Integration and Synthesis Summary for Plants, Caribbean Islands

Assessment Group 2*: Ferns and allies
Assessment Group 4: Monocots with abiotic pollination vectors
Assessment Group 5: Monocots reliant on outcrossing with biotic pollination vectors
Assessment Group 6: Monocots reliant on biotic pollination vectors and able to use self-fertilization or vegetative reproduction at least partially to maintain populations over time
Assessment Group 7: Monocots reliant on biotic pollination vectors, other reproductive mechanisms unknown
Assessment Group 8: Dicots reliant on abiotic pollination vectors
Assessment Group 9: Dicots reliant on outcrossing by biotic pollination vectors
Assessment Group 10: Dicots reliant on biotic pollination vectors and able to use self-fertilization or vegetative reproduction at least partially to maintain populations over time
Assessment Group 11: Dicots reliant on biotic pollination vectors, other reproductive mechanisms unknown

*There are no listed lichen or conifer and cycad species in the Caribbean islands, therefore group 1 and 3 assessment documents were not produced

The tables below contain summaries of the information and data we used to determine the ranking (high, medium, low) for vulnerability, risk and usage indicators. Information in most of the columns was used directly in the ranking determination (green fill). Where indicated, information in other columns was not used directly in the ranking calculation, but provided additional information about the species that fed into one of the ranking metrics or was used to make the draft determination when relevant. The assessment group summaries for the Caribbean plants also include new conservation measures[1] that have been incorporated into the Action since the draft biological opinion was released. The measures and our related assumptions are incorporated into our analysis (immediately above Table 3), and also factor into the rationales for our conclusions for each species, as described below.

All species in Group 2 are ferns or lycophytes, fern "allies." They do not have flowers or seeds and reproduce sexually via spores pollinated and dispersed by wind. Ferns and their allies can also reproduce asexually, through vegetative reproduction in the form of bulbets or rhizomes. During sexual reproduction, ferns produce two free-living generations, a diploid sporophyte (what we think of as a fern plant) and a haploid gametophyte. The gametophytes are typically very small (around ½ inch), fragile and have very specific requirements for growth, such as damp soil conditions and high humidity.

All species in Groups 4 through 7 are monocots, a class of angiosperm flowering plant defined by having only one cotyledon (embryonic seed leaves). There are a large variety of monocot species, typical monocot plants include grasses, lilies and palms. The monocots in assessment group 4 use abiotic vectors to accomplish pollination, such as wind and water. Species in assessment group 5 need to achieve outcrossing (pollen transfer between individuals), in order to reproduce successfully and maintain their populations over time. Species in assessment group 6 use biotic vectors to accomplish pollination, but can also rely on self-fertilization or asexual reproduction at least partially in order to maintain their populations over time. Species in assessment group 7 utilize biotic vectors to accomplish pollination, such as insects; other aspects of their reproductive mechanisms are unknown. Seed dispersal for all monocots is achieved by biotic (dispersed by birds and mammals) and/or abiotic (dispersal by wind, water or gravity) means.

All species in Groups 8 through 11 are dicots, a class of angiosperm flowering plant defined by having two cotyledons (embryonic seed leaves). Dicots are a hugely diverse class of flowering plants, with tens of thousands of species. Familiar dicots include plants such as daisies, roses and oak trees. The dicots in assessment group 8 use abiotic vectors to accomplish pollination, such as wind and water. Species in assessment group 9 need to achieve outcrossing (pollen transfer between individuals) in order to reproduce successfully and maintain their populations over time. Species in assessment group 10 use biotic vectors to accomplish pollination, but can also rely on self-fertilization or asexual reproduction at least partially in order to maintain their populations over time. Species in assessment group 11 utilize biotic vectors to accomplish pollination, such as insects; other aspects of their reproductive mechanisms are unknown. Seed dispersal for all dicots is achieved by biotic (dispersed by birds and mammals) and/or abiotic (dispersal by wind, water or gravity) means.

[1] Additional information on these new conservation measures can be found in the Description of the Action section of this biological opinion.

Table 1: Summarizing Data and Information for Vulnerability Ranking

Data Sources: Status of the Species (SOS) accounts updated as of November 2019 (Appendix C); NA=Not Applicable; PR=Puerto Rico, VI=American Virgin Islands

Scientific Name	Common Name	Assessment Group	Location	Status	Population Level Trends	Species Level Trends	Number of Populations	Distribution	Number of Individuals	Pesticides Listed as a Threat	Pollinator Loss Listed as a Threat	Vulnerability Ranking
Adiantum vivesii	No common name	2	PR	Endangered	One individual (USFWS, 2008)	Sterile hybrid (USFWS, 2008)	0 (USFWS, 2008)	It is known from only one population in a privately-owned limestone hill in Quebradillas, Puerto Rico. Proctor (1991) estimated 1,000 plants, or growing apices, at the locality. Sepulveda-Orengo (2000) located and measured the extent of the population, finding an area of 21m x l0m (68.9 ft. x 32.8 ft.). (USFWS 2008)	1 (USFWS, 2008)	No Mention	No Mention	High
Agave eggersiana	No common name	5	VI	Endangered	Decreasing (USFWS, 2013)	Decreasing (USFWS, 2013)	7 native; 3 introduced (USFWS, 2013)	*Agave eggersiana* is currently found on the north and south coasts of St. Croix, USVI. Seven populations support approximately 313 adult plants and more than 316 juveniles. The current distribution of populations of *Agave eggersiana* on St. Croix that are presumed to be wild is as follows: a. North coast—(1) Gallows Bay with an estimate of 2 individuals; and (2) Protestant Cay with an estimated 40 individuals. b. South coast—(3) Manchenil Bay with an estimated 8 individuals; (4) West side of Vagthus point with a single individual; (5) Great Pond with approximately 65 individuals; (6) South Shore with an estimate of 182 individuals; and (7) Cane Garden Bay with 15 individuals. Most of the sites have juvenile individuals except for Gallows Bay and Vagthus Point. In addition, there are introduced individuals located at Salt River National Park and Ecological Preserve (SARI) with an estimate of 90 individuals (mostly juveniles); Buck Island National Monument with an estimate of 11 individuals; and Ruth Island with 1 individual (O. Monsegur and M. Vargas, Service, pers. obs., 2010 and 2013; Dalmita-Smith, DPNR, pers. comm., 2010). (USFWS, 2013)	300+ adults and 300+ juveniles (USFWS, 2013)	No Mention	No Mention	High

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Aristida chaseae	No common name	4	PR	Endangered	Not Available	Improving (USFWS, 2010)	2 (see current range/distribution)	Known from two sites: the CRNWR and the upper slopes of the Cerro Mariquita in Sierra Bermeja. (USFWS, 2010)	> 1,000 (inferred from USFWS, 2010)	No Mention	No Mention	High
Aristida portoricensis	Pelos del diablo	4	PR	Endangered	Not Available	Stable (USFWS, 2010)	2 (see current range/distribution)	*A. portoricensis* is not endemic to Puerto Rico and its current range of the species includes Puerto Rico and Cuba. Pelos del diablo is currently known from Cerro Mariquita in Sierra Bermeja. Pelos del diablo has not been observed at the historic site known as Cerro Las Mesas. (USFWS, 2010).	Not available (USFWS, 2010)	No Mention	No Mention	High
Auerodendron pauciflorum	No common name	11	PR	Endangered	Not Available	Unknown (USFWS, 2011)	1 (USFWS, 2011)	Currently known only from the limestone hill region on the northern karst of Puerto Rico. (USFWS, 2011)	~21 (USFWS, 2011)	No Mention	No Mention	High
Banara vanderbiltii	Palo de ramon	11	PR	Endangered	Increasing (USFWS, 2014)	Unknown (USFWS, 2014)	10 (USFWS, 2014)	Known to exist in two populations, five at the central mountain “Tetas de Cayey” site and six in the Rio Lajas limestone hills near Bayamon in northwestern Puerto Rico. Both of these known populations occur on private land. (USFWS, 1991)	201 (USFWS, 2014)	No Mention	No Mention	High
Buxus vahlii	Vahl's boxwood	11	PR, VI	Endangered	Increasing (USFWS, 2013)	Not Available	9 (USFWS, 2013)	Endemic to the island of Puerto Rico, where it is known from only two locations within the karst region on the northern side of the island. (USFWS, 1987)	> 4,000 (USFWS, 2013)	No Mention	No Mention	High
Callicarpa ampla	Capa rosa	11	PR	Endangered	Unknown (USFWS, 2015)	Unknown (USFWS, 2015)	5 (USFWS, 2015)	Known from the lower montane forests of Puerto Rico (Ewel and Whitmore 1973) and one from St. Thomas, U.S. Virgin Islands (Vivaldi and Woodbury). (USFWS, 1993)	~15 total individuals (USFWS< 2015)	No Mention	No Mention	High
Calyptranthes thomasiana	No common name	11	VI, VI-British	Endangered	Decreasing (USFWS, 2013)	Unknown (USFWS, 2013)	2 (USFWS, 2013)	Currently, the species is known only from St. John and Virgin Gorda (USFWS, 2013).	59 (USFWS, 2013)	No Mention	No Mention	High
Calyptronoma rivalis	Palma de manaca	7	PR, Hispaniola (Dominican Republic)	Threatened	Increasing (USFWS, 2009)	Increasing (USFWS, 2009)	8 (USFWS, 2009)	Endemic to Puerto Rico, where it grows along streambanks in the semi—evergreen forests of the karst region. Three natural populations, composed of approximately 275 individuals, are known from the Camuy, Quebradillas, and San Sebastian area. (USFWS, 1992)	~1,154 (USFWS, 2009)	No Mention	No Mention	Medium

