypta walkeriana* | Snail, Morro shoulderband (=Banded dune) | Yes | No | No |
| *Heraclides aristodemus ponceanus* | Butterfly, Schaus swallowtail | Yes | No | No |
| *Hesperia dacotae* | Dakota Skipper | Yes | No | No |
| *Hesperia leonardus montana* | Skipper, Pawnee montane | Yes | No | No |
| *Hylaeus anthracinus* | Bee, anthricinan yellow-faced | Yes | Yes | No |
| *Hylaeus assimulans* | Bee, assimulans yellow-faced | Yes | Yes | No |
| *Hylaeus facilis* | Bee, easy yellow-faced | Yes | Yes | No |
| *Hylaeus hilaris* | Bee, hilaris yellow-faced | Yes | Yes | No |
| *Hylaeus kuakea* | Bee, Hawaiian yellow-faced | Yes | no | No |
| *Hylaeus longiceps* | Bee, Hawaiian yellow-faced | Yes | Yes | No |
| *Hylaeus mana* | Bee, hawaiian yellow-faced | Yes | No | No |
| *Hypolimnas octocula mariannensis* | Butterfly, Mariana eight-spot | Yes | No | No |
| *Icaricia icarioides fenderi* | Butterfly, Fender's blue | Yes | No | No |
| *Icaricia icarioides missionensis* | Butterfly, mission blue | Yes | No | No |
| *Ischnura luta* | Damselfly, Rota blue | Yes | No | Yes |
| *Lednia tumana* | Stonefly, meltwater lednian | Yes | No | Yes |
|  |  |  |  |  |
| *Lycaeides argyrognomon lotis* | Butterfly, lotis blue | Yes | No | No |
| *Lycaeides melissa samuelis* | Butterfly, Karner blue | Yes | No | No |
| *Lycaena hermes* | Butterfly, hermes copper | Yes | No | No |
| *Manduca blackburni* | Moth, Blackburn's sphinx | Yes | No | No |
| *Megalagrion leptodemas* | Damselfly, crimson Hawaiian | Yes | No | Yes |
| *Megalagrion nesiotes* | Damselfly, flying earwig Hawaiian | Yes | No | Yes |
| *Megalagrion nigrohamatum nigrolineatum* | Damselfly, blackline Hawaiian | Yes | No | Yes |
| *Megalagrion oceanicum* | Damselfly, oceanic Hawaiian | Yes | No | Yes |
| *Megalagrion pacificum* | Damselfly, Pacific Hawaiian | Yes | No | Yes |
| *Megalagrian xanthomelos* | Damselfly, orangeblack Hawaiian | Yes | No | Yes |
| *Microhexura montivaga* | Spider, spruce-fir moss | Yes | No | No |
| *Neoleptoneta microps* | Spider, Government Canyon Bat Cave | No\* | No\* | No\* |
| *Neoleptoneta myopica* | Spider, Tooth Cave | No\* | No\* | No\* |
| *Neonympha mitchellii francisci* | Butterfly, Saint Francis' satyr | Yes | No | No |
| *Neonympha mitchellii mitchellii* | Butterfly, Mitchell's satyr | Yes | No | No |
| *Newcombia cumingi* | Tree snail, Newcomb's | Yes | No | No |
| *Nicrophorus americanus* | Beetle, American burying | Yes | No | No |
| *Oarisma poweshiek* | Poweshiek Skipperling | Yes | No | No |
| *Orthalicus reses (not incl. nesodryas)* | Snail, Stock Island tree | Yes | No | No |
| *Ostodes strigatus* | Snail [unnamed] | Yes | No | No |
| *Oxyloma haydeni kanabensis* | Ambersnail, Kanab | Yes | No | No |
| *Papaipema eryngii* | Moth, rattlesnake master borer | Yes | Yes | No |
| *Partula gibba* | Snail, humped tree | Yes | No | No |
| *Partula langfordi* | Snail, Langford’s tree | Yes | No | No |
| *Partula radiolata* | Snail, Guam tree | Yes | No | No |
| *Partulina semicarinata* | Snail, Lanai tree | Yes | No | No |
| *Partulina variabilis* | Snail, Lanai tree | Yes | No | No |
| *Patera clarki nantahala* | globe, noonday | Yes | Yes | No |
| *Plebejus shasta charlestonensis* | Butterfly, Mount Charleston blue | Yes | No | No |
| *Polygyriscus virginianus* | Snail, Virginia fringed mountain | No | Yes | No |
| *Polyphylla barbata* | June Beetle, Mount Hermon | No | Yes | No |
| *Pseudocopaeodes eunus obscurus* | Skipper, Carson wandering | Yes | No | No |
| *Pseudonophthalmus caecus* | Beetle, Clifton Cave | No\* | No\* | No\* |
| *Pseudonophthalmus frigidus* | Beetle, Icebox Cave | No\* | No\* | No\* |
| *Pseudonophthalmus parvus* | Beetle, Tatum Cave | No\* | No\* | No\* |
| *Pseudonophthalmus troglodytes* | Beetle, Louisville Cave | No\* | No\* | No\* |
| *Pyrgus ruralis lagunae* | Skipper, Laguna Mountains | Yes | No | No |
| *Rhadine exilis* | Ground beetle, [unnamed] | No\* | No\* | No\* |
| *Rhadine infernalis* | Ground beetle, [unnamed] | No\* | No\* | No\* |
| *Rhadine persephone* | Beetle, Tooth Cave ground | No\* | No\* | No\* |
| *Rhaphiomidas terminatus abdominalis* | Fly, Delhi Sands flower-loving | Yes | Yes | No |
| *Samoana fragilis* | Snail, fragile tree | Yes | No | No |
| *Somatochlora hineana* | Dragonfly, Hine's emerald | Yes | No | Yes |
| *Spelaeorchestia koloana* | Amphipod, Kauai cave | No\* | No\* | No\* |
| *Speyeria callippe callippe* | Butterfly, callippe silverspot | Yes | No | No |
| *Speyeria zerene behrensii* | Butterfly, Behren's silverspot | Yes | No | No |
| *Speyeria zerene hippolyta* | Butterfly, Oregon silverspot | Yes | No | No |
| *Speyeria zerene myrtleae* | Butterfly, Myrtle's silverspot | Yes | No | No |
| *Strymon acis bartrami* | Bartram's Scrub-Hairsterak Butterfly | Yes | No | No |
| *Succinea chittenangoensis* | Snail, Chittenango ovate amber | Yes | No | No |
| *Tartarocreagris texana* | Pseudoscorpion, Tooth Cave | No\* | No\* | No\* |
| *Texamaurops reddelli* | Beetle, Kretschmarr Cave mold | No\* | No\* | No\* |
| *Texella cokendolpheri* | Harvestman, Cokendolpher Cave | No\* | No\* | No\* |
| *Texella reddelli* | Harvestman, Bee Creek Cave | No\* | No\* | No\* |
| *Texella reyesi* | Harvestman, Bone Cave | No\* | No\* | No\* |
| *Trimerotropis infantilis* | Grasshopper, Zayante band-winged | Yes | No | No |
| *Triodopsis platysayoides* | Snail, flat-spired three-toothed | Yes | No | No |
| *Vagrans egistina* | Butterfly, Mariana wandering | Yes | No | No |

\* The species is only found in caves (see below for discussion).

1. **Habitat**

When considering the listed terrestrial invertebrates included in this report (which excludes those considered extinct), all of the species utilize terrestrial habitats (*e.g*., forests, rock outcrops). Some species are only found in caves (22 species) (see discussion below). Several non-cave-dwelling species utilize wetland and riparian areas. A select few also use aquatic habitats for part of their life-stage and/or to forage for food. **Table A 1-20.10** lists the generic habitats associated with the listed terrestrial invertebrates. Details on each species are provided in **SUPPLEMENTAL INFORMATION 3**.

