**ATTACHMENT 1-21: Biological Information on Listed Species of Plants and Lichens 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 plant and lichen species from the US Fish and Wildlife Service and National Marine Fisheries 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 which may be used to estimate pesticide exposures to listed plants and lichens. This report also focuses on defining species characteristics that may be used to assess potential indirect effects to the species (*e.g.,* pollination, fruit dispersal 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** (**Federally Listed Plant Attribute Database**, dated 8/25/2016). **SUPPLEMENTAL INFORMATION 1** also contains the completed database containing biological information on each listed plant and lichen species.

At this time, there are a total of 895 plant and lichen species, subspecies or populations that are listed as threatened or endangered under the Endangered Species Act (ESA) that occur in the United States. In addition, there are 3 species that are proposed for endangered status, 1 species proposed for threatened status and 62 candidate species (**Table A-21.1**). 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-21.1. Number of Listed Plants/Lichens by Status.**

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| --- | --- |
| **Status** | **Number of listings** |
| Endangered | 731 |
| Threatened | 164 |
| Proposed Endangered | 3 |
| Proposed Threatened | 1 |
| Candidate | 62 |
| Delisted | 3 |
| Not warranted | 5 |
| Total | 969 |

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

There are a total of 961 listings for plants and lichens that will be discussed further in this report and included in pesticide risk assessments. Of these species, 466 have designated critical habitats. The majority of the listed species or subspecies are in the orders Asterales (N= 175), Caryophylalles (N = 110), Lamiales (N = 100), and Fabales (N = 59). **Table A-21.2** contains a list of the number of listed species or subspecies that are represented by each order. **SUPPLEMENTAL INFORMATION 2 (Species Information)** includes the full list of species that will be considered further in these assessments.

**Table A-21.2. Orders of Plants/Lichens that have Listed Species or Subspecies and the Number of Species or Subspecies in Each Order.**

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| --- | --- | --- |
| **Order** | **Common names of species within order** | **Number of listed species/subspecies** |
| Alismatales | Arrowhead and pondweed | 4 |
| Apiales | Carrot | 22 |
| Aquifoliales | Holly | 2 |
| Arecales | Palm | 11 |
| Asparagales | Asparagus and orchid | 21 |
| Asterales | Aster and daisy | 175 |
| Boraginales | Borage, forget-me-not | 13 |
| Brassicales | Cabbage, capers, mustard and nasturtiums | 48 |
| Buxales | Boxwood | 1 |
| Canellales | Chupacallos | 1 |
| Caryophyllales | Carnation | 110 |
| Celastrales | Bittersweet | 1 |
| Cornales | Dogwood | 1 |
| Cucurbitales | Begonia, squash, gourd and cucumber | 4 |
| Ericales | Rhododendron | 45 |
| Fabales | Legume | 59 |
| Fagales | Beech, oaks, walnuts, hickories and birches | 3 |
| Gentianales | Gentian | 43 |
| Geraniales | Geranium | 5 |
| Hymenophyllales | Ferns | 1 |
| Isoetales | Quillwort | 3 |
| Lamiales | Mint | 100 |
| Laurales | Laural | 1 |
| Lecanorales | Lichn-forming fungi | 2 |
| Liliales | Lilly | 15 |
| Linales | Flax | 2 |
| Lycopodiales | Clubmosses, firmosses, spikemosses, and quillworts | 3 |
| Magnoliales | Magnolia | 3 |
| Malpighiales | Willow, violet, spurge, mangrove and coca | 34 |
| Malvales | Hibiscus or mallow | 35 |
| Myrtales | Myrtle | 14 |
| Pinales | Pine | 4 |
| Piperales | Pepper | 3 |
| Poales | Grasses, Sedges and Rushes | 41 |
| Polypodiales | Polypod ferns | 30 |
| Ranunculales | Buttercup | 15 |
| Rosales | Roses | 22 |
| Salviniales | Water spangle and mosquito fern | 1 |
| Santalales | Sandalwood | 6 |
| Sapindales | Citrus | 30 |
| Saxifragales | Saxifrage | 12 |
| Solanales | Nightshades and morning glories | 14 |

1. **Reproductive and Dispersal Mechanisms**
   1. **Pollination Mechanisms**

EPA has assigned all of the included species into potential pollinator classes. These classes are generalized to the following: Abiotic (*e.g.,* wind, water), Insect, Bird, and Mammal. These broad classes will be used to identify potential risks to successful sexual reproduction in plants through direct effects to the animal taxa upon which they rely. **SUPPLEMENTAL INFORMATION 2** (**Pollination Mechanisms**) provides the potential pollinator class assigned for each species. Many species are assigned multiple pollinator classes.

Initial pollinator assignments were made by reviewing the information provided in USFWS documents for each species. If information on potential pollinators was provided in the documents for a given species then EPA assigned the corresponding pollinator classes. When assignments were not clear (*e.g.*, species in the Asteraceae family), EPA relied upon other listed species within the same genus that had identified pollinators in the USFWS documents, as well as applying pollination syndrome assumptions at the genus level. Pollination syndromes are suites of floral characteristics (*e.g.,* color, size, shape) which are broadly associated with different general mechanisms of pollination (*e.g.,* Birds, Beetles, Bats, Bees). Plants vary in their potential successful pollen dispersal mechanisms at species, genus and/or family scales. However, there are some fairly straightforward taxa (species, genera, families and orders) that can easily be assigned a potential pollinator class (*e.g.,* Poaceae, Conifers and Cycads). This was often a relatively simple task of assignment to the Insect class. The Bird and Mammal classes were more often identified as Insect/Bird or Insect/Mammal to account for the uncertainty in the potential pollinator across the Genus where pollinator information was limited or absent.