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Catesbaea melanocarpa	No common name	11	PR, VI	Endangered	Not Available	Stable (USFWS, 2011)	3 (USFWS, 2018)	*Catesbaea melanocarpa* is currently known from five islands in the Caribbean; U. S. Virgin Islands, Puerto Rico, Barbuda, Antigua, and Guadeloupe. In 2011, the population was estimated to be 132 individuals from 4 populations in the USVI and PR (USFWS 2011). In 2018, there were approximately 547 wild individuals known from three locations within the U.S. Territories in the Caribbean, 522 individuals in the U.S. Virgin Islands, and 13 in Puerto Rico. Although increased effort has led to the discovery of more individuals in the USVI, the number of individuals in Puerto Rico has gone down and one of the populations in Puerto Rico appears to have disappeared since 2011. The population at the Guánica Commonwealth Forest in Puerto Rico remains relatively protected at this time (USFWS, 2018).	547 (535 wild, 12 propagated) (USFWS, 2018)	No Mention	No Mention	High
Chamaecrista glandulosa var. mirabilis	No common name	9	PR	Endangered	Unknown (USFWS, 2015)	Unknown (USFWS, 2015)	4 (USFWS, 2015)	*Chamaecrista glandulosa var. mirabilis* occurs in the north central coastal plain of Puerto Rico (USFWS, 2015)	Unknown (USFWS, 2015)	No Mention	No Mention	High
Cordia bellonis	No common name	10	PR	Endangered	Not Available	Not Available	Not Available	It is known from only three public forests: Maricao, Susua, and Rio Abajo in Puerto Rico (USFWS, 1999).	~81 (USFWS, 1999)	No Mention	No Mention	High
Cornutia obovata	Palo de nigua	9	PR	Endangered	Unknown (USFWS, 2014)	Unknown (USFWS, 2014)	7 (EPA, 2016)	*C. obovata* currently exists within the following natural areas: Monte Torrecilla, Susúa Commonwealth Forest, Río Abajo Commonwealth Forest, Sumidero Tres Pueblos, and the Arecibo Observatory (USFWS, 2014).	~19 (USFWS, 2014)	No Mention	No Mention	High
Cranichis ricartii	No common name	6	PR	Endangered	Not Available	Not Available	3 (USFWS, 1995)	Currently known from five discrete sites in the sierra palm, palo colorado, and dwarf forests of the Caribbean National Forest. *Cranichis ricartii* has been found at only three locations in the Maricao Forest in western Puerto Rico (USFWS, 1995).	~30 (USFWS, 1995)	No Mention	No Mention	High

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Crescentia portoricensis	Higuero de sierra	9	PR	Endangered	Not Available	Not Available	7 (USFWS, 1991)	Presently known from only 7 sites in Puerto Rico: five within the Maricao Commonwealth Forest and two within the nearby Susua Commonwealth Forest (USFWS, 1991).	~100 (USFWS, 1991)	No Mention	No Mention	High
Cyathea dryopteroides	Elfin tree fern	2	PR	Endangered	Unknown (USFWS, 2013)	Uncertain (USFWS, 2013)	4 (USFWS, 2013)	Only three populations are known for the elfin tree fern. It is found on three peaks located approximately 12 miles (20 kilometers) apart, Monte Guilarte, Cerro Rosa and Monte Jayuya. A total of approximately 95 individuals have been located at these three sites. (USFWS, 1990)	Not Available	No Mention	No Mention	High
Daphnopsis helleriana	No common name	11	PR	Endangered	Not Available	Stable (USFWS, 2013)	Not Available	At present, *D. helleriana* is found in the municipalities of Isabela/Quebradillas, Arecibo, Vega Baja, Dorado, and Toa Baja. Introduced individuals, are located in Guajataca, Río Abajo, and Cambalache Commonwealth Forests (USFWS, 2013).	~1,029 (USFWS, 2013)	No Mention	No Mention	High
Elaphoglossum serpens	No common name	2	PR	Endangered	Not Available	Unknown (USFWS, 2010)	1 (USFWS, 2010)	Found at a single site in the montane dwarf forest of the summit of Cerro Punta in the central mountains, municipality of Jayuya. (USFWS, 1994)	22 (USFWS, 2010)	No Mention	No Mention	High
Eugenia haematocarpa	Uvillo	9	PR	Endangered	Unknown (USFWS, 2014)	Increasing (USFWS, 2014)	9 (USFWS, 2014)	Uvillo was originally reported from the Luquillo Mountains and from a single locality within the Sierra de Cayey. The range within the Cayey region has expanded to include four additional localities, as new populations have been discovered in this area. Therefore, we expect that further populations may occur within this area, including within the boundaries of the Carite Commonwealth Forest. Furthermore, during the last decade, at least three new populations have been reported in the municipality of Isabela, extending its distribution now to the northwestern corner of Puerto Rico (USFWS, 2014).	247 (USFWS, 2014)	No Mention	No Mention	Medium
Eugenia woodburyana	No common name	11	PR	Endangered	Not Available	Not Available	3 (USFWS, 1994)	Currently known from the range of hills known as the Sierra Bermeja in the municipalities of Cabo Rojo and Lajas, Puerto Rico. Some individuals are located on land	~45 (USFWS, 1994)	No Mention	No Mention	High

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								recently added to the Laguna Cartagena National Wildlife Refuge and others are located on adjacent private land. The species is also known from the Guánica Commonwealth Forest in Guánica. An additional individual has been reported from the Cabo Rojo National Wildlife Refuge, adjacent to the Sierra Bermeja. Approximately 150 individuals are known from these localities (USFWS, 1998).				
Gesneria pauciflora	No common name	9	PR	Threatened	Not Available	Stable (USFWS, 2013)	4 (USFWS, 2013)	At the time of listing and when the recovery plan was signed, only three populations of this small shrub were known to exist in the western mountains of Maricao and Sabana Grande municipalities. Two of the three known populations are located in the Maricao Commonwealth Forest (MCF). The third locality lies on a Lajas River tributary outside of the MCF boundaries. Herbarium specimens indicate that the species has also been collected in the past from the Yagüez River and from “Cerro Las Mesas” in the Mayagüez municipality, but these sites have not been intensively surveyed (USFWS, 1998).	> 800 - 1,500 (USFWS, 2013)	No Mention	No Mention	High
Goetzea elegans	Beautiful goetzea	9	PR	Endangered	Not Available	Increasing (USFWS, 2013)	16 (USFWS, 2015)	The species is present in ten localities within the municipalities of Isabela and Quebradillas, one locality in Fajardo, and five localities in the island of Vieques (USFWS, 2013).	1,700 (USFWS, 2013)	No Mention	No Mention	Medium
Gonocalyx concolor	No common name	9	PR	Endangered	Not Available	Not Available	3 (USFWS, 2013)	It currently occurs at Cerro La Santa and Charco Azul, both in the Carite Commonwealth Forest (Pacheco and Monsegur, Service, unpubl. report, 2013, p. 2) (USFWS, 2013).	Not Available	No Mention	No Mention	High
Harrisia portoricensis	Higo Chumbo	10	PR	Threatened	Not Available	Stable (USFWS, 2013)	3 (USFWS, 2013)	Currently known only from three islands located to the west of Puerto Rico in the Mona Passage: Mona, Monito, and Desecheo (USFWS, 1996).	~20,000 - 50,000 (USFWS, 2013)	No Mention	No Mention	High
Ilex cookii	Cook's holly	11	PR	Endangered	Unknown (USFWS, 2013)	Unknown (USFWS, 2013)	5 (USFWS, 2013)	It is currently known from only seven herbarium collections, all from Cerro Punta and Monte Jayuya (USFWS, 2013).	35 (USFWS, 2013)	No Mention	No Mention	High

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Ilex sintenisii	No common name	11	PR	Endangered	Unknown (USFWS, 2015)	Unknown (USFWS, 2015)	23 subpopulations (USFWS, 2015)	Specimens originally collected in the upper elevations of the Luquillo Mountains, Puerto Rico. (USFWS, 1993)	~465 total individuals (USFWS, 2015)	No Mention	No Mention	High
Juglans jamaicensis	West Indian Walnut (=Nogal)	8	PR	Endangered	Not Available	Not Available	One (USFWS, 2013)	Known from Cuba, Hispaniola, and Puerto Rico, but little information is currently available on its status in the first two countries (Liogier and Martorell 1982). The Center for Plant Conservation (1992) described it as “not common” and Proctor (1992) stated it was becoming increasingly rare on these two islands (USFWS, 1999).	~31 individuals (USFWS, 2013)	No Mention	Unknown pollination biology for this species including presumption of wind-pollination (USFWS, 2019).	High
Lepanthes eltoroensis	No common name	6	PR	Endangered	Increasing (USFWS, 2015)	Not Available	Six-subpopulations (USFWS, 2015)	Known from six discrete sites in the Caribbean National Forest, the palm forest to the east of El Toro, and the colorado and dwarf forests to the west and south of this same peak, all at elevations greater than 750 meters. Approximately 360 individuals have been reported from the Forest (Tremblay, personal communication). The species has been reported from several species of trees, all supporting abundant mosses and liverworts. Collectors apparently eliminated the palm forest population between 1969 and 1975 (Vivaldi et al. 1981) (USFWS, 1995).	~3,000 plants (USFWS, 2015)	No Mention	No Mention	High
Leptocereus grantianus	No common name	11	PR	Endangered	Increasing (USFWS, 2015)	Not Available	Six (USFWS, 2015)	Known only from one location on Culebra, an island off the northeastern coast of Puerto Rico. The one known population, which consists of approximately 50 individuals, occurs in dry thickets along a rocky shore near Punta Melones, on the southwestern part of the island (USFWS, 1994).	267 total individuals (USFWS, 2015)	No Mention	No Mention	High
Lyonia truncata var. proctorii	No common name	9	PR	Endangered	Not Available	Stable (USFWS, 2010)	1 (USFWS, 2010)	Endemic to Puerto Rico and are known to occur only in the summit area of Cerro Mariquita in the Sierra Bermeja, municipality	63 (USFWS 2010)	No Mention	No Mention	High