**Table A 1-20.10. Generic habitat descriptions of listed terrestrial invertebrates.**

| **Scientific Name** | **Common Name** | **Terrestrial?** | **Aquatic-associated terrestrial?** | **Aquatic?** | **Only Lives in Caves?** |
| --- | --- | --- | --- | --- | --- |
| *Achatinella abbreviata* | Oahu tree snail | Yes | No | No | No |
| *Achatinella apexfulva* | Oahu tree snail | Yes | No | No | No |
| *Achatinella bellula* | Oahu tree snail | Yes | No | No | No |
| *Achatinella bulimoides* | Oahu tree snail | Yes | No | No | No |
| *Achatinella byronii* | Oahu tree snail | Yes | No | No | No |
| *Achatinella cestus* | Oahu tree snail | Yes | No | No | No |
| *Achatinella concavospira* | Oahu tree snail | Yes | No | No | No |
| *Achatinella curta* | Oahu tree snail | Yes | No | No | No |
| *Achatinella decipiens* | Oahu tree snail | Yes | No | No | No |
| *Achatinella dimorpha* | Oahu tree snail | Yes | No | No | No |
| *Achatinella elegans* | Oahu tree snail | Yes | No | No | No |
| *Achatinella fulgens* | Oahu tree snail | Yes | No | No | No |
| *Achatinella fuscobasis* | Oahu tree snail | Yes | No | No | No |
| *Achatinella juddi* | Oahu tree snail | Yes | No | No | No |
| *Achatinella juncea* | Oahu tree snail | Yes | No | No | No |
| *Achatinella leucorraphe* | Oahu tree snail | Yes | No | No | No |
| *Achatinella lila* | Oahu tree snail | Yes | No | No | No |
| *Achatinella livida* | Oahu tree snail | Yes | No | No | No |
| *Achatinella lorata* | Oahu tree snail | Yes | No | No | No |
| *Achatinella mustelina* | Oahu tree snail | Yes | No | No | No |
| *Achatinella phaeozona* | Oahu tree snail | Yes | No | No | No |
| *Achatinella pulcherrima* | Oahu tree snail | Yes | No | No | No |
| *Achatinella pupukanioe* | Oahu tree snail | Yes | No | No | No |
| *Achatinella rosea* | Oahu tree snail | Yes | No | No | No |
| *Achatinella sowerbyana* | Oahu tree snail | Yes | No | No | No |
| *Achatinella stewartii* | Oahu tree snail | Yes | No | No | No |
| *Achatinella swiftii* | Oahu tree snail | Yes | No | No | No |
| *Achatinella taeniolata* | Oahu tree snail | Yes | No | No | No |
| *Achatinella turgida* | Oahu tree snail | Yes | No | No | No |
| *Achatinella valida* | Oahu tree snail | Yes | No | No | No |
| *Achatinella viridans* | Oahu tree snail | Yes | No | No | No |
| *Achatinella vulpina* | Oahu tree snail | Yes | No | No | No |
| *Adelocosa anops* | Spider, Kauai cave wolf or pe'e pe'e maka 'ole | Yes | No | No | Yes |
| *Anaea troglodyta floridalis* | Florida Leafwing Butterfly | Yes | No | No | No |
| *Anguispira picta* | Snail, painted snake coiled forest | Yes | No | No | No |
| *Apodemia mormo langei* | Butterfly, Lange's metalmark | Yes | No | No | No |
| *Arsapnia arapahoe* | Snowfly, Arapahoe | Yes | No | Yes | No |
| *Atlantea tulita* | Butterfly, Puerto Rican harlequin | Yes | No | No | No |
| *Batrisodes texanus* | Beetle, Coffin Cave mold | Yes | No | No | Yes |
| *Batrisodes venyivi* | Beetle, Helotes mold | Yes | No | No | Yes |
| *Boloria acrocnema* | Butterfly, Uncompahgre fritillary | Yes | No | No | No |
| *Callophrys mossii bayensis* | Butterfly, San Bruno elfin | Yes | No | No | No |
| *Cicindela dorsalis dorsalis* | Tiger beetle, Northeastern beach | Yes | No | No | No |
| *Cicindela nevadica lincolniana* | Tiger beetle, Salt Creek | Yes | No | No | No |
| *Cicindela ohlone* | Tiger beetle, Ohlone | Yes | No | No | No |
| *Cicindela puritana* | Tiger beetle, Puritan | Yes | No | No | No |
| *Cicindelidia floridana* | Tiger beetle, Miami | Yes | No | No | No |
| *Cicindelidia highlandensis* | Tiger beetle, highlands | Yes | No | No | No |
| *Cicurina baronia* | Meshweaver, Robber Baron Cave | Yes | No | No | Yes |
| *Cicurina madla* | Meshweaver, Madla's Cave | Yes | No | No | Yes |
| *Cicurina venii* | Meshweaver, Braken Bat Cave | Yes | No | No | Yes |
| *Cicurina vespera* | Meshweaver, Government Canyon Bat Cave | Yes | No | No | Yes |
| *Cyclargus (=Hemiargus) thomasi bethunebakeri* | Butterfly, Miami Blue | Yes | No | No | No |
| *Desmocerus californicus dimorphus* | Beetle, valley elderberry longhorn | Yes | No | No | No |
| *Dinacoma caseyi* | June Beetle, Caseys | Yes | No | No | No |
| *Discus macclintocki* | Snail, Iowa Pleistocene | Yes | No | No | No |
| *Drosophila aglaia* | Pomace fly, [unnamed] | Yes | No | No | No |
| *Drosophila differens* | Fly, Hawaiian picture-wing | Yes | No | No | No |
| *Drosophila digressa* | Fly, Hawaiian picture-wing | Yes | No | No | No |
| *Drosophila hemipeza* | Pomace fly, [unnamed] | Yes | No | No | No |
| *Drosophila heteroneura* | Pomace fly, [unnamed] | Yes | No | No | No |
| *Drosophila montgomeryi* | Pomace fly, [unnamed] | Yes | No | No | No |
| *Drosophila mulli* | Pomace fly, [unnamed] | Yes | No | No | No |
| *Drosophila musaphilia* | Pomace fly, [unnamed] | Yes | No | No | No |
| *Drosophila neoclavisetae* | Fly, Hawaiian picture-wing | Yes | No | No | No |
| *Drosophila obatai* | Pomace fly, [unnamed] | Yes | No | No | No |
| *Drosophila ochrobasis* | Pomace fly, [unnamed] | Yes | No | No | No |
| *Drosophila sharpi* | Fly, Hawaiian picture-wing | Yes | No | No | No |
| *Drosophila substenoptera* | Pomace fly, [unnamed] | Yes | No | No | No |
| *Drosophila tarphytrichia* | Pomace fly, [unnamed] | Yes | No | No | No |
| *Elaphrus viridis* | Beetle, delta green ground | Yes | No | Yes | No |
| *Eua zebrina* | Snail [unnamed] | Yes | No | No | No |
| *Euchloe ausanides insulanus* | Butterfly, island marble | Yes | No | No | No |
| *Euphilotes battoides allyni* | Butterfly, El Segundo blue | Yes | No | No | No |
| *Euphilotes enoptes smithi* | Butterfly, Smith's blue | Yes | No | No | No |
| *Euphydryas editha bayensis* | Butterfly, bay checkerspot | Yes | No | No | No |
| *Euphydryas editha quino (=E. e. wrighti)* | Butterfly, Quino checkerspot | Yes | No | No | No |
| *Euphydryas editha taylori* | Checkerspot, Taylor's (=whulge) | Yes | No | No | No |
| *Euproserpinus euterpe* | Moth, Kern primrose sphinx | Yes | No | No | No |
| *Glaucopsyche lygdamus palosverdesensis* | Butterfly, Palos Verdes blue | Yes | No | No | No |
| *Helminthoglypta walkeriana* | Snail, Morro shoulderband (=Banded dune) | Yes | No | No | No |
| *Heraclides aristodemus ponceanus* | Butterfly, Schaus swallowtail | Yes | No | No | No |
| *Hesperia dacotae* | Dakota Skipper | Yes | No | No | No |
| *Hesperia leonardus montana* | Skipper, Pawnee montane | Yes | No | No | No |
| *Icaricia icarioides fenderi* | Butterfly, Fender's blue | Yes | No | No | No |
| *Icaricia icarioides missionensis* | Butterfly, mission blue | Yes | No | No | No |
| *Hylaeus anthracinus* | Bee, anthricinan yellow-faced | Yes | No | No | No |
| *Hylaeus assimulans* | Bee, assismulans yellow-faced | Yes | No | No | No |
| *Hylaeus facilis* | Bee, easy yellow-faced | Yes | No | No | No |
| *Hylaeus hilaris* | Bee, hilaris yellow-faced | Yes | No | No | No |
| *Hylaeus kuakea* | Bee, Hawaiian yellow-faced | Yes | No | No | No |
| *Hylaeus longiceps* | Bee, Hawaiian yellow-faced | Yes | No | No | No |
| *Hylaeus mana* | Bee, Hawaiian yellow-faced | Yes | No | No | No |
| *Hypolimnas octocula mariannensis* | Butterfly, Marian eight-spot | Yes | No | No | No |
| *Ischura luta* | Damselfly, Rota blue | Yes | No | Yes | No |
| *Lednia tumana* | Stonefly, meltwater lednian | Yes | No | Yes | No |
| *Lycaeides argyrognomon lotis* | Butterfly, lotis blue | Yes | Yes | No | No |
| *Lycaeides melissa samuelis* | Butterfly, Karner blue | Yes | No | No | No |
| *Lycaena hermes* | Butterfly, hermes copper | Yes | No | No | No |
| *Manduca blackburni* | Moth, Blackburn's sphinx | Yes | No | No | No |
| *Megalagrion leptodemas* | Damselfly, crimson Hawaiian | Yes | No | Yes | No |
| *Megalagrion nesiotes* | Damselfly, flying earwig Hawaiian | Yes | No | Yes | No |
| *Megalagrion nigrohamatum nigrolineatum* | Damselfly, blackline Hawaiian | Yes | No | Yes | No |
| *Megalagrion oceanicum* | Damselfly, oceanic Hawaiian | Yes | No | Yes | No |
| *Megalagrion pacificum* | Damselfly, Pacific Hawaiian | Yes | No | Yes | No |
| *Megalagrian xanthomelos* | Daselfly, orangeblack Hawaiian | Yes | No | Yes | No |
| *Microhexura montivaga* | Spider, spruce-fir moss | Yes | No | No | No |
| *Neoleptoneta microps* | Spider, Government Canyon Bat Cave | Yes | No | No | Yes |
| *Neoleptoneta myopica* | Spider, Tooth Cave | Yes | No | No | Yes |
| *Neonympha mitchellii francisci* | Butterfly, Saint Francis' satyr | Yes | No | No | No |
| *Neonympha mitchellii mitchellii* | Butterfly, Mitchell's satyr | Yes | Yes | No | No |
| *Newcombia cumingi* | Tree snail, Newcomb's | Yes | No | No | No |
| *Nicrophorus americanus* | Beetle, American burying | Yes | No | No | No |
| *Oarisma poweshiek* | Poweshiek Skipperling | Yes | No | No | No |
| *Orthalicus reses (not incl. nesodryas)* | Snail, Stock Island tree | Yes | No | No | No |
| *Ostodes strigatus* | Snail [unnamed] | Yes | No | No | No |
| *Oxyloma haydeni kanabensis* | Ambersnail, Kanab | Yes | Yes | No | No |
| *Papaipema eryngii* | Moth, rattlesnake master borer | Yes | No | No | No |
| *Partula gibba* | Snail, humped tree | Yes | No | No | No |
| *Partula langfordi* | Snail, Langford’s tree | Yes | No | No | No |
| *Partula radiolata* | Snail, Guam tree | Yes | No | No | No |
| *Partulina semicarinata* | Snail, Lanai tree | Yes | No | No | No |
| *Partulina variabilis* | Snail, Lanai tree | Yes | No | No | No |
| *Patera clarki nantahala* | globe, noonday | Yes | Yes | No | No |
| *Plebejus shasta charlestonensis* | Butterfly, Mount Charleston blue | Yes | No | No | No |
| *Polygyriscus virginianus* | Snail, Virginia fringed mountain | Yes | No | No | No |
| *Polyphylla barbata* | June Beetle, Mount Hermon | Yes | No | No | No |
| *Pseudanophthalmus caecus* | Beetle, Clifton Cave | Yes | No | No | Yes |
| *Pseudanophthalmus frigidus* | Beetle, Icebox Cave | Yes | No | No | Yes |
| *Pseudanophthalmus parvus* | Beetle, Tatum Cave | Yes | No | No | Yes |
| *Pseudanophthalmus troglodytes* | Beetle, Louisville Cave | Yes | No | No | Yes |
| *Pseudocopaeodes eunus obscurus* | Skipper, Carson wandering | Yes | No | No | No |
| *Pyrgus ruralis lagunae* | Skipper, Laguna Mountains | Yes | No | No | No |
| *Rhadine exilis* | Ground beetle, [unnamed] | Yes | No | No | Yes |
| *Rhadine infernalis* | Ground beetle, [unnamed] | Yes | No | No | Yes |
| *Rhadine persephone* | Beetle, Tooth Cave ground | Yes | No | No | Yes |
| *Rhaphiomidas terminatus abdominalis* | Fly, Delhi Sands flower-loving | Yes | No | No | No |
| *Samoana fragilis* | Snail, fragile tree | Yes | No | No | No |
| *Somatochlora hineana* | Dragonfly, Hine's emerald | Yes | No | Yes | No |
| *Spelaeorchestia koloana* | Amphipod, Kauai cave | Yes | No | No | Yes |
| *Speyeria callippe callippe* | Butterfly, callippe silverspot | Yes | No | No | No |
| *Speyeria zerene behrensii* | Butterfly, Behren's silverspot | Yes | No | No | No |
| *Speyeria zerene hippolyta* | Butterfly, Oregon silverspot | Yes | No | No | No |
| *Speyeria zerene myrtleae* | Butterfly, Myrtle's silverspot | Yes | No | No | No |
| *Strymon acis bartrami* | Bartram's Scrub-Hairsterak Butterfly | Yes | No | No | No |
| *Succinea chittenangoensis* | Snail, Chittenango ovate amber | Yes | Yes | No | No |
| *Tartarocreagris texana* | Pseudoscorpion, Tooth Cave | Yes | No | No | Yes |
| *Texamaurops reddelli* | Beetle, Kretschmarr Cave mold | Yes | No | No | Yes |
| *Texella cokendolpheri* | Harvestman, Cokendolpher Cave | Yes | No | No | Yes |
| *Texella reddelli* | Harvestman, Bee Creek Cave | Yes | No | No | Yes |
| *Texella reyesi* | Harvestman, Bone Cave | Yes | No | No | Yes |
| *Trimerotropis infantilis* | Grasshopper, Zayante band-winged | Yes | No | No | No |
| *Triodopsis platysayoides* | Snail, flat-spired three-toothed | Yes | No | No | No |
| *Vagrans egistina* | Butterfly, Mariana wandering | Yes | No | No | No |