EPA used the example pollination syndromes found at the following USDA website to verify the assignments made at the generic level: http://www.fs.fed.us/wildflowers/pollinators/What\_is\_Pollination/syndromes.shtml

* 1. **Fruit/Diaspore Dispersal Mechanisms**

Assigning potential routes of dispersal for the diaspore (reproductive unit) is a more complicated process than for pollinator assignments, as not all fruits are adequately described for each species to evaluate potential abiotic or animal dispersal of the fruit. Another complicating factor is that the seed may actually be dispersed by mechanisms independent of those mechanisms by which the encapsulating fruit is dispersed. Because of these factors, EPA assigned species into two categories of dispersal: Abiotic (*e.g.,* wind) and Biotic (*e.g.,* bird, mammal, insect). **SUPPLEMENTAL INFORMATION 2** (**Diaspore Dispersal Mechanisms**) provides the potential fruit/diaspore dispersal class assigned for each species.

In order to compile a list of potential dispersal mechanisms, EPA began by reviewing the information provided in USFWS documents for each species. For species that have dispersal discussed in the available USFWS documents, and for Lichens, Ferns and Fern Allies, the assignments were made based on the provided information as well as accounting for the uncertainty in the biological life history presented in the documents. For example, if a species was mentioned as having a winged fruit, but the discussion of dispersal was insect dispersal of the seed, the species was characterized as having potential dispersal through abiotic and biotic mechanisms. When assignments were not clear (*e.g.*, Asteraceae), EPA relied upon other listed species within the same genus that had identified dispersal mechanisms in the USFWS documents, as well as additional information gathered from botanical literature (e.g., Zomlefer 1994) to identify general fruit types found across the entire family. EPA has considered this information when assigning the species to abiotic or biotic potential dispersal mechanisms.

For the majority of species, additional fruit and seed information will be needed to more accurately identify the broad taxonomic groups associated with fruit/diaspore dispersal beyond the biotic dispersal category.

* 1. **Asexual Mechanisms**

Many plants have evolved mechanisms for asexual reproduction (*e.g.,* bulbs, rhizomes, and tubers). At this time there are few listed species with information on their potential for asexual reproduction. However, it is important to note that any toxicity to a developing seedling or mature plant would be expected to have similar effects on the asexual propagule for that species or a determined surrogate species. The distribution of asexual propagules away from the parent plant may be local (*e.g.,* clonal) or can occur over larger distances through biotic or abiotic mechanisms. Indirect effects to the distribution of asexual propagules over longer distances may occur when these propagules are distributed through biotic mechanisms.

1. **Habitat**

Listed plants were identified as having terrestrial, wetland and/or aquatic habitat. Of the 961 species, 755 reside in terrestrial habitats only, 76 reside in wetland habitats only, 1 resides in aquatic habitats only, 105 have both terrestrial and wetland habitats, and 25 have wetland and aquatic habitats. **SUPPLEMENTAL INFORMATION 2** (**Habitat**) lists the generic habitats associated with the listed plants.

1. **Exposure models**

Potential exposure from direct contact to pesticide via spray drift and run-off 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 spray drift and run-off are assessed using TerrPlant for species with terrestrial and/or wetland habitat and using the Pesticide Root Zone Model (PRZM5) and the Variable Volume Water Model (VVWM) for species with aquatic habitat. **SUPPLEMENTAL INFORMATION 2** (**Habitat**) 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 pollinators and fruit/seed dispersers.

1. **Obligate Relationships**

Of the 961 listed plants considered in this report, 32 are believed to have obligate relationships with other organisms. Of the species believed to have obligate relationships, 17 are obligates with terrestrial invertebrates, 6 are obligates with plants (*e.g.,* host plants for parasitic species), 9 are obligates with fungus (*i.e.,* orchids reliant on mycorrhizal fungus for survival), and 3 are obligates with birds (*e.g.,* hummingbirds). **SUPPLEMENTAL INFORMATION 2** (**Obligate Relationships**) provides information on the obligate relationships identified for listed plants. The remaining species that require pollinators or other organisms to complete their life history do not appear to be associated with only one (or a limited number of) species, and thus are not considered to have obligate relationships.

1. **Geographic Ranges of Listed Species**

Many listed plants have limited geographic ranges, occurring in only one state or territory. Listed species of plants are known to occur in most states. A listing of the states and territories where each listed species is located can be found in **SUPPLEMENTAL INFORMATION 2** (**Species Information**). County-specific location information for each listed species or subspecies is provided in **SUPPLEMENTAL INFORMATION 1**.

1. **Elevation Restrictions**

**SUPPLEMENTAL INFORMATION 2** (**Elevation Restrictions**) lists the elevation restrictions of the 961 listed plants considered in this report. Of these plants, 672 have known elevation restrictions.

1. **Strategy for grouping species**

In order to efficiently assess the risks of a pesticide to listed plants, 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 plants can be broadly separated into five groups: conifers and cycads, ferns and fern allies, dicot flowering plants, monocot flowering plants and lichens. Plants also are lumped according to their habitat (*i.e.,* terrestrial, wetland, and/or aquatic), which influences exposure. Since indirect effects are based on pollinators and diaspore dispersal mechanisms, plants are further lumped based on these categories.

1. **References**

Zomlefer, W.B. 1994. Guide to flowering plant families. Chapel Hill Press.