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								of Cabo Rojo. Elevations range from 270 to 300 meters (USFWS, 1994).				
Mitracarpus maxwelliae	No common name	11	PR	Endangered	Increasing (USFWS, 2011)	Not Available	Four (USFWS, 2011)	Known from only one locality in the Guanica Commonwealth Forest, Guanica, Puerto Rico (USFWS, 1998).	1,443 - 1,882 plants (USFWS, 2011).	No Mention	No Mention	High
Mitracarpus polycladus	No common name	11	PR	Endangered	Increasing (USFWS, 2011)	Not Available	Four (USFWS, 20110)	Known from only one location in Puerto Rico, in the Guanica Commonwealth Forest in the municipality of Guayanilla, Puerto Rico, where it grows in crevices and soil pockets of coastal rocks in arid areas (Figure 1). Exact numbers of individuals have been difficult to estimate due to extreme drought conditions in recent years. It is also known from the island of Saba in the Lesser Antilles (Proctor 199 ib). (USFWS, 1998)	1,400 mature plants and 1,500 seedlings (USFWS, 2011)	No Mention	No Mention	High
Myrcia paganii	No common name	11	PR	Endangered	Not Available	Not Available	3 (USFWS, 1996)	Currently known from 3 locations in the limestone hill region of the northwestern part of Puerto Rico (USFWS, 1996).	8 individuals total (USFWS, 1996)	No Mention	No Mention	High
Ottoschulzia rhodoxylon	Palo de rosa	11	PR	Endangered	Not Available	Not Available	16 (USFWS, 1994)	In Puerto Rico, known in the following areas of western Puerto Rico: Guaynabo; Quebradillas/Isabela; Cambalache Commonwealth Forest: Guanica Commonwealth Forest; Maricao Commonwealth Forest; Susua Commonwealth Forest; and the Sierra Bermeja in Cabo Rojo (USFWS, 1994).	~ 200 individuals (USFWS, 1994)	No Mention	No Mention	High
Peperomia wheeleri	Wheeler's peperomia	10	PR	Endangered	Increasing (USFWS, 2014)	Increasing (USFWS, 2014)	Four (USFWS, 2014)	Known only from Culebra, a small island approximately 27 kilometers to the east of Puerto Rico. The species has not been reported from adjacent small islands or the main island of Puerto Rico (USFWS, 1990)	~ 1,400 (USFWS, 2014)	No Mention	No Mention	Medium
Pleodendron macranthum	Chupacallos	11	PR	Endangered	Not Available	Not Available	~10 (USFWS, 2014)	Known from the Caribbean National Forest and the Rio Abajo Commonwealth Forest, which are administered by the USDA Forest Service and the Department of Natural and Environmental Resources (USFWS, 1998).	~97 total individuals (USFWS, 2014)	No Mention	No Mention	High

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Polystichum calderonense	No common name	2	PR	Endangered	Not Available	Uncertain (USFWS, 2010)	2 (USFWS, 2010)	*Polystichum calderonense* is a terrestrial fern that when listed, was known only from the summit of La Silla de Calderon in the Guilarte Commonwealth Forest, and from a private property in Monte Cerrote, in the municipality of Peiiuelas (Proctor 1991, USFWS 2010). For these two populations, Proctor (1991) reported 45 and 12 individuals, respectively. However, Jeanine Velez (University of Puerto Rico, Mayaguez Campus) described a third population at the Summit of Monte Guilarte (pers. comm. as cited in Possley and Lange 2016), the fifth highest peak in Puerto Rico (elevation 3,934 ft (1,199 m)). Nevertheless, Possley and Lange (2017) surveyed the area and were unable to find any individuals. An average of 14 plants and recruitment were reported at Silla de Calderon between 2014 and 2017 (Possley and Lange 2017). During these surveys, Possley and Lange (2017) along with Service staff noticed invasive plants species encroaching the area, and remnants of human induced fires just neighboring the *P. calderonenses* individuals. On both localities (i.e., Silla Calderon and Monte Guilarte) Possley and Lange (2017) also discovered pockets of suitable habitat for the species. The current status of *P. calderonense* at Monte Cerrote remains unknown. This area has not been surveyed since 1991 (USFWS, 2019).	< 100 (USFWS, 2010)	No Mention	No Mention	High
Schoepfia arenaria	No common name	11	PR	Threatened	Not Available	Not Available	Four (USFWS, 1991)	known from four sites in Puerto Rico: Isabela, Pinones, Fajardo, and the Rio Abajo Commonwealth Forest. (USFWS, 1991)	~190 total indivduals (USFWS, 1991)	No Mention	No Mention	High
Solanum conocarpum	Marron bacora	9 (2019 SSA)	VI	Proposed Endangered	Not Available	Not Available	7 in the USVI (2019 SSA)	Tropical dry forest shrub known only from St. John in the U.S. Virgin Islands (USVI) and the British Virgin Islands. Six of the known populations on National Park Service lands in the USVI (2019 SSA).	324 (2019 SSA)	No Mention	No Mention	High

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Solanum drymophilum	Erubia	11	PR	Endangered	Not Available	Unknown (USFWS, 2015)	1 (USFWS 2015)	Known from the Salinas site in east-central Puerto Rico, and at sites in the municipalities of Florida and Arecibo in northern Puerto Rico (USFWS, 2015).	150 - 200 (USFWS, 2015)	No Mention	No Mention	High
Stahlia monosperma	Cobana negra	11	PR, Dominican Repubic	Threatened	Decreasing (USFWS, 2014)	Not Available	Nine (USFWS, 2014)	At present, natural populations of Cóbana negra are found in nine areas: Punta Ventana, Punta Guaniquilla, Laguna Joyuda, Punta Melones, Road PR 307 (Boquerón Country Club), near Villa Taina, Sierra Bermeja, Punta Picúa, and Vieques Island (Table 2). Additionally, based on a propagation effort conducted for more than 13 years, the species has been planted at least 18 municipalities throughout Puerto Rico (Figure 3). This information does not include those individuals that have been planted as part of reforestation efforts and public education, and those that have been planted island-wide around public parks, and along state and rural roads and private parcels (USFWS, 2014).	~200 total individuals (USFWS, 2014)	No Mention	No Mention	High
Styrax portoricensis	Palo de jazmin	11	PR	Endangered	Unknown (USFWS, 2015)	Unknown (USFWS, 2015)	One (USFWS, 2015)	All the currently known localities of *Callicarpa ampla, Ilex sintenisii, Styrax portoricensis, Ternstroemia luquillensis,* and *Ternstroemia subsessilis* occur within the Caribbean National Forest, which is administered by the USDA Forest Service. The following are known sites for the species: Barrio Guzman Arriba. Rio Grande municipality. Only a single tree is known, growing west of El Cacique (USFWS, 1993).	~19 individuals (USFWS, 2015)	No Mention	No Mention	High
Tectaria estremerana	No common name	2	PR	Endangered	Not Available	Not Available	3 (USFWS, 2010)	Known from only one site located in the municipality of Arecibo, within the property of the Arecibo Radio Telescope managed by Cornell University under a cooperative agreement from National Science Foundation. Approximately 23 individual plants were found in the area (Proctor 1989). Dr. Franklin Axelrod, in a letter dated September 9, 1994, mentioned that this species was collected by him in the Rio Abajo Commonwealth Forest in Arecibo and in a sinkhole near an old	23+ (USFWS, 2010)	No Mention	No Mention	High

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								quarry in Florida, Abajo Ward in the municipality of Florida. (USFWS, 1994)				
Ternstroemia luquillensis	Palo colorado	11	PR	Endangered	Unknown (USFWS, 2015)	Unknown (USFWS, 2015)	Four (USFWS, 2015)	*Ternstroemia luquillensis* (palo colorado) is an evergreen tree only known from six individuals within the palo colorado and dwarf forests of the Luquillo Mountains (USFWS, 1993).	Six total individuals (USFWS, 2015)	No Mention	No Mention	High
Ternstroemia subsessilis	No common name	11	PR	Endangered	Unknown (USFWS, 2015)	Unknown (USFWS, 2015)	Four (USFWS, 2015)	USFWS (2015) notes that there are 4 populations, all within the Luquillo Mountains.	37 total individuals (USFWS, 2015)	No Mention	No Mention	High
Thelypteris inabonensis	No common name	2	PR	Endangered	Declining (USFWS, 1994)	Unknown (USFWS, 2015)	2 (USFWS, 1994)	Known from two localities in the Toro Negro Commonwealth Forest: the headwaters of the Rio Inabon in Ponce and Cerro Rosa in Ciales. Forty-six plants were counted in both localities combined (Proctor 1991) (USFWS, 1994)	46 (USFWS, 1994)	No Mention	No Mention	High
Thelypteris verecunda	No common name	2	PR	Endangered	Not Available	Unknown (USFWS, 2015)	3 (USFWS, 1994)	It is found at three localities: Charcas Ward in Quebradillas, Bayaney Ward in Hatillo, and Cidral Ward in the municipality of San Sebastian. In Bayaney Ward about 20 plants are known (Proctor 1991). All of these localities are privately owned lands. (USFWS, 1994)	Not Available	No Mention	No Mention	High
Thelypteris yaucoensis	No common name	2	PR	Endangered	Not Available	Unknown (USFWS, 2015)	3 (USFWS, 1994)	*Thelypteris yaucoensis* is known from Los Tres Picachos in the municipality of Ciales, and from two other private properties in the municipality of Yauco: Pico Rodadero, Sierra Alta and at Rubias Wards. Current population estimates for each location is unclear, however, Proctor (1991) reported 65 individuals for all three sites. Nonetheless, Possley and Lange (2016) re- discovered the species at Pico Rodadero and documented about 59 plants of what seemed to be *T. yaucoensis*. Morphological similarities with *T. sclerophylla* pose taxonomical questions on the identity of *T. yaucoensis* (Possley and Lange 2016, 2017). Currently, tissue samples are being analyzed at the University of Florida (Possley and Lange	65 (USFWS, 1994)	No Mention	No Mention	High