***Cave-Dwelling Terrestrial Invertebrates:***

Of the 22 terrestrial invertebrate species that are only found in caves, all of them only use terrestrial environments and rely wholly on terrestrial food sources. Several studies cite that nutrients in cave ecosystems are derived from exterior sources (Poulson and White 1969; Howarth 1983; and Culver 1986) and in particular are directly from organic material washed in or brought in by animals. Bats are usually the major source of these nutrients (Kunz 1982).

All of the listed terrestrial cave-dwelling invertebrates rely, to some degree, on food items that may originate from outside of their cave systems. Some of the cave dwelling species identified rely on surface-derived nutrients that include leaf litter fallen or washed in, animal droppings (*e.g*., bat guano), and animal carcasses. Some feed on terrestrial inverts found within the caves (there is a potential for some of these food to originate from outside the cave systems). . One cave dwelling species (*S. koloana*) is known to graze on the penetrating roots of surface plants and also may ingest leaf litter that has washed into its cave. Hawaiian caves lack trogloxenic (temporary cave visitors; like bats) organisms in numbers sufficient to provide an adequate food base. For this reason, Hawaiian cave habitats must be close enough to terrestrial plant communities so woody, long-lived plants are present to ensure a dependable food supply is available.

For listed terrestrial invertebrates that eat bat guano there is a potential for exposure to a pesticide via contaminated guano. The exposure could result from bats within a population/colony foraging on contaminated prey items within a use area, potentially resulting in contaminated guano, that could accumulate within a cave and be available for ingestion by listed invertebrates. Or less likely, the exposure could result from a single bat consuming one or more contaminated prey items that introduces the pesticide into their digestive tract and ultimately into their feces. An invertebrate feeding on the guano related to a single defecation event could, also, potentially be exposed via ingestion of the contaminated guano. There are studies available that have detected organophosphate pesticides in guano (*e.g*., Sandel 1999; Eidels, *et al*. 2007; Land 2001).

Listed species that eat detritus, may also be exposed to pesticides. Detritus within caves is made up of decaying plant and animal matter (*e.g*., leaf litter, animal droppings, and/or animal carcasses fallen or washed into the cave). Detritus can get contaminated via terrestrial applications that result in accumulation of pesticides in the detritus via agricultural practices over or near lava tubes, sinkholes, or other porous features near the surface of cave habitats. Additionally, detritus could be contaminated by terrestrial organisms within caves that have potentially accumulated the pesticide from outside the cave (*e.g*., if they die or defecate within a cave). For example, some studies have detected pesticides in bats, some of which were found dead in caves during hibernacula surveys [*e.g*., including organophosphates: (MacFarland 1998; Eidels, *et al.* 2007); organophosphates and organochlorines (Land 2001); and organochlorines and pyrethroids (MacFarland 1998)].

EPA does not currently have methods available to estimate potential exposures to listed cave-dwelling terrestrial invertebrates. Therefore, potential risks to listed cave-dwelling invertebrates will be assessed qualitatively.

1. **Obligate Relationships**

Of the 155 listed terrestrial invertebrates considered in this report, 53 are believed to have obligate relationships with other organisms (**Table A 1-20.11**). All 52 of the 53 species of terrestrial invertebrates are obligates with terrestrial plants (most of which serve as larval host plants) – one is dependent on insects (*i.e*., springtails) for food. Four of the species with obligate relationships also have a mutualistic relationship with other terrestrial invertebrates (*i.e*., ants). In these species, the larvae secrete a sugary substance that is eaten by the ants and the ants help protect the larvae and host plant from predation.

**Table A 1-20.11. Obligate relationships of listed terrestrial invertebrates. All other listed terrestrial invertebrates have no obvious obligate relationships with other taxa.**

| **Scientific Name** | **Common Name** | **Obligate Taxon 1 (specific species)** | **Obligate Taxon 2 (specific species)** |
| --- | --- | --- | --- |
| *Apodemia mormo langei* | Butterfly, Lange's metalmark | Terrestrial plant (*Eriogonum nudum* var. auriculum) | NA |
| *Atlantea tulita* | Butterfly, Puerto Rican harlequin | Terrestrial plant (*Oplonia espinosa*) | NA |
| *Boloria acrocnema* | Butterfly, Uncompahgre fritillary | Terrestrial plant (*Salix reticulata* spp. nivalis) | NA |
| *Callophrys mossii bayensis* | Butterfly, San Bruno elfin | Terrestrial plant (*Sedum spathulifolium*) | Terrestrial invertebrate [mutualism with terrestrial invertebrates (ants)] |
| *Cyclargus (=Hemiargus) thomasi bethunebakeri* | Butterfly, Miami Blue | Terrestrial plant (blackbead (*Pithecellobium* spp.), nickerbean (*Caesalpinia* spp.), balloonvine (*Cardiospermum* spp.), and presumably *Acacia* spp.) | Terrestrial invertebrate (ants, *C. floridanus*) |
| *Desmocerus californicus dimorphus* | Beetle, valley elderberry longhorn | Terrestrial plants (elderberry tree - *Sambucus* spp.) | NA |
| *Drosophila aglaia* | Pomace fly, [unnamed] | Terrestrial plant (*Urera glabra*) | NA |
| *Drosophila digressa* | Fly, Hawaiian picture-wing | Terrestrial plant (*Charpentiera* spp. and *Pisonia* spp.) | NA |
| *Drosophila hemipeza* | Pomace fly, [unnamed] | Terrestrial plant (*Cyanea angustifolia, C. calycina, C. grimesiana grimesiana , C.grimesiana Obatae, C. membranacea, C. pinnatifida, C. superba Superb, Lobelia hypoleuca, L. niihauensis, L. yuccoides,* and *Urera kaalae*) | NA |
| *Drosophila heteroneura* | Pomace fly, [unnamed] | Terrestrial plant (*Cheirodendron trigynum* spp. *trigynum, Clermontia clermontioides, C. clermontioides* spp. *rockiana, C. hawaiiensis, C. kohalae, C. lindseyana*, *C. montis-loa, C. parviflora, C. peleana*, *C. pyrularia*, and *Delissea parviflora*) | NA |
| *Drosophila montgomeryi* | Pomace fly, [unnamed] | Terrestrial plant (*Urera Kaalae*) | NA |
| *Drosophila mulli* | Pomace fly, [unnamed] | Terrestrial plant (*Pritchardia beccariana*) | NA |
| *Drosophila musaphilia* | Pomace fly, [unnamed] | Terrestrial plant (*Acacia koa tree*) | NA |
| *Drosophila obatai* | Pomace fly, [unnamed] | Terrestrial plant (*Pleomele forbesii*) | NA |
| *Drosophila sharpi* | Fly, Hawaiian picture-wing | Terrestrial plant (likely *Cheirodendron* sp. and *Tetraplasandra* sp.) | NA |
| *Drosophila substenoptera* | Pomace fly, [unnamed] | Terrestrial plant (*Cheirodendron platyphyllum* spp. *platyphyllum, C. trigynum* spp. *trigynum, Tetraplasandra kavaiensis*, and *T. oahuensis*) | NA |
| *Drosophila tarphytrichia* | Pomace fly, [unnamed] | Terrestrial plant (*Charpentiera obovata*) | NA |
| *Elaphrus viridis* | Beetle, delta green ground | Terrestrial invertebrates (springtails most common food; may also eat midges) | NA |
| *Euphilotes battoides allyni* | Butterfly, El Segundo blue | Terrestrial plant (*Eriogonum parviflorum*) | Terrestrial invertebrate (ants, *Linepfthema humile* or *Conomyrmex* species) |
| *Euphilotes enoptes smithi* | Butterfly, Smith's blue | Terrestrial plant (*Eriogonum* sp.) | NA |
| *Euphydryas editha bayensis* | Butterfly, bay checkerspot | Terrestrial plant (*Plantago Erecta* and secondary plant, *Castilleja densiplura*) | NA |
| *Euphydryas editha quino (=E. e. wrighti)* | Butterfly, Quino checkerspot | Terrestrial plant (*Plantago erecta* (erect or dwarf plantain), *Plantago patagonica* (Patagonian plantain), and *Anterrhinum coulterianum* (white snapdragon); *Collinsia concolor (*Chinese houses). | NA |
| *Euphydryas editha taylori* | Checkerspot, Taylor's (=whulge) | Terrestrial plant (members of the Broomrape family (Orobanchaceae), such as Castilleja (paintbrushes) and *Orthocarpus* = *Tryphysaria* (owl’s clover), and native and nonnative Plantago species, which are members of the Plantain family (Plantaginaceae) | NA |
| *Euproserpinus euterpe* | Moth, Kern primrose sphinx | Terrestrial plant (*Camissonia contorta*) | NA |
| *Glaucopsyche lygdamus palosverdesensis* | Butterfly, Palos Verdes blue | Terrestrial plant (*Astragalus trichopodus lonchus* (coast locoweed) and *Acmispon glaber* (deerweed)) | NA |
| *Heraclides aristodemus ponceanus* | Butterfly, Schaus swallowtail | Terrestrial plant (torchwood and wild lime) | NA |
| *Hesperia dacotae* | Dakota Skipper | Terrestrial plant (native grass species, such as little bluestem) | NA |
| *Hesperia leonardus montana* | Skipper, Pawnee montane | Terrestrial plant [(prairie gayfeather (*Liatris punctata*) and blue grama grass (*Buteloua gracilis*)] | NA |
| *Hypolimnas octocula mariannensis* | Butterfly, Mariana eight-spot | Terrestrial plant (*Procris pedunculata* and *Elatostema calcareum* | NA |
| *Icaricia icarioides fenderi* | Butterfly, Fender's blue | Terrestrial plant (*Lupinus  sulphureu*s spp. *kincaidii, L. arbustus,* or occasionally *L. albicaulis*) | NA |
| *Icaricia icarioides missionensis* | Butterfly, mission blue | Terrestrial plant [(*Lupinus albifrons* (silver lupine), *L. varicolor* (manycolored lupine), and *L. formosus* (summer lupine)] | Terrestrial invertebrate (mutualistic relationship with ants) |
| *Lycaeides argyrognomon lotis* | Butterfly, lotis blue | Terrestrial plant (assumed hostplant is assumed to be Coast trefoil) | NA |
| *Lycaeides melissa samuelis* | Butterfly, Karner blue | Terrestrial plant (wild lupine) | NA |
| *Lycaena hermes* | Butterfly, hermes copper | Terrestrial plant (*Rhamnus crocea*; and *Eriogonum fasciculatum*) | NA |
| *Manduca blackburni* | Moth, Blackburn's sphinx | Terestrial plant ( four tree species within the genus *Nothocestrum* (aiea) | NA |
| *Neonympha mitchellii francisci* | Butterfly, Saint Francis' satyr | Terrestrial plant (*Carex mitchelliana*) | NA |
| *Neonympha mitchellii mitchellii* | Butterfly, Mitchell's satyr | Terrestrial plant (almost certainly sedges, and *C. stricta* is probably the primary hostplant) | NA |
| *Newcombia cumingi* | Tree snail, Newcomb's | Terrestrial plant (Host plant - ohia, *Metrosideros polymorpha*) | NA |
| *Oarisma poweshiek* | Poweshiek Skipperling | Terrestrial plant (untilled high-quality prairie, ranging from wet-mesic tallgrass prairie to dry-mesic mixed-grass prairie to prairie fens) | NA |
| *Papaipema eryngii* | Moth, rattlesnake master borer | Terrestrial plant (rattlesnake master) | NA |
| *Plebejus shasta charlestonensis* | Butterfly, Mount Charleston blue | Terrestrial plant (*Astragalus calycosus* var. calycosus (Torrey’s milkvetch), *Oxytropis oreophila var. oreophila* (mountain oxytrope), *Astragalus platytropis* (Broad keeled milkvetch) and *Erigeron clokeyi* (Clokey’s fleabane), *Hymenoxys lemmonii* (Lemmon bitterweed), *Hymenoxys cooperi* (Cooper rubberweed), and *Eriogonum umbellatum* var. versicolor (sulphurflower buckwheat)). | NA |
| *Pseudocopaeodes eunus obscurus* | Skipper, Carson wandering | Terrestrial plant (*Distichlis spicata*) | NA |
| *Pyrgus ruralis lagunae* | Skipper, Laguna Mountains | Terrestrial plant (*Horkelia clevelandii*, and on occasion with *Potentilla glandulosa*) | NA |
| *Rhaphiomidas terminatus abdominalis* | Fly, Delhi Sands flower-loving | Terrestrial plant (*Ermogonum fasciculatum*) | NA |
| *Speyeria callippe callippe* | Butterfly, callippe silverspot | Terrestrial plant (*Viola pedunculata*) | NA |
| *Speyeria zerene behrensii* | Butterfly, Behren's silverspot | Terrestrial plant [Blue Violet (*Viola adunca*)] | NA |
| *Speyeria zerene myrtleae* | Butterfly, Myrtle's silverspot | Terrestrial plant [Blue Violet (*Viola adunca*)] | NA |
| *Strymon acis bartrami* | Bartram's Scrub-Hairsterak Butterfly | Terrestrial plant (pineland croton) | NA |
| *Drosophila differens* | Hawaiian picture-wing fly | Terrestrial plant (*Clermontia arborescens, C. granidiflora, C.kakeana, C. oblongifolia*, and *C. pallida*) | NA |
| *Drosophila neoclavisetae* | Hawaiian picture-wing fly | Terrestrial plant (likely *Cyanea kunthiana* and *C. macrostegia* macrostegia tree) | NA |
| *Drosophila ochrobasis* | Pomace fly, [unnamed] | Terrestrial plant (*Clermontia calophylla, C. clermontioides, C. clermontioides* spp*. rockiana, C. drepanomorph*a, *C. hawaiiensis, C. kohalae, C. lindseyana, C. montis-loa, C. parviflora, C. peleana, C. pyrularia), C. waimeae, Marattia douglasii, Myrsine lanaiensis, M. lessertiana*, and *M. sandwicensis*) | NA |
| *Speyeria zerene hippolyta* | Butterfly, Oregon silverspot | Terrestrial plant (blue violet (Viola adunca)) | NA |
| *Vagrans egistina* | Butterfly, Mariana wandering | Terrestrial plant (*Maytenus thompsonii*) | NA |