Scientific Name	Common Name	Assessment Group	Location	Status	Population Level Trends	Species Level Trends	Number of Populations	Distribution	Number of Individuals	Pesticides Listed as a Threat	Pollinator Loss Listed as a Threat	Vulnerability Ranking
								2017). The other two localities, Los Tres Picachos and Rubias Ward, have not been visited since 1991 and, therefore, their current status remains unknown. Furthermore, it is unclear if the population of *T. yauconenis* at Los Tres Picachos lies within the boundaries of the area managed for conservation by the Puerto Rico Department of Natural and Environmental Resources. *Thelypteris inabonensis* is only known from two localities within the Toro Negro Commonwealth Forest: headwaters of Rio Inabon, and Cerro Rosa, where 34 and 12 plants were reported by Proctor (1991), respectively (USFWS 2010). Neither of these populations have been visited since 1991 and, therefore, their current status is unknown.				
Trichilia triacantha	Bariaco	10	PR	Endangered	Not Available	Not Available	~15 (USFWS, 2012)	Specimens and population sites located with uncertainties smaller than 300 m occur at elevations from 25 to 175 m above sea level (Ventosa, 2007), on soils of the following series: Pitahaya-Limestone outcrop-Seboruco complex, La Covana-Limestone outcrop-Seboruco complex, Seboruco gravelly clay, El Papayo gravelly clay loam, Aguilita stony clay, San Germán-Duey complex, Tuque stony clay, and Yauco silty clay loam, most of them on slopes of 20-60%. Other specimen localities, but with inaccurate locality descriptions (inaccuracies from 2,000 to 15,620 m), were collected within the municipalities of Guánica, Yauco or Peñuelas (USFWS, 2012).	~162 total plants (USFWS, 2012)	No Mention	No Mention	High
Varronia rupicola	No common name	11	PR, VI-British	Threatened	Not Available	Not Available	Not Available	*Varronia rupicola* is currently known from at least seven main localities in Puerto Rico (Table 2) and several localities from the island of Anegada. Monsegur and Breckon (2007, p. 1) visited the historical localities in Puerto Rico and provided updated information about the status and distribution	Not Available	No Mention	No Mention	High

Scientific Name	Common Name	Assessment Group	Location	Status	Population Level Trends	Species Level Trends	Number of Populations	Distribution	Number of Individuals	Pesticides Listed as a Threat	Pollinator Loss Listed as a Threat	Vulnerability Ranking
								of the species. The distribution of *V. rupicola* in the Gua´nica Commonwealth Forest extents to at least six small populations or subpopulations within the east section of the forest. Another population was located on the west unit of the Gua´nica Commonwealth Forest by Alcides Morales (Sociedad Ornitologica Puertoriquena, Inc., pers. comm., 2012). This is the westernmost recorded distribution for the species. From the municipality of Penuelas, Monsegur and Breckon (2007, p. 6) found a single individual in a ravine area on the west side of El Peno´n site. This seems to be part of the same population identified by Breckon and Kolterman in 1995. In addition, the Service confirmed the presence of about eight clusters of the species in an area just north of the Ponce Holiday Inn in the municipality of Ponce (O. Monsegur, Service, and J. Sustache, DNER, unpubl. Data, 2013) (USFWS, 2014).				
Vernonia proctorii	No common name	11	PR	Endangered	Not Available	Not Available	Two (USFWS, 2019)	This species in known only from a small area near the Cerro Mariquita mountain peak in southwest Puerto Rico. Approximately 80% of the known individual plants are protected within the Cartagena Lagoon National Wildlife Refuge (2019 5-year Status Review).	~200 (USFWS, 2019)	No Mention	No Mention	High
Zanthoxylum thomasianum	St. Thomas prickly-ash	9	PR, VI	Endangered	Not Available	Not Available	5 (USFWS, 2015)	The available information on the distribution of St. Thomas prickly-ash indicates that its distribution includes the islands of St. Thomas and St. John in U.S. Virgin Islands, the municipalities of Coamo, Salinas, and Isabela in Puerto Rico (USFWS 1988), and later reported in the British Virgin Islands in Gorda Peak National Park on Virgin Gorda (Clubbe et al. 2003), and at Hawk's Nest on Tortola (Pascoe 2014) (USFWS, 2015).	6 to 116 per population (USFWS, 2015)	No Mention	No Mention	High

*Information in this column was used to inform the ranking metrics or the draft determination when relevant.

Risk Summaries

Risk to Individuals if exposed:
The individual plants in assessment groups 4-7 are not expected to experience effects to growth or survival from exposure to malathion. Individual plants in assessment groups 2 and 8-11 are estimated to experience up to a 12% decrease in dry weight if exposed to malathion on the following use sites, based on labeled application rates: orchards and vineyards, developed, nurseries, open space developed and Christmas trees. No effects are expected on other use sites.

Assessment Group 2:
Risk to Individuals, Pollinators and seed dispersers if exposed: The individual plants in this assessment group are estimated to experience up to a 12% decrease in dry weight if exposed to malathion on the following use sites, based on labeled application rates: orchards and vineyards, developed, nurseries, open space developed and Christmas trees. No effects are expected on other use sites. Ferns and their allies do not rely on animal species for pollination or seed dispersal, thus no effects are expected to these plants from loss in seed dispersers from malathion exposure across use sites within their ranges. The Fadang (a cycad) utilizes unknown biotic seed dispersers. Mortality is expected for insect seed dispersers exposed to malathion on use sites or via spray drift. Some bird seed dispersers exposed to malathion on use sites may experience mortality or sublethal effects, depending on the site of exposure and size of the bird. Smaller birds exposed on use sites with higher allowable use rates (e.g., developed, open space developed, orchards and vineyards) have a greater chance of being affected. Exposure to spray drift is not expected to result in effects to bird seed dispersers. No effects (mortality or sublethal) are expected for mammalian seed dispersers from malathion exposure either on use sites or from spray drift.

Assessment Group 4:
Risk to Individuals, Pollinators and seed dispersers if exposed: The individual plants in this assessment group are not expected to experience effects to growth or survival from exposure to malathion. The monocots in this assessment group do not rely on animal species for pollination, thus no effects are expected to these plants from loss in pollinator populations from malathion exposure across use sites within their ranges. Mortality is expected for insect seed dispersers exposed to malathion on use sites or via spray drift. Some bird seed dispersers exposed to malathion on use sites may experience mortality or sublethal effects, depending on the site of exposure and size of the bird. Smaller birds exposed on use sites with higher allowable use rates (e.g., developed, open space developed, orchards and vineyards) have a greater chance of being affected. Exposure to spray drift is not expected to result in effects to bird seed dispersers. No effects (mortality or sublethal effects) are expected for mammalian seed dispersers from malathion exposure either on use sites or from spray drift.

Group 5:
Risk to Individuals, Pollinators and seed dispersers if exposed: The individual plants in this assessment group are not expected to experience effects to growth or survival from exposure to malathion. Mortality is expected for insect pollinators and seed dispersers exposed to malathion on use sites, via spray drift, and from mosquito control applications. Because terrestrial invertebrates exhibit a range of sensitivities to malathion, insect abundance is expected to be reduced where exposure occurs, but not completely eliminated. However, some species are likely to incur greater levels of mortality than others based on their sensitivity. As plants often have unknown or specific pollinators and seed dispersers for which toxicity data is unavailable, we assume insects that pollinate or disperse the seeds of listed plants are sensitive to malathion, and that exposure will cause mortality. In field studies, reductions of common insect species following pesticide exposure are often temporary with recovery over a short period of time. However, since listed plants may be reliant on insect pollinators or seed dispersers that are limited in range or abundance, these insect species may be less likely to recover following pesticide exposure. Some bird pollinators and seed dispersers exposed to malathion on use sites may experience mortality or sublethal effects, depending on the site of exposure and size of the bird. Smaller birds exposed on use sites with higher allowable use rates (e.g., developed, open space developed, orchards and vineyards) have a greater chance of being affected. Exposure to spray drift is not expected to result in effects to bird seed dispersers. No effects (mortality or sublethal effects) are expected for mammalian pollinators or seed dispersers from malathion exposure either on use sites or from spray drift.

Group 6:
Risk to Individuals, Pollinators and Seed dispersers if exposed: The individual plants in this assessment group are not expected to experience effects to growth or survival from exposure to malathion. Mortality is expected for insect pollinators and seed dispersers exposed to malathion on use sites, via spray drift, and from mosquito control applications. Because terrestrial invertebrates exhibit a range of sensitivities to malathion, insect abundance is expected to be reduced where exposure occurs, but not completely eliminated. However, some species are likely to incur greater levels of mortality than others based on their sensitivity. As plants often have unknown or specific pollinators and seed dispersers for which toxicity data is unavailable, we assume insects that pollinate or disperse the seeds of listed plants are sensitive to malathion, and that exposure will cause mortality. In field studies, reductions of common insect species following pesticide exposure are often temporary with recovery over a short period of time. However, since listed plants may be reliant on insect pollinators or seed dispersers that are limited in range or abundance, these insect species may be less likely to recover following pesticide exposure. Some bird pollinators and seed dispersers exposed to malathion on use sites may experience mortality or sublethal effects, depending on the site of exposure and size of the bird. Smaller birds exposed on use sites with higher allowable use rates (e.g., developed, open space developed, orchards and vineyards) have a greater chance of being affected. Exposure to spray drift is not expected to result in effects to bird seed dispersers. No mortality or sublethal effects are expected for mammalian pollinators or seed dispersers from malathion exposure either on use sites or from spray drift.