1. **Geographic Ranges of Listed Species**

Many listed terrestrial invertebrates occur in only one state or territory. Listed species of terrestrial invertebrates are known to occur in most states. Hawaii has the most listings (66), followed by California (25) and Texas (17). The remaining states and territories with known occurrences of listed terrestrial invertebrates are provided in **Table A 1-20.12**. County specific location information for each listed species, subspecies or DPS is provided in **SUPPLEMENTAL INFORMATION 3**.

**Table A 1-20.12. Number of listed terrestrial invertebrates by state or territory.**

| **Abbreviation** | **State** | **Count** |
| --- | --- | --- |
| AL | Alabama | 0 |
| AK | Alaska | 0 |
| AS | American Samoa | 2 |
| AZ | Arizona | 1 |
| AR | Arkansas | 2 |
| CA | California | 25 |
| CO | Colorado | 3 |
| MP | Commonwealth of the Northern Mariana Islands | 3 |
| CT | Connecticut | 1 |
| DE | Delaware | 0 |
| DC | District of Columbia | 0 |
| FL | Florida | 7 |
| GA | Georgia | 0 |
| GU | Guam | 4 |
| HI | Hawaii | 66 |
| ID | Idaho | 0 |
| IL | Illinois | 4 |
| IN | Indiana | 2 |
| IA | Iowa | 3 |
| KS | Kansas | 1 |
| KY | Kentucky | 5 |
| LA | Louisiana | 0 |
| ME | Maine | 0 |
| MD | Maryland | 2 |
| MA | Massachusetts | 2 |
| MI | Michigan | 4 |
| MN | Minnesota | 3 |
| MS | Mississippi | 0 |
| MO | Missouri | 1 |
| MT | Montana | 1 |
| NE | Nebraska | 2 |
| NV | Nevada | 2 |
| NH | New Hampshire | 1 |
| NJ | New Jersey | 0 |
| NM | New Mexico | 0 |
| NY | New York | 2 |
| NC | North Carolina | 4 |
| ND | North Dakota | 2 |
| OH | Ohio | 0 |
| OK | Oklahoma | 2 |
| OR | Oregon | 3 |
| PA | Pennsylvania | 0 |
| PR | Puerto Rico | 1 |
| RI | Rhode Island | 1 |
| SC | South Carolina | 0 |
| SD | South Dakota | 3 |
| TN | Tennessee | 2 |
| TX | Texas | 17 |
| VI | United States Virgin Islands | 0 |
| UT | Utah | 1 |
| VT | Vermont | 0 |
| VA | Virginia | 2 |
| WA | Washington | 2 |
| WV | West Virginia | 1 |
| WI | Wisconsin | 3 |
| WY | Wyoming | 0 |

1. **Elevation Restrictions**

**Table A 1-20.13** lists the elevation restrictions of the 155 listed terrestrial invertebrates considered in this report. Of these terrestrial invertebrates, 78 have known elevation restrictions (see **Table A 1-20.13**).

**Table A 1-20.13. Elevation restrictions of listed terrestrial invertebrates.**

| **Scientific Name** | **Common Name** | **Elevation restriction?** | **If yes, define (in m)** |
| --- | --- | --- | --- |
| *Achatinella abbreviata* | Oahu tree snail | Yes | > 400 |
| *Achatinella apexfulva* | Oahu tree snail | Yes | > 400 |
| *Achatinella bellula* | Oahu tree snail | Yes | > 400 |
| *Achatinella bulimoides* | Oahu tree snail | Yes | > 400 |
| *Achatinella byronii* | Oahu tree snail | Yes | > 400 |
| *Achatinella cestus* | Oahu tree snail | Yes | > 400 |
| *Achatinella concavospira* | Oahu tree snail | Yes | > 400 |
| *Achatinella curta* | Oahu tree snail | Yes | > 400 |
| *Achatinella decipiens* | Oahu tree snail | Yes | > 400 |
| *Achatinella dimorpha* | Oahu tree snail | Yes | > 400 |
| *Achatinella elegans* | Oahu tree snail | Yes | > 400 |
| *Achatinella fulgens* | Oahu tree snail | Yes | > 400 |
| *Achatinella fuscobasis* | Oahu tree snail | Yes | > 400 |
| *Achatinella juddi* | Oahu tree snail | Yes | > 400 |
| *Achatinella juncea* | Oahu tree snail | Yes | > 400 |
| *Achatinella leucorraphe* | Oahu tree snail | Yes | > 400 |
| *Achatinella lila* | Oahu tree snail | Yes | > 400 |
| *Achatinella livida* | Oahu tree snail | Yes | > 400 |
| *Achatinella lorata* | Oahu tree snail | Yes | > 400 |
| *Achatinella mustelina* | Oahu tree snail | Yes | > 400 |
| *Achatinella phaeozona* | Oahu tree snail | Yes | > 400 |
| *Achatinella pulcherrima* | Oahu tree snail | Yes | > 400 |
| *Achatinella pupukanioe* | Oahu tree snail | Yes | > 400 |
| *Achatinella rosea* | Oahu tree snail | Yes | > 400 |
| *Achatinella sowerbyana* | Oahu tree snail | Yes | > 400 |
| *Achatinella stewartii* | Oahu tree snail | Yes | > 400 |
| *Achatinella swiftia* | Oahu tree snail | Yes | > 400 |
| *Achatinella taeniolata* | Oahu tree snail | Yes | > 400 |
| *Achatinella turgida* | Oahu tree snail | Yes | > 400 |
| *Achatinella valida* | Oahu tree snail | Yes | > 400 |
| *Achatinella viridans* | Oahu tree snail | Yes | > 400 |
| *Achatinella vulpina* | Oahu tree snail | Yes | > 400 |
| *Adelocosa anops* | Spider, Kauai cave wolf or pe'e pe'e maka 'ole | No | NR |
| *Anaea troglodyta floridalis* | Florida Leafwing Butterfly | No | NR |
| *Anguispira picta* | Snail, painted snake coiled forest | Yes | 229 - 396 |
| *Apodemia mormo langei* | Butterfly, Lange's metalmark | No | NR |
| *Arsapnia arapahoe* | Snowfly, Arapahoe | Yes | ≥1,768 |
| *Atlantea tulita* | Puerto Rico harlequin butterfly | No | NR |
| *Batrisodes texanus* | Beetle, Coffin Cave mold | No | NR |
| *Batrisodes venyivi* | Beetle, Helotes mold | No | NR |
| *Boloria acrocnema* | Butterfly, Uncompahgre fritillary | Yes | > 3,810 |
| *Callophrys mossii bayensis* | Butterfly, San Bruno elfin | Yes | 275 - 325 |
| *Cicindela dorsalis dorsalis* | Tiger beetle, Northeastern beach | No | NR |
| *Cicindelidia floridana* | Tiger beetle, Miami | No | NR |
| *Cicindelidia highlandensis* | Tiger beetle, highlands | No | NR |
| *Cicindela nevadica lincolniana* | Tiger beetle, Salt Creek | No | NR |
| *Cicindela ohlone* | Tiger beetle, Ohlone | No | NR |
| *Cicindela puritana* | Tiger beetle, Puritan | No | NR |
| *Cicurina baronia* | Meshweaver, Robber Baron Cave | No | NR |
| *Cicurina madla* | Meshweaver, Madla's Cave | No | NR |
| *Cicurina venii* | Meshweaver, Braken Bat Cave | No | NR |
| *Cicurina vespera* | Meshweaver, Government Canyon Bat Cave | No | NR |
| *Cyclargus (=Hemiargus) thomasi bethunebakeri* | Butterfly, Miami Blue | No | NR |
| *Desmocerus californicus dimorphus* | Beetle, valley elderberry longhorn | No | NR |
| *Dinacoma caseyi* | June Beetle, Caseys | No | NR |
| *Discus macclintocki* | Snail, Iowa Pleistocene | No | NR |
| *Drosophila aglaia* | Pomace fly, [unnamed] | Yes | 568 - 910 |
| *Drosophila differens* | Fly, Hawaiian picture-wing | Yes | 1,111 – 1,370 |
| *Drosophila digressa* | Fly, Hawaiian picture-wing | Yes | 610 – 1,370 |
| *Drosophila hemipeza* | Pomace fly, [unnamed] | Yes | 460 - 916 |
| *Drosophila heteroneura* | Pomace fly, [unnamed] | Yes | 815 – 1,840 |
| *Drosophila montgomeryi* | Pomace fly, [unnamed] | Yes | 524 - 910 |
| *Drosophila mulli* | Pomace fly, [unnamed] | Yes | 655 - 990 |
| *Drosophila musaphilia* | Pomace fly, [unnamed] | Yes | 790 – 1,130 |
| *Drosophila neoclavisetae* | Fly, Hawaiian picture-wing | Yes | 1,036 – 1,399 |
| *Drosophila obatai* | Pomace fly, [unnamed] | Yes | 450 - 773 |
| *Drosophila ochrobasis* | Pomace fly, [unnamed] | Yes | 1,173 – 1,643 |
| *Drosophila sharpi* | Fly, Hawaiian picture-wing | Yes | 914 – 1,200 |
| *Drosophila substenoptera* | Pomace fly, [unnamed] | Yes | 585 – 1,228 |
| *Drosophila tarphytrichia* | Pomace fly, [unnamed] | Yes | 524 - 910 |
| *Elaphrus viridis* | Beetle, delta green ground | No | NR |
| *Eua zebrina* | No common name | No | NR |
| *Euchloe ausonides insulans* | Butterfly, island marble | No | NR |
| *Euphilotes battoides allyni* | Butterfly, El Segundo blue | No | NR |
| *Euphilotes enoptes smithi* | Butterfly, Smith's blue | No | NR |
| *Euphydryas editha bayensis* | Butterfly, bay checkerspot | No | NR |
| *Euphydryas editha quino (=E. e. wrighti)* | Butterfly, Quino checkerspot | Yes | 153 – 1,533 |
| *Euphydryas editha taylori* | Checkerspot, Taylor's (=whulge) | Yes | ≤ 1,220 |
| *Euproserpinus euterpe* | Moth, Kern primrose sphinx | Yes | 1,470 – 3,000 |
| *Glaucopsyche lygdamus palosverdesensis* | Butterfly, Palos Verdes blue | Yes | < 915 |
| *Helminthoglypta walkeriana* | Snail, Morro shoulderband (=Banded dune) | No | NR |
| *Heraclides aristodemus ponceanus* | Butterfly, Schaus swallowtail | Yes | 3 – 4.6 |
| *Hesperia dacotae* | Dakota Skipper | No | NR |
| *Hesperia leonardus montana* | Skipper, Pawnee montane | Yes | 1,829 – 2,134 |
| *Hylaeus anthracinus* | Bee, anthricinan yellow-faced | No | NR |
| *Hylaeus assimulans* | Bee, assimulans yellow-faced | No | NR |
| *Hylaeus facilis* | Bee, easy yellow-faced | No | NR |
| *Hylaeus hilaris* | Bee, hilaris yellow-faced | No | NR |
| *Hylaeus kuakea* | Bee, Hawaiian yellow-faced | No | NR |
| *Hylaeus longiceps* | Bee, Hawaiian yellow-faced | No | NR |
| *Hylaeus mana* | Bee, Hawaiian yellow-faced | No | NR |
| *Hypolimnas octocula mariannensis* | Butterfly, Mariana eight-spot | No | NR |
| *Icaricia icarioides fenderi* | Butterfly, Fender's blue | Yes | 50 - 130 |
| *Icaricia icarioides missionensis* | Butterfly, mission blue | Yes | 210 - 360 |
| *Ischnura luta* | Damselfly, Rota blue | No | NR |
| *Lednia tumana* | Stonefly, meltwater lednian | Yes | 1610 - 2332 |
| *Lycaeides argyrognomon lotis* | Butterfly, lotis blue | No | NR |
| *Lycaeides melissa samuelis* | Butterfly, Karner blue | No | NR |
| *Lycaena hermes* | Hermes copper butterfly | No | NR |
| *Manduca blackburni* | Moth, Blackburn's sphinx | Yes | ≤ 1,525 |
| *Megalagrion leptodemas* | Damselfly, crimson Hawaiian | No | NR |
| *Megalagrion nesiotes* | Damselfly, flying earwig Hawaiian | Yes | < ~1,200 |
| *Megalagrion nigrohamatum nigrolineatum* | Damselfly, blackline Hawaiian | Yes | < ~730 |
| *Megalagrion oceanicum* | Damselfly, oceanic Hawaiian | Yes | > 100 |
| *Megalagrion pacificum* | Damselfly, Pacific Hawaiian | Yes | < 600 |
| *Megalagrion xanthomelas* | Damselfly, orangeblack Hawaiian | Yes | < 914 |
| *Microhexura montivaga* | Spider, spruce-fir moss | Yes | ≥ 1,646 |
| *Neoleptoneta microps* | Spider, Government Canyon Bat Cave | No | NR |
| *Neoleptoneta myopica* | Spider, Tooth Cave | No | NR |
| *Neonympha mitchellii francisci* | Butterfly, Saint Francis' satyr | No | NR |
| *Neonympha mitchellii mitchellii* | Butterfly, Mitchell's satyr | No | NR |
| *Newcombia cumingi* | Tree snail, Newcomb's | Yes | < 1,000 |
| *Nicrophorus americanus* | Beetle, American burying | No | NR |
| *Oarisma poweshiek* | Poweshiek Skipperling | No | NR |
| *Orthalicus reses (not incl. nesodryas)* | Snail, Stock Island tree | Yes | > 1.5 |
| *Ostodes strigatus* | Snail [unnamed] | Yes | 60 - 390 |
| *Oxyloma haydeni kanabensis* | Ambersnail, Kanab | No | NR |
| *Papaipema eryngii* | Moth, rattlesnake-master borer | No | NR |
| *Partula gibba* | Humped tree snail | No | NR |
| *Partula langfordi* | Langford's tree snail | No | NR |
| *Partula radiolata* | Guam tree snail | No | NR |
| *Partulina semicarinata* | Snail, Lanai tree | Yes | ≤ 2,000 |
| *Partulina variabilis* | Snail, Lanai tree | Yes | < 1,000 |
| *Patera clarki nantahala* | globe, noonday | No | NR |
| *Plebejus shasta charlestonensis* | Butterfly, Mount Charleston blue | Yes | > 2,000 |
| *Polygyriscus virginianus* | Snail, Virginia fringed mountain | Yes | 549 |
| *Polyphylla barbata* | June Beetle, Mount Hermon | No | NR |
| *Pseudanophthalmus caecus* | Beetle, Clifton Cave | No | NR |
| *Pseudanophthalmus frigidus* | Beetle, Icebox Cave | No | NR |
| *Pseudanophthalmus parvus* | Beetle, Tatum Cave | No | NR |
| *Pseudanophthalmus troglodytes* | Beetle, Louisville Cave | No | NR |
| *Pseudocopaeodes eunus obscurus* | Skipper, Carson wandering | Yes | < 1,524 |
| *Pyrgus ruralis lagunae* | Skipper, Laguna Mountains | Yes | 1,158 – 2,000 |
| *Rhadine exilis* | Ground beetle, [unnamed] | No | NR |
| *Rhadine infernalis* | Ground beetle, [unnamed] | No | NR |
| *Rhadine persephone* | Beetle, Tooth Cave ground | No | NR |
| *Rhaphiomidas terminatus abdominalis* | Fly, Delhi Sands flower-loving | No | NR |
| *Samoana fragilis* | Snail, fragile tree | No | NR |
| *Somatochlora hineana* | Dragonfly, Hine's emerald | No | NR |
| *Spelaeorchestia koloana* | Amphipod, Kauai cave | No | NR |
| *Speyeria callippe callippe* | Butterfly, callippe silverspot | No | NR |
| *Speyeria zerene behrensii* | Butterfly, Behren's silverspot | Yes | 215 - 305 |
| *Speyeria zerene hippolyta* | Butterfly, Oregon silverspot | No | NR |
| *Speyeria zerene myrtleae* | Butterfly, Myrtle's silverspot | Yes | ≤ 300 |
| *Strymon acis bartrami* | Bartram's Scrub-Hairsterak Butterfly | No | NR |
| *Succinea chittenangoensis* | Snail, Chittenango ovate amber | No | NR |
| *Tartarocreagris texana* | Pseudoscorpion, Tooth Cave | No | NR |
| *Texamaurops reddelli* | Beetle, Kretschmarr Cave mold | No | NR |
| *Texella cokendolpheri* | Harvestman, Cokendolpher Cave | No | NR |
| *Texella reddelli* | Harvestman, Bee Creek Cave | No | NR |
| *Texella reyesi* | Harvestman, Bone Cave | No | NR |
| *Trimerotropis infantilis* | Grasshopper, Zayante band-winged | No | NR |
| *Triodopsis platysayoides* | Snail, flat-spired three-toothed | Yes | 548 - 610 |
| *Vagrans egistina* | Butterfly, Mariana wandering | No | NR |

1. **Strategy for grouping species**

In order to efficiently assess the risks of a pesticide to listed terrestrial invertebrates, it is necessary to group them by their defining features that are relevant in the context of the risk assessment framework. There are two major factors that impact the risk of a pesticide to a species: exposure and effects. In terms of effects, relevance of surrogate test species for a listed species may alter the confidence associated with the risk call. Surrogacy is determined by taxonomy. Listed terrestrial invertebrates can be broadly separated into three groups: arachnids, insects, and snails. For surrogacy, the lumping strategy will specifically consider whether toxicity data are available for species within the same order as the listed species. Therefore, species are grouped according to their broad category and order (**Table A 1-20.3**). Terrestrial invertebrates also are lumped according to their diet (**Tables A 1-20.6 to A 1-20.8**), which influences exposure. Since indirect effects are based on diet and habitat, lumping according to diet will also serve the needs of indirect effects. Species are also grouped according to similarity of their habitats (**Table A 1-20.10**). A final consideration in this strategy is whether or not a species has an obligate relationship(s). If a species has an obligate relationship(s), it may be treated separately from other species. **Table A 1-20.14** summarizes the 45 groups of listed terrestrial invertebrates. Each group of species will share risk hypotheses and lines of evidence. Note that 29 species did not have similarities to other listed terrestrial invertebrates, therefore, they will be assessed separately.