Group 7:
Risk to Individuals, Pollinators and seed dispersers if exposed: The individual plants in this assessment group are not expected to experience effects to growth or survival from exposure to malathion. Mortality is expected for insect pollinators and seed dispersers exposed to malathion on use sites, via spray drift, and from mosquito control applications. Because terrestrial invertebrates exhibit a range of sensitivities to malathion, insect abundance

is expected to be reduced where exposure occurs, but not completely eliminated. However, some species are likely to incur greater levels of mortality than others based on their sensitivity. As plants often have unknown or specific pollinators and seed dispersers for which toxicity data is unavailable, we assume insects that pollinate or disperse the seeds of listed plants are sensitive to malathion, and that exposure will cause mortality. In field studies, reductions of common insect species following pesticide exposure are often temporary with recovery over a short period of time. However, since listed plants may be reliant on insect pollinators or seed dispersers that are limited in range or abundance, these insect species may be less likely to recover following pesticide exposure. Some bird pollinators and seed dispersers exposed to malathion on use sites may experience mortality or sublethal effects, depending on the site of exposure and size of the bird. Smaller birds exposed on use sites with higher allowable use rates (e.g., developed, open space developed, orchards and vineyards) have a greater chance of being affected. Exposure to spray drift is not expected to result in effects to bird seed dispersers. No mortality or sublethal effects are expected for mammalian pollinators or seed dispersers from malathion exposure either on use sites or from spray drift.

Group 8: Risk to Individuals, Pollinators and seed dispersers if exposed: The individual plants in this assessment group are estimated to experience up to a 12% decrease in dry weight if exposed to malathion on the following use sites, based on labeled application rates: orchards and vineyards, developed, nurseries, open space developed and Christmas trees. No effects are expected on other use sites. The dicots in this assessment group do not rely on animal species for pollination, thus no effects are expected to these plants from loss in pollinator populations from malathion exposure across use sites within their ranges. Mortality is expected for insect seed dispersers exposed to malathion on use sites or via spray drift. Some bird seed dispersers exposed to malathion on use sites may experience mortality or sublethal effects, depending on the site of exposure and size of the bird. Smaller birds exposed on use sites with higher allowable use rates (e.g., developed, open space developed, orchards and vineyards) have a greater chance of being affected. Exposure to spray drift is not expected to result in effects to bird seed dispersers. No mortality or sublethal effects are expected for mammalian seed dispersers from malathion exposure either on use sites or from spray drift.

Group 9, 10 and 11: Risk to Individuals, Pollinators, and Seed dispersers if exposed: The individual plants in these assessment groups are estimated to experience up to a 12% decrease in dry weight if exposed to malathion on the following use sites, based on labeled application rates: orchards and vineyards, developed, nurseries, open space developed and Christmas trees. No effects are expected on other use sites. Mortality is expected for insect pollinators and seed dispersers exposed to malathion on use sites, via spray drift, and from mosquito control applications. Because terrestrial invertebrates exhibit a range of sensitivities to malathion, insect abundance is expected to be reduced where exposure occurs, but not completely eliminated. However, some species are likely to incur greater levels of mortality than others based on their sensitivity. As plants often have unknown or specific pollinators and seed dispersers for which toxicity data is unavailable, we assume insects that pollinate or disperse the seeds of listed plants are sensitive to malathion, and that exposure will cause mortality. In field studies, reductions of common insect species following pesticide exposure are often temporary with recovery over a short period of time. However, since listed plants may be reliant on insect pollinators or seed dispersers that are limited in range or abundance, these insect species may be less likely to recover following pesticide exposure. Some bird pollinators and seed dispersers exposed to malathion on use sites may experience mortality or sublethal effects, depending on the site of exposure and size of the bird. Smaller birds exposed on use sites with higher allowable use rates (e.g., developed, open space developed, orchards and vineyards) have a greater chance of being affected. Exposure to spray drift is not expected to result in effects to bird pollinators or seed dispersers. No effects (mortality or sublethal effects) are expected for mammalian pollinators or seed dispersers from malathion exposure either on use sites or from spray drift.

Table 2: Summarizing Data and Information for Risk Ranking

Data Sources: SOS accounts (Appendix C); NA=Not Applicable; PR=Puerto Rico; VI=American Virgin Islands

Scientific Name	Common Name	Assessment Group	Location	Direct effects expected (yes or no, reduction in dry weight when exposed in use areas that may have effects)	Effects to Pollinators	Method of Reproduction (risk modifier)	Seed dispersal vector (risk modifier)	Obligate or specific pollinator (risk modifier)	Pollination Vector*	% Range Overlap with Federal Lands	Risk Ranking
Adiantum vivesii	No common name	2	PR	Yes (12%)	Low	Non-flowering	Abiotic	NA	Abiotic		Low
Agave eggersiana	No common name	5	VI	No	Medium	Biotic - Outcrosser	Abiotic	No Mention	Insect, Bird		Low

Scientific Name	Common Name	Assessment Group	Location	Direct effects expected (yes or no, reduction in dry weight when exposed in use areas that may have effects)	Effects to Pollinators	Method of Reproduction (risk modifier)	Seed dispersal vector (risk modifier)	Obligate or specific pollinator (risk modifier)	Pollination Vector*	% Range Overlap with Federal Lands	Risk Ranking
Aristida chaseae	No common name	4	PR	No	Low	Abiotic, Biotic	Abiotic, Biotic	NA	Abiotic		Low
Aristida portoricensis	Pelos del diablo	4	PR	No	Low	Abiotic, Biotic	Abiotic, Biotic	NA	Abiotic		Low
Auerodendron pauciflorum	No common name	11	PR	Yes (12%)	High	Biotic - Unknown	Abiotic, Biotic	Unknown	Insect		High
Banara vanderbiltii	Palo de ramon	11	PR	Yes (12%)	Medium	Biotic - Unknown	Bird	Unknown	Unknown	4.175735	Medium
Buxus vahlii	Vahl's boxwood	11	PR, VI	Yes (12%)	High	Biotic - Unknown	Abiotic	unknown	Insect	1.049676	Medium
Callicarpa ampla	Capa rosa	11	PR	Yes (12%)	High	Biotic - Unknown	No Mention	unknown	Insect		High
Calyptranthes thomasiana	No common name	11	VI, VI-British	Yes (12%)	Low	Biotic - Unknown	Abiotic, Biotic	unknown	Mammal		Low
Calyptronoma rivalis	Palma de manaca	7	PR, Hispaniola (Dominican Republic)	No	High	Biotic - Unknown	Abiotic, Bird, Mammal	No	Insect	5.06E-05	Medium
Catesbaea melanocarpa	No common name	11	PR, VI	Yes (12%)	High	Biotic - Unknown	Abiotic, Biotic	Unknown	Insect	1.843587	High
Chamaecrista glandulosa var. mirabilis	No common name	9	PR	Yes (12%)	High	Biotic - Outcrosser	Abiotic, Biotic	No Mention	Insect	15.89917	High
Cordia bellonis	No common name	10	PR	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	No	Insect		High
Cornutia obovata	Palo de nigua	9	PR	Yes (12%)	Medium	Biotic - Outcrosser	Abiotic, Biotic	No Mention	Insect, Bird		High
Cranichis ricartii	No common name	6	PR	No	High	Biotic - Asexual, Self-pollinating	Abiotic	No Mention	Insect		Medium
Crescentia portoricensis	Higuero de sierra	9	PR	Yes (12%)	Low	Biotic - Outcrosser	Abiotic, Mammal	No Mention	Mammal		Medium
Cyathea dryopteroides	Elfin tree fern	2	PR	Yes (12%)	Low	Non-flowering	Abiotic	NA	Abiotic		Low
Daphnopsis helleriana	No common name	11	PR	Yes (12%)	High	Biotic - Unknown	Abiotic, Biotic	Unknown	Insect	0.08358	High
Elaphoglossum serpens	No common name	2	PR	Yes (12%)	Low	Non-flowering	Abiotic	NA	Abiotic		Low

Scientific Name	Common Name	Assessment Group	Location	Direct effects expected (yes or no, reduction in dry weight when exposed in use areas that may have effects)	Effects to Pollinators	Method of Reproduction (risk modifier)	Seed dispersal vector (risk modifier)	Obligate or specific pollinator (risk modifier)	Pollination Vector*	% Range Overlap with Federal Lands	Risk Ranking
Eugenia haematocarpa	Uvillo	9	PR	Yes (12%)	High	Biotic - Outcrosser	Abiotic, Biotic	No Mention	Insect		High
Eugenia woodburyana	No common name	11	PR	Yes (12%)	High	Biotic - Unknown	Abiotic, Biotic	No	Insect	0.886726	High
Gesneria pauciflora	No common name	9	PR	Yes (12%)	Medium	Biotic - Outcrosser	Abiotic, Biotic	No Mention	Bird		High
Goetzea elegans	Beautiful goetzea	9	PR	Yes (12%)	Medium	Biotic - Outcrosser	Bird, Mammal	No Mention	Insect, Bird	9.238082	High
Gonocalyx concolor	No common name	9	PR	Yes (12%)	Medium	Biotic - Outcrosser	Biotic	No Mention	Insect, Bird		High
Harrisia portoricensis	Higo Chumbo	10	PR	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Insect, Bird, Mammal	No	Insect		High
Ilex cookii	Cook's holly	11	PR	Yes (12%)	Medium	Biotic - Unknown	Bird, Mammal	Unknown	Abiotic, Insect		Medium
Ilex sintenisii	No common name	11	PR	Yes (12%)	Medium	Biotic - Unknown	Bird, Mammal	Unknown	Abiotic, Insect		Medium
Juglans jamaicensis	West Indian Walnut (=Nogal)	8	PR, Dominican Republic, Haiti, Cuba, Hispaniola	Yes (12%)	Low	Abiotic - Pollinating Agent	Abiotic, Mammal	Not Applicable	Abiotic	0.000225	Low
Lepanthes eltoroensis	No common name	6	PR	No	High	Biotic - Asexual, Self-pollinating	Abiotic	Unknown	Insect		Medium
Leptocereus grantianus	No common name	11	PR	Yes (12%)	High	Biotic - Unknown	Insect, Bird, Mammal	Unknown	Insect	16.01536	High
Lyonia truncata var. proctorii	No common name	9	PR	Yes (12%)	High	Biotic - Outcrosser	Abiotic, Bird, Mammal	No Mention	Insect	3.197314	High
Mitracarpus maxwelliae	No common name	11	PR	Yes (12%)	High	Biotic - Unknown	Abiotic, Biotic	Unknown	Insect	0.000911	High
Mitracarpus polycladus	No common name	11	PR	Yes (12%)	High	Biotic - Unknown	Abiotic, Biotic	Unknown	Insect	0.0003	High
Myrcia paganii	No common name	11	PR	Yes (12%)	High	Biotic - Unknown	Abiotic, Biotic	Unknown	Insect		High
Ottoschulzia rhodoxylon	Palo de rosa	11	PR	Yes (12%)	High	Biotic - Unknown	Mammal	Unknown	Insect	1.233297	High

Scientific Name	Common Name	Assessment Group	Location	Direct effects expected (yes or no, reduction in dry weight when exposed in use areas that may have effects)	Effects to Pollinators	Method of Reproduction (risk modifier)	Seed dispersal vector (risk modifier)	Obligate or specific pollinator (risk modifier)	Pollination Vector*	% Range Overlap with Federal Lands	Risk Ranking
Peperomia wheeleri	Wheeler's peperomia	10	PR	Yes (12%)	Medium	Biotic - Asexual, Self-pollinating	Biotic	Unknown	Abiotic, Insect		Medium
Pleodendron macranthum	Chupacallos	11	PR	No	Medium	Biotic - Unknown	Bird	Unknown	Insect, Mammal		Medium
Polystichum calderonense	No common name	2	PR	Yes (12%)	Low	Non-flowering	Abiotic	NA	Abiotic		Low
Schoepfia arenaria	No common name	11	PR	Yes (12%)	High	Biotic - Unknown	Abiotic, Biotic	Unknown	Insect	0.893721	High
Solanum conocarpum	Marron bacora	9	VI	Yes (12%)	High	Biotic - Unknown	Biotic	Unknown	Insect, Bird	69.79108	High
Solanum drymophilum	Erubia	11	PR	Yes (12%)	High	Biotic - Unknown	Biotic, Bird	Unknown	Insect	9.095325	High
Stahlia monosperma	Cobana negra	11	PR, Dominican Republic	Yes (12%)	High	Biotic - Unknown	Abiotic, Biotic	Unknown	Insect	11.8981	High
Styrax portoricensis	Palo de jazmin	11	PR	Yes (12%)	High	Biotic - Unknown	Abiotic, Bird, Mammal	Unknown	Insect		High
Tectaria estremerana	No common name	2	PR	Yes (12%)	Low	Non-flowering	Abiotic	NA	Abiotic		Low
Ternstroemia luquillensis	Palo colorado	11	PR	Yes (12%)	High	Biotic - Unknown	Abiotic, Bird, Mammal	Unknown	Insect		High
Ternstroemia subsessilis	No common name	11	PR	Yes (12%)	High	Biotic - Unknown	Abiotic, Bird, Mammal	Unknown	Insect		High
Thelypteris inabonensis	No common name	2	PR	Yes (12%)	Low	Non-flowering	Abiotic	NA	Abiotic		Low
Thelypteris verecunda	No common name	2	PR	Yes (12%)	Low	Non-flowering	Abiotic	NA	Abiotic		Low
Thelypteris yaucoensis	No common name	2	PR	Yes (12%)	Low	Non-flowering	Abiotic	NA	Abiotic		Low
Trichilia triacantha	Bariaco	10	PR	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	No	Insect	0.904499	High
Varronia rupicola	No common name	11	PR, VI-British	Yes (12%)	High	Biotic - Unknown	Abiotic, Biotic	No	Insect	7.373002	High
Vernonia proctorii	No common name	11	PR	Yes (12%)	Medium	Biotic - Unknown	Abiotic, Biotic	unknown	Abiotic, Insect	3.197314	Medium
Zanthoxylum thomasianum	St. Thomas prickly-ash	9	PR, VI	Yes (12%)	High	Biotic - Outcrosser	Abiotic, Biotic	No Mention	Insect	37.55303	High

*Information in this column was used to inform the ranking metrics or the draft determination when relevant.

Cumulative Effects and Environmental Baseline: Please refer to the Status of the Species accounts (Appendix C) and overarching Environmental Baseline and Cumulative Effects sections of this Opinion.

Additional Conservation Measures

Additional information on these new conservation measures can be found in the *Description of the Action* section and Appendix A-2 of this biological opinion, and further information on the anticipated impacts of each measure in the *Effects of the Action* section.

Several additional conservation measures have recently been provided by EPA and will be implemented as part of the Action. The following measures apply to all species in these assessment groups with corresponding use type overlap and usage (i.e., mosquito adulticide, agricultural and residential uses). All measures are anticipated to limit the exposure of pollinators and seed dispersers to malathion in the described use area where it occurs in or around the range of the species, thus reducing the risk of reproductive effects to the species.

General Conservation Measures:

Mosquito adulticide timing restrictions: Conservation measures for mosquito adulticide use will prohibit application during most daylight hours (from two hours after dawn until two hours before sunset). This period is when many diurnal insect pollinators are most active. This measure is anticipated to limit the exposure of pollinators/seed dispersers present in and around the range of the species to malathion when used as a mosquito adulticide.

Bloom restrictions: New restrictions on orchards and vineyards, pasture, and other crops UDLs will prohibit application of malathion within three days prior to bloom, during bloom, and until petal fall is complete on certain crops. This measure is anticipated to limit the exposure of pollinators/seed dispersers to malathion in this use area where it occurs in or around the range of the species, reducing the risk of impacts to reproduction.

Reduced application number and rate: New restrictions on corn, cotton, orchards and vineyards, pasture, other crops, and vegetables and groundfruit lower the maximum allowable number of applications (previously ranging from 3-13 applications per year, depending on the specific crop) to 2-4 per year, as described in the Description of the Action of this Opinion. This is anticipated to reduce the amount of malathion used and decrease exposure to the species and its pollinators/seed dispersers, thus decreasing the risk of impacts to reproduction and direct impacts to the plant itself.

Reduced citrus application rate: The reduction in the maximum application rate for citrus is anticipated to reduce potential environmental concentrations to one-third of modeled values, reducing the effects to species and their pollinators/seed dispersers on and adjacent to these use areas.

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are anticipated to substantially reduce exposure to species and their pollinators/seed dispersers that overlap with developed and open space developed areas. Label changes will ensure that residential use is limited to spot treatments only (rendering spray drift offsite unlikely) and reducing the extent of area which can be treated in the developed and open space developed areas by as much as 75% or more from modeled values. In addition, we expect the frequency of exposure to decrease as the number of allowable applications is reduced from “repeat as necessary” to a maximum of 2–4 applications per year (depending on the specific residential use). Retreatment intervals of 7-10 days between any repeated applications are expected to reduce environmental concentrations by allowing initial residues to degrade prior to the next application.

Species-Specific Conservation Measures:

The following species-specific measure is now part of the Action and will be included in *BulletinsLive! Two*.

This measure does not allow malathion application within the range of the species, plus 100 feet beyond the range to account for potential spray drift from applicators adjacent to the range. While the exact amount of spray drift reduction from the extra 100 feet around the range will vary depending on the traits of the ecosystem as well as the application method, based on AgDRIFT modeling, we anticipate spray drift reductions ranging from 82 to 90%.

Species-specific conservation measures are referenced, where applicable, in the Rationale for Species Conclusions section below Table 3.

Table 3: Summary of Conclusions

Number	Scientific Name	Common Name	Plant Assessment Group	Location	Vulnerability Ranking	Risk Ranking without Habitat	Exposure Ranking	Species Conclusion (J, NJ)*
1	*Adiantum vivesii*	No common name	2	PR	High	Low	Not determined**	NJ
2	*Cyathea dryopteroides*	Elfin tree fern	2	PR	High	Low	Not determined**	NJ
3	*Elaphoglossum serpens*	No common name	2	PR	High	Low	Not determined**	NJ
4	*Polystichum calderonense*	No common name	2	PR	High	Low	Not determined**	NJ
5	*Tectaria estremerana*	No common name	2	PR	High	Low	Not determined**	NJ
6	*Thelypteris inabonensis*	No common name	2	PR	High	Low	Not determined**	NJ
7	*Thelypteris verecunda*	No common name	2	PR	High	Low	Not determined**	NJ
8	*Thelypteris yaucoensis*	No common name	2	PR	High	Low	Not determined**	NJ
9	*Aristida chaseae*	No common name	4	PR	High	Low	Not determined**	NJ
10	*Aristida portoricensis*	Pelos del diablo	4	PR	High	Low	Not determined**	NJ
11	*Agave eggersiana*	No common name	5	VI	High	Low	Medium	NJ
12	*Cranichis ricartii*	No common name	6	PR	High	Medium	Low	NJ
13	*Lepanthes eltoroensis*	No common name	6	PR	High	Medium	Low	NJ
14	*Calyptronoma rivalis*	Palma de manaca	7	PR, Hispaniola (Dominican Republic)	Medium	Medium	Low	NJ
15	*Juglans jamaicensis*	West Indian Walnut (=Nogal)	8	PR, Dominican Republic, Haiti, Cuba, Hispaniola	High	Low	Not determined**	NJ
16	*Goetzea elegans*	Beautiful goetzea	9	PR	Medium	High	High	NJ
17	*Zanthoxylum thomasianum*	St. Thomas prickly-ash	9	PR, VI	High	High	Medium	NJ
18	*Eugenia haematocarpa*	Uvillo	9	PR	Medium	High	Low	NJ
19	*Chamaecrista glandulosa var. mirabilis*	No common name	9	PR	High	High	Low	NJ
20	*Cornutia obovata*	Palo de nigua	9	PR	High	High	Low	NJ
21	*Crescentia portoricensis*	Higuero de sierra	9	PR	High	Medium	Low	NJ
22	*Gesneria pauciflora*	No common name	9	PR	High	High	Low	NJ
23	*Gonocalyx concolor*	No common name	9	PR	High	High	Low	NJ
24	*Lyonia truncata var. proctorii*	No common name	9	PR	High	High	Low	NJ
25	*Cordia bellonis*	No common name	10	PR	High	High	Medium	NJ
26	*Peperomia wheeleri*	Wheeler's peperomia	10	PR	Medium	Medium	Low	NJ
27	*Harrisia portoricensis*	Higo Chumbo	10	PR	High	High	Low	NJ