**Table A 1-20.14. Summary of the listed terrestrial invertebrate as grouped for assessment purposes.**

| **Type** | **Order** | **Habitat** | **Diet** | **Obligate Relationship(s) (Taxa)** | **Species** | **N** | **Model(s) (for direct effects)** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Arachnidae | **Araneae**1 | Terrestrial; Caves only | Terrestrial invertebrates | No | *Adelocosa anops; Cicurina baronia; Cicurina madla; Cicurina venii; Cicurina vespera; Neoleptoneta microps* | 6 | N/A\* |
| Terrestrial; Caves only | Leaf litter | No | *Neoleptoneta myopica* | 1 | N/A\* |
| Terrestrial | Terrestrial invertebrates | No | *Microhexura montivaga* | 1 | T-REX |
| Opiliones | Terrestrial; Caves only | Leaves; Carrion | No | *Texella reddelli; Texella reyesi* | 2 | N/A\* |
| Terrestrial; Caves only | Terrestrial invertebrates | No | *Texella cokendolpheri* | 1 | N/A\* |
| Pseudoscorpiones | Terrestrial; Caves only | Leaves; Carrion | No | *Tartarocreagris texana* | 1 | N/A\* |
| Insects | **Coleoptera** | Terrestrial; Caves only | Leaves; Soil; Carrion | No | *Batrisodes texanus* | 1 | N/A\* |
| Terrestrial; Caves only | Terrestrial invertebrates | No | *Batrisodes venyivi;* *Rhadine exilis;* *Rhadine infernalis; Rhadine persephone; Pseudanophthalmus caecus; Pseudanophthalmus frigidus; Pseudanophthalmus parvus; Pseudanophthalmus troglodytes* | 8 | N/A\* |
| Terrestrial; Caves only | Soil; Carrion | No | *Texamaurops reddelli* | 1 | N/A\* |
| Terrestrial; Soil-dwelling2 | Terrestrial invertebrates; Soil-dwelling invertebrates; Fish | No | *Cicindela dorsalis dorsalis* | 1 | T-REX; EFM3 |
| Terrestrial; Soil-dwelling | Terrestrial invertebrates; Soil-dwelling invertebrates | No | *Cicindela nevadica lincolniana; Cicindela ohlone; Cicindela puritan; Cicindelidia floridana; Cicindelidia highlandensis; Dinacoma caseyi* | 6 | T-REX; EFM |
| Terrestrial; Soil-dwelling | Roots | No | *Polyphylla barbata* | 1 | EFM |
| Terrestrial | Leaves; Flowers | Yes (Terrestrial Plants) | *Desmocerus californicus dimorphus* | 1 | T-REX |
| Terrestrial | Terrestrial invertebrates; Soil-dwelling invertebrates; | Yes (Terrestrial invertebrates) | *Elaphrus viridis* | 1 | T-REX; EFM |
| Terrestrial | Terrestrial invertebrates; soil-dwelling invertebrates; Carrion | No | *Nicrophorus americanus* | 1 | T-REX; EFM |
| **Diptera** | Terrestrial | Leaves | Yes (Terrestrial plants) | *Drosophila aglaia; Drosophila digressa; Drosophila hemipeza; Drosophila heteroneura; Drosophila montgomeryi; Drosophila mulli; Drosophila neoclavisetae; Drosophila obatai; Drosophila ochrobasis; Drosophila sharpi; Drosophila substenoptera; Drosophila tarphytrichia* | 12 | T-REX |
| Terrestrial | Leaves; Nectar/Pollen | Yes (Terrestrial plants) | *Drosophila musaphilia* | 1 | T-REX |
| Terrestrial; Soil-dwelling | Nectar/Pollen; Soil-dwelling invertebrates | Yes (Terrestrial plants) | *Rhaphiomidas terminatus abdominalis* | 1 | T-REX; EFM |
| **Hymenoptera** | Terrestrial; soil-dwelling (may nest in burrows) | Nectar; pollen | No | *Hylaeus anthracinus; Hylaeus assimulans*; *Hylaeus facilis; Hylaeus hilaris; Hylaeus longiceps* | 5 | T-REX; EFM |
| Terrestrial | Nectar; pollen | No | *Hylaeus kuakea; Hylaeus mana* | 2 | T-REX |
| **Lepidoptera** | Terrestrial | Leaves; Flowers; Nectar/Pollen | Yes (Terrestrial plants; Terrestrial invertebrates) | *Callophrys mossii bayensis; Icaricia icarioides missionensis* | 2 | T-REX |
| Terrestrial | Leaves; Nectar/Pollen | Yes (Terrestrial plants; Terrestrial invertebrates) | *Cyclargus (=Hemiargus) thomasi bethunebakeri; Euphilotes battoides allyni* | 2 | T-REX |
| Terrestrial | Grass; Nectar/Pollen | Yes (Terrestrial plants) | *Hesperia dacotae; Hesperia leonardus montana; Neonympha mitchellii mitchellii; Oarisma Poweshiek; Pseudocopaeodes eunus obscurus* | 5 | T-REX |
| Terrestrial | Seeds; Nectar/Pollen; Terrestrial invertebrates | Yes (Terrestrial plants) | *Glaucopsyche lygdamus palosverdesensis* | 1 | T-REX |
| Terrestrial | Seeds; Flowers; Nectar/Pollen | Yes (Terrestrial plants) | *Euphilotes enoptes smithi* | 1 | T-REX |
| Terrestrial | Leaves; Fruit; Nectar/Pollen; Soil | No | *Anaea troglodyta floridalis* | 1 | T-REX; EFM |
| Terrestrial | Leaves; Seeds; Flowers; Nectar/Pollen | Yes (Terrestrial plants) | *Lycaeides argyrognomon lotis* | 1 | T-REX |
| Terrestrial | Leaves; Flowers; Nectar/Pollen | Yes (Terrestrial plants) | *Manduca blackburni* | 1 | T-REX |
| Terrestrial | Stems; roots; nectar | Yes (Terrestrial Plants) | *Papaipema eryngii* | 1 | T-REX |
| Terrestrial | Leaves; Nectar/Pollen | Yes (Terrestrial plants) | *Atlantea tulitia; Euchloe ausonides insulans; Hypolimnas octocula mariennensis; Lycaena hermes; Speyeria callippe callippe; Apodemia mormo langei; Boloria acrocnema; Euphydryas editha bayensis; Euphydryas editha quino (=E. e. wrighti); Euphydryas editha taylori; Heraclides aristodemus ponceanus; Icaricia icarioides fender; Lycaeides melissa samuelis; Neonympha mitchellii francisci; Plebejus shasta charlestonensis; Pyrgus ruralis lagunae; Speyeria zerene myrtleae; Speyeria zerene behrensii; Euproserpinus euterpe; Speyeria zerene hippolyta; Strymon acis bartrami; Vagrans egistina* | 22 | T-REX |
| **Odonata** | Terrestrial; Aquatic | Terrestrial invertebrates; Freshwater invertebrates; Freshwater fish | No | *Ischnura luta; Megalagrion leptodemas; Megalagrion nesiotes; Megalagrion nigrohamatum nigrolineatum; Megalagrion oceanicum; Megalagrion pacificum; Megalagrian; Somatochlora hineana* | 8 | T-REX; PRZM5/VVWM |
| **Orthoptera** | Terrestrial | Leaves | No | *Trimerotropis infantilis* | 1 | T-REX |
| **Plecoptera** | Terrestrial; Aquatic | Detritus; algae; lichen; nectar; pollen | No | *Arsapnia arapahoe* | 1 | T-REX; PRZM/VVWM |
| Terrestrial; Aquatic | Detritus; algae; leaves; buds; pollen | No | *Lednia tumana* | 1 | T-REX; PRZM/VVWM |
| Crustacean | **Amphipoda** | Terrestrial; Caves only | Roots; Leaf litter | No | *Spelaeorchestia koloana* | 1 | N/A\* |
| Snails | **Stylommatophora** | Terrestrial | Grass; Leaves | No | *Eua zebrina; Oxyloma haydeni kanabensis; Partula gibba; Partula langfordi; Partula radiolata; Somoana fragilis* | 6 | T-REX |
| Terrestrial; Soil-dwelling | Soil | No | *Polygyriscus virginianus* | 1 | EFM |
| Terrestrial | Leaves; Fungus | Yes (Terrestrial plants) | *Newcombia cumingi* | 1 | T-REX |
| Terrestrial | Leaves; Fungus | No | *Partulina semicarinata; Partulina variabilis* | 2 | T-REX |
| Terrestrial | Leaves; Terrestrial invertebrates | No | *Orthalicus reses* (not incl. *nesodryas*) | 1 | T-REX |
| Terrestrial | Leaves | No | *Anguispira picta; Discus macclintocki; Succinea chittenangoensis* | 3 | T-REX |
| Terrestrial | Leaves; Fungus; Flowers; Terrestrial invertebrates | No | *Succinea chittenangoensis* | 1 | T-REX |
| Terrestrial | Fungus; Soil | No | *Patera clarki nantahala* | 1 | T-REX; EFM |
| Terrestrial | Fungus | No | *Helminthoglypta walkeriana; Achatinella abbreviata; Achatinella apexfulva; Achatinella bellula; Achatinella bulimoides; Achatinella byronii; Achatinella cestus; Achatinella concavospira; Achatinella curta; Achatinella decipiens; Achatinella dimorpha; Achatinella elegans; Achatinella fulgens; Achatinella fuscobasis; Achatinella juddi; Achatinella juncea; Achatinella leucorraphe; Achatinella lila; Achatinella livida; Achatinella lorata; Achatinella mustelina; Achatinella phaeozona; Achatinella pulcherrima; Achatinella pupukanioe; Achatinella rosea; Achatinella sowerbyana; Achatinella stewartii; Achatinella swiftia; Achatinella taeniolata; Achatinella turgida; Achatinella valida; Achatinella viridans; Achatinella vulpina* | 33 | T-REX |
| Architaenioglossa | Terrestrial | Leaves; fungus | No | *Ostodes strigatus* | 1 | T-REX |