Number	Scientific Name	Common Name	Plant Assessment Group	Location	Vulnerability Ranking	Risk Ranking without Habitat	Exposure Ranking	Species Conclusion (J, NJ)*
28	*Trichilia triacantha*	Bariaco	10	PR	High	High	Low	NJ
29	*Catesbaea melanocarpa*	No common name	11	PR, VI	High	High	High	NJ
30	*Solanum drymophilum*	Erubia	11	PR	High	High	Medium	NJ
31	*Stahlia monosperma*	Cobana negra	11	PR, Dominican Republic	High	High	Medium	NJ
32	*Calyptranthes thomasiana*	No common name	11	VI, VI-British	High	Low	Low	NJ
33	*Auerodendron pauciflorum*	No common name	11	PR	High	High	Low	NJ
34	*Banara vanderbiltii*	Palo de ramon	11	PR	High	Medium	Low	NJ
35	*Buxus vahlii*	Vahl's boxwood	11	PR, VI	High	Medium	Low	NJ
36	*Callicarpa ampla*	Capa rosa	11	PR	High	High	Low	NJ
37	*Daphnopsis helleriana*	No common name	11	PR	High	High	Low	NJ
38	*Eugenia woodburyana*	No common name	11	PR	High	High	Low	NJ
39	*Ilex cookii*	Cook's holly	11	PR	High	Medium	Low	NJ
40	*Ilex sintenisii*	No common name	11	PR	High	Medium	Low	NJ
41	*Leptocereus grantianus*	No common name	11	PR	High	High	Low	NJ
42	*Mitracarpus maxwelliae*	No common name	11	PR	High	High	Low	NJ
43	*Mitracarpus polycladus*	No common name	11	PR	High	High	Low	NJ
44	*Myrcia paganii*	No common name	11	PR	High	High	Low	NJ
45	*Ottoschulzia rhodoxylon*	Palo de rosa	11	PR	High	High	Low	NJ
46	*Pleodendron macranthum*	Chupacallos	11	PR	High	Medium	Low	NJ
47	*Schoepfia arenaria*	No common name	11	PR	High	High	Low	NJ
48	*Solanum conocarpum*	Marron bacora	11	VI	High	High	Low	NJ - conference
49	*Styrax portoricensis*	Palo de jazmin	11	PR	High	High	Low	NJ
50	*Ternstroemia luquillensis*	Palo colorado	11	PR	High	High	Low	NJ
51	*Ternstroemia subsessilis*	No common name	11	PR	High	High	Low	NJ
52	*Varronia rupicola*	No common name	11	PR, VI-British	High	High	Low	NJ
53	*Vernonia proctorii*	No common name	11	PR	High	Medium	Low	NJ

*NJ = No Jeopardy; J = Jeopardy
**An Exposure ranking was not undertaken for species in this Assessment Group as the magnitude of exposure for these species should not affect the analysis given they do not use biotic vectors in their life cycle.

Rationale for Species Conclusions:

For these species, we anticipate their medium to high vulnerabilities and medium to high levels of risk (as applicable) to individuals or species is offset by low levels of usage of malathion in most cases, as described below. For species with a portion of their range on Federal lands, we did not quantitatively evaluate use or usage on in these areas, but we assume only low levels of usage, per the rationale described in the Biological Opinion. For

the non-Federal lands portion of the species ranges, we have limited information on past malathion usage in the Caribbean Islands, and thus our estimation of usage and exposure on non-Federal lands contains a large degree of uncertainty. Briefly, we anticipate that usage in non-agricultural areas will be low (up to 5% of overlap in any given area). We anticipate that the available agricultural usage data, which is from a single year and does not distinguish between use categories, likely provides an upper bound of malathion usage for our analysis, particularly as it includes all insecticides. For the Caribbean Islands as a whole, this usage is also anticipated to be low (~11% of agricultural lands treated across the islands as an upper bound for malathion), though we cannot predict the degree of usage in proximity to particular species' ranges. However, given that 89% of agricultural fields are not anticipated to be treated with insecticides, we assume a low probability that any individual plant will be in proximity to agricultural usage of malathion. We further discuss our assumptions and analysis of usage data on Federal lands and in the Caribbean Islands in the Usage section of this Opinion. (Due to the large number of species in this assessment group, we use the numbers assigned for the purpose of this analysis in the preceding table in our Assessment Group discussions below).

Assessment Group 2 (*Ferns and Allies, species numbered 1-8*):

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the 8 plant species in assessment group 2 in the Caribbean (*Adiatum vivesii*, *Cyathea dryopteroides*, *Elaphoglossum serpens*, *Polystichum calderonense*, *Tetaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis*).

The species in this assessment group have high vulnerabilities based on their status, distribution, and trends, as described above. The risk to all species in this group posed by labeled uses across the non-Federal portions of their ranges is anticipated to be low as shown above. As described in the Approach for the Analysis for Pacific and Caribbean Island Species, we considered available usage data broadly and determined the relative likelihood of exposure of island species based on their habitat. However, for ferns and allies we did not undertake an Exposure ranking as the magnitude of exposure for these species should not affect the outcome of the analysis given they do not rely on biotic pollinator or seed dispersal vectors. As such, we were able to make a conclusion for these species based on their vulnerability and risk ranking.

While all species in this group had high vulnerabilities based on their endangered status and restricted ranges, all species had low risk given we do not anticipate adverse effects to the reproduction and survival of these species as they do not use biotic pollinator or seed dispersal vectors. While we expect some individual plants will experience reduced growth due to direct exposure to malathion, we do not anticipate this reduction in growth will cause species-level effects, and the additional conservation measures described above will further decrease the exposure and sub-lethal effects to these species from malathion. For example, residential uses of malathion are now limited to two applications per year (reduced from as many as necessary) and to spot treatments only, reducing the application footprint and likelihood of spray drift within developed and open space developed areas. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of these species (*Adiatum vivesii*, *Cyathea dryopteroides*, *Elaphoglossum serpens*, *Polystichum calderonense*, *Tetaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis*) in the wild.

Assessment Group 4 (*Monocots with abiotic pollination vectors, species number 9 and 10)*:
After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the two plant species (*Aristida chaseae* and *Aristida portoricensis*) in assessment group 4 in the Caribbean.
The species in this assessment group, *Aristida chaseae* and *Aristida portoricensis*, have high vulnerabilities based on their status, distribution and trends, as described above. The risk to the species in this group posed by the labeled uses across the non-Federal portions of their ranges are anticipated to be low, as shown above. As described in the Approach for the Analysis for Pacific and Caribbean Island Species, we considered available usage data broadly and determined the relative likelihood of exposure of island species based on their habitat. However, for monocots using abiotic pollination vectors, we did not undertake an Exposure ranking as the magnitude of exposure for these species should not affect the outcome of the analysis give they do not rely on biotic vectors. As such, we were able to make a conclusion for these species based on their vulnerability and risk ranking. Pollinating animals do not play a role in the life cycle of this group of monocot plants, instead they use wind or water to transport pollen between individual populations. As a result, we expect there will be no effects to the reproduction of these species due to loss of pollinators from malathion exposure in the non-Federal portion of the species' ranges. Furthermore, the individual plants in this assessment group are not expected to experience mortality or effects to growth from exposure to malathion, as monocot plants are not anticipated to experience effects from direct exposure to malathion. However, these monocot species do rely on animals to disperse a portion of their seeds. We do not know the specific seed dispersal species they rely on, but assume it is a mixture of abiotic vectors and a variety of biotic vectors such as insects, birds, and mammals. No mortality or sublethal effects are expected for mammalian seed dispersers, however bird and insect dispersal species are expected to experience losses due to malathion exposure. Given that these species can rely on a variety of seed dispersal vectors, including abiotic vectors, we do not anticipate effects to its insect or bird dispersers to cause species-level effects to the reproductive capacity of these species. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of *Aristida chaseae* and *Aristida portoricensis* in the wild.

Assessment Group 5 (*Monocots reliant upon outcrossing with biotic pollination vectors, species 11*):

After reviewing the current status of the species the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the *Agave eggersiana*.