\* N/A = Not applicable (since these species are only found in caves).

1 Bolded orders indicates that toxicity data are not available for this order.

2 ‘Soil-dwelling’ includes subterranean habitats (*e.g*., burrows).

3 EFM = Earthworm Fugacity Model

4 ‘TBD’ = To be determined, because they refer to orders that apply to candidate and proposed species.

**11. References:**

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**SUPPLEMENTAL INFORMATIN 1. Instructions for extracting biological information for listed terrestrial invertebrates**

The purpose of this project is to compile biological information on federally listed endangered and threatened terrestrial invertebrates. This document contains instructions for extracting relevant biological information on each of these species and a form for entering this information.

**Instructions:**

Step 1. Copy the template (below) for the listed terrestrial invertebrate species Excell worksheet used to record biological information for individual species. Paste this into a new worksheet. This worksheet will be used to record biological information for each of the listed terrestrial invertebrate species.

Step 2. Go to the species profile for the species of interest.

Step 3. If available, acquire the most recent recovery plan available for the listed species of interest. Recovery plans can be located by clicking on the “recovery” quick link of the species profile for the species of interest. Save the pdf of the recovery plan.

Step 4. Extract information on the parameters listed in the attached sheet. When information is entered into the worksheet, note the source in the ‘source column’. These data can generally be found in the life history portion of the recovery plan, so it is not necessary to review the entire recovery plan. When a data point is extracted, highlight the appropriate information in the PDF. When all data are extracted from the recovery plan, save the revised file. All information that appear in the species worksheet must have a source and must be highlighted in the original document. This is a critical component of the Quality Control (QC) for this project.

Step 5. Determine if the species has an obligate relationship with other species. If so, describe the nature of the obligate relationship.

* Obligate relationships of a listed species may be explicitly stated in a recovery plan (*e.g.,* the golden coqui frog has obligate relationships with bromeliads[[1]](#footnote-1)). It is recommended that the data extractor do a search of the recovery plan for the term “obligate” to determine whether the listed species of interest has any obligate relationships with other species.
* In some cases, obligate relationships may not be explicitly stated; however this relationship may be inferred from the description of the diet or habitat of the listed species. If the recovery plan indicates that the listed species requires a specific species for its survival (*i.e.,* for diet or habitat), then EFED scientists may determine that the species has an obligate relationship with the specific species that is noted in the recovery plan.

Step 6. If data are not located in the recovery plan, other scientifically valid sources (*e.g.,* scientific literature, USFWS publications) may be used to acquire the necessary information. Please check with Kris Garber before extracting data from other sources.

Notes:

1. Many recovery plans include information on multiple listed species. If this is the case, data can be extracted at the same time for all of the species included in the recovery plan.
2. Melissa Panger will complete the EFED model portion of the worksheet for all species.
3. If a source provides different body weights for different life stages or distinguishes between male and female body weights, enter all of the available values. In that case, note what each body weight corresponds to.
4. “Locations known to occur” may include a state or a county. For Hawaii, it may be a specific island.
5. If a recovery plan specifically describes an animal’s habitats as agricultural or golf courses, or other areas where pesticides are expected to be applied, please note this in the habitat or comments section of the worksheet.

**SUPPLEMENTAL INFORMATION 2. Template for worksheet used to collect biological information on listed terrestrial invertebrate species**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SCIENTIFIC NAME** | **COMMON NAME** | **DPS** | **Attribute** | **Attribute Value** | **Comment** | **Reference** | **Page** | **URL** |
|  |  |  | **Primary Data Collection Complete (Yes/No)** |  |  |  |  |  |
|  |  |  | **QA/QC Complete (Yes/No)** |  |  |  |  |  |
|  |  |  | **Scientist Assignment** |  |  |  |  |  |
|  |  |  | **Collection Date** |  |  |  |  |  |
|  |  |  | **QA/QC Assignment** |  |  |  |  |  |
|  |  |  | **QA/QC Date** |  |  |  |  |  |
|  |  |  | **Listed Status (E/T)** |  |  |  |  |  |
|  |  |  | **Designated Critical Habitat (Yes/No)** |  |  |  |  |  |
|  |  |  | **Primary Constituent Elements (PCEs) (Yes/No)** |  |  |  |  |  |
|  |  |  | **Federal Lands/Indian Reservations** |  |  |  |  |  |
|  |  |  | **Locations Known to Occur State (Counties)** |  |  |  |  |  |
|  |  |  | **Map of Range/occurences available? (Yes/No)** |  |  |  |  |  |
|  |  |  | **Range Size** |  |  |  |  |  |
|  |  |  | **Habitat** |  |  |  |  |  |
|  |  |  | **Does species only live in caves? (Yes/No)** |  |  |  |  |  |
|  |  |  | **Population Size** |  |  |  |  |  |
|  |  |  | **Does population growth or modeling information exist? (Yes/No)** |  |  |  |  |  |
|  |  |  | **Holometabolous or hemimetabolous** |  |  |  |  |  |
|  |  |  | **Diapause Timing (Stages during calendar year)** |  |  |  |  |  |
|  |  |  | **Description of lifecycle and associated timing** |  |  |  |  |  |
|  |  |  | **Lifespan (years)** |  |  |  |  |  |
|  |  |  | **Daily activity (Diurnal/Nocturnal)** |  |  |  |  |  |
|  |  |  | **Reproduction Timing** |  |  |  |  |  |
|  |  |  | **Reproduction Frequency** |  |  |  |  |  |
|  |  |  | **Reproduction Output** |  |  |  |  |  |
|  |  |  | **Do Sex Ratio data exist?** |  |  |  |  |  |
|  |  |  | **Does Body Growth Information Exist? (Yes/No)** |  |  |  |  |  |
|  |  |  | **Adult Body Length (cm)** |  |  |  |  |  |
|  |  |  | **Adult Body Weight (g)** |  |  |  |  |  |
|  |  |  | **Diet** |  |  |  |  |  |
|  |  |  | **Larval mass consumption** |  |  |  |  |  |
|  |  |  | **Adult mass consumption** |  |  |  |  |  |
|  |  |  | **Feeding type** |  |  |  |  |  |
|  |  |  | **Aquatic Phase** |  |  |  |  |  |
|  |  |  | **Does species fly? (Yes/No)** |  |  |  |  |  |
|  |  |  | **Elevation (meters)** |  |  |  |  |  |
|  |  |  | **Temperature Range of Species (in °C)** |  |  |  |  |  |
|  |  |  | **Obligate Relationships** |  |  |  |  |  |
|  |  |  | **Additional Comments** |  |  |  |  |  |

1. USFWS. 1984. Recovery plan for the golden coqui. United States Fish and Wildlife Service. Available online at: http://ecos.fws.gov/docs/recovery\_plan/840419c.pdf. [↑](#footnote-ref-1)