Agave eggersiana has high vulnerability based on its endangered status and restricted distributions and trends, as described above. *Agave eggersiana* is found on the north and south coasts of St. Croix, USVI and has seven populations that support approximately 313 adult plants and more than 316 juveniles. The risk to this species posed by the labeled uses across the non-Federal portion of the species range is anticipated to be low, mainly due to it being a monocot and using abiotic seed dispersal vectors, as shown above. This species relies on unknown species of insects and birds for pollination and is believed to require outcrossing (movement of pollen from one individual to another) in order to reproduce successfully. Mortality is expected for insect pollinators exposed to malathion on use sites or via spray drift. Some bird pollinators exposed to malathion on use sites may experience mortality or sublethal effects, depending on the site of exposure and size of the bird. Smaller birds exposed on use sites with higher allowable use rates (e.g., developed, open space developed, orchards and vineyards) have a greater chance of being affected. Exposure to spray drift is not expected to result in effects to avian pollinators. We anticipate adverse effects to this species due to the reduction in pollinating insects and birds that would result in reduced reproductive success, where exposure occurs. However, conservation measures will be implemented that are anticipated to reduce the risk of exposure to pollinators and resultant reproductive effects to this species, as described above. For example, residential uses of malathion are now limited to two applications per year (reduced from as many as necessary) and to spot treatments only, reducing the application footprint and likelihood of spray drift within developed and open space developed areas. The reduced application footprint and likelihood of spray drift are a result of the allowable application methods for spot treatment (such as the use of hand-pump sprayers, which are not capable of producing broadcast use) and low amounts of chemical used.

This species uses abiotic (likely wind) pollination vectors for seed dispersal, therefore we do not anticipate use of malathion within the non-Federal portion of its range will cause adverse effects to seed dispersal or reproductive capacity of this species. Since this species can use both insects and birds as pollinating vectors and may rely on one type of pollination vector if the other is temporarily reduced in numbers, we do not anticipate the adverse reproductive effects to this plant as a result of pollinator mortality will cause species-level effects. Furthermore, *Agave eggersiana* is not expected to experience mortality or growth effects from exposure to malathion, as monocot plants are not anticipated to experience effects from direct exposure to malathion.

As described in the Approach for the Analysis for Pacific and Caribbean Island Species, we considered available usage data broadly and determined the relative likelihood of exposure of island species based on their habitat. We anticipate *Agave eggersiana* will have a medium level of exposure to malathion given they exist on coastal cliffs with sparse vegetation and dry coastal shrubland vegetation communities within the subtropical dry forest life zone where we anticipate less exposure to malathion. The species can also be found near residential and urban development areas (Felix Lopez, USFWS pers. comm. 2020). As discussed above, non-agricultural use areas, including developed, we anticipate a low level of usage. As such, we anticipate that a medium level of exposure to malathion is not likely over the entire non-Federal portion of the species range. Furthermore, there is also a low probability of encountering a use site in the Caribbean, as described above, so it is unlikely malathion usage will occur in or near this species' range. We do not anticipate that the use of this pesticide is likely to have species-level effects due to their reliance on more than one type of pollinator, existence in habitat areas where they do not have a high likelihood for malathion exposure, their reliance on abiotic seed dispersal. Moreover, we anticipate the conservation measures will further reduce the likelihood of exposure of the species and its pollinators. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of *Agave eggersiana* in the wild.

Assessment Group 6 (*Monocots reliant on biotic pollination vectors and able to use self-fertilization or vegetative reproduction at least partially to maintain populations over time, species numbered 12 and 13*):
After reviewing the current status of the species the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the two plants, *Cranichis ricartii* and *Lepanthes eltoroensis*, in assessment group 6.

Cranichis ricartii and *Lepanthes eltoroensis* are both orchid species and have high vulnerabilities based on their endangered status and limited distributions, as shown above. The risk to these species posed by the labeled uses across the non-Federal portion of the species' ranges is anticipated to be medium, as shown above. As described in the Approach for the Analysis for Pacific and Caribbean Island Species, we considered available usage data broadly and determined the relative likelihood of exposure of island species based on their habitat.

Specific pollinator species are unknown, but suspected to be insects based on known pollinators of other orchids. Mortality is expected for insect pollinators exposed to malathion on use sites or via spray drift. We anticipate adverse effects to these species due to the reduction in pollinating insects. However, conservation measures will be implemented that are anticipated to reduce the risk of exposure to pollinators and resultant reproductive effects to this species, as described above. For example, residential uses of malathion are now limited to two applications per year (reduced from as many as necessary) and to spot treatments only, reducing the application footprint and likelihood of spray drift within developed and open space developed areas. The reduced application footprint and likelihood of spray drift are a result of the allowable application methods for spot treatment (such as the use of hand-pump sprayers, which are not capable of producing broadcast use) and low amounts of chemical used.

Both species use abiotic (likely wind) pollination vectors for seed dispersal, therefore we do not anticipate use of malathion within non-Federal portion of their ranges will cause adverse effects to seed dispersal or reproductive capacity of these species. In addition, these species are not expected to experience mortality or growth effects from exposure to malathion, as monocot plants are not anticipated to experience effects from direct exposure to malathion. We anticipate that both of these species will have a low level of exposure to malathion given the habitats they occur in, and this exposure is anticipated to be reduced further. *Lepanthes eltoroensis* is currently known from five discrete sites in the sierra palm, palo colorado, and dwarf forests of the El Yunque National Forest wilderness area (2015 5-year review). *Cranichis ricartii* has been found at only three locations in the Maricao Commonwealth Forest in western Puerto Rico, though comprehensive surveys have not been undertaken since listing in 1995 (USFWS, 1995; 2016 5-year review). As a result, we anticipate there is a very low likelihood of malathion exposure in these protected areas. Thus, based on the low level of exposure expected, we do not anticipate the reductions in pollinator numbers and resulting reduction in reproductive capacity for these species to rise to the level of species-level effects. Moreover, we anticipate the conservation measures will further reduce the likelihood of exposure of the species. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of *Cranichis ricartii* and *Lepanthes eltoroensis* in the wild.

Assessment Group 7 (*Monocots reliant on biotic pollination vectors; other reproductive mechanisms unknown, species number 14*):

After reviewing the current status of the species and the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the *Calyptronoma rivalis* (palma de manaca).

Calyptronoma rivalis has a medium vulnerability based on its status, distribution, and trends, as shown above. This species is a palm that grows along stream banks in the northwestern karst region of Puerto Rico. The natural populations of palma de manaca are located within mature and young evergreen and semideciduous forest, and the montane evergreen forest (2016 5-year Review). *Calyptronoma rivalis* occurs naturally in three locations, with a total of approximately 550 individuals. In addition, captive propagation and reintroduction has successfully introduced populations in the Rio Abajo and Guajataca Commonwealth Forests. There are also a number of individuals in the Maricao and Guilarte Commonwealth Forests. The Service has also outplanted this species to a protected area in Arecibo. Some threats to the species include deforestation and associated flash flooding and habitat modifications such as clearing for agriculture and pasture farming and the conversion of agricultural lands to residential development. The three natural populations are located on privately owned lands threatened by modification of habitat for housing development and infrastructure.

We anticipate medium risk to the species posed by labeled uses across the non-Federal portion of the species range, as shown above. Bees and wasps have been observed on flowers of this species and are assumed to be the main pollinators (Recovery Plan, 1992). Mortality is expected for insect pollinators exposed to malathion on use sites or via spray drift. We anticipate adverse effects to reproduction of these species due to the reduction in pollinating insects. However, the conservation measures to be implemented are anticipated to reduce the risk of exposure to pollinators and resultant reproductive effects to this species, as described above. For example, residential uses of malathion are now limited to two applications per year (reduced from as many as necessary) and to spot treatments only, reducing the application footprint and likelihood of spray drift within developed and open space developed areas. The reduced application footprint and likelihood of spray drift are a result of the allowable application methods for spot treatment (such as the use of hand-pump sprayers, which are not capable of producing broadcast use) and low amounts of chemical used.

The species relies on abiotic means for a portion of their seed dispersal (gravity – most seeds simply drop to the ground), giving this species the capability to reproduce successfully even in the absence of a portion of their biotic seed dispersal vectors (suspected to be birds and mammals). Furthermore, *Calyptronoma rivalis* is not expected to experience mortality or growth effects from exposure to malathion, as monocot plants are not anticipated to experience effects from direct exposure to malathion.

However, we anticipate low exposure within the non-Federal portion of the species range, as described above. As described in the Approach to the Analysis for Pacific and Caribbean Island Species, we considered available usage data broadly and determined the relative likelihood of exposure of island species based on their habitat. As a result, we anticipate malathion usage on a very small portion of the non-Federal portion of the range of this species. The resulting level of pollinator and seed disperser mortalityis not anticipated to cause species-level reproductive effects. Moreover, we anticipate the conservation measures will further reduce the likelihood of exposure of the species and its pollinators. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of *Calyptronoma rivalis* in the wild.

Assessment Group 8 (*Dicots reliant on abiotic pollination vectors, species number 15*):

After reviewing the current status of the species and the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed is not likely to jeopardize the continued existence of *Juglans jamaicensis* (West Indian Walnut (=Nogal)).

While Juglans jamaicensis has a high vulnerability based on its status, distribution, and trends, the risk to this species posed by labeled uses across the non-Federal portion of its range is low, as shown above. Pollinating animals do not play a role in the life cycle of this species, a walnut tree that uses wind to transport pollen between individuals and populations. As a result, we expect there will be no effects to the reproduction and survival of this species due to loss of pollinators from malathion exposure in the range. In addition, *Juglans jamaicensis* utilizes abiotic seed dispersal vectors, therefore we do not anticipate effects to the reproduction and survival of these species due to loss of animal seed dispersers from malathion exposure in the non-Federal portion of its range. We expect some individual plants will experience reduced growth due to direct exposure to malathion, but we do not anticipate this reduction in growth to give rise to species-level effects.

As described in the Approach to the Analysis of Pacific and Caribbean Island Species, we considered available usage data broadly and determined the relative likelihood of exposure of island species based on their habitat. However, for dicots using abiotic pollination vectors, we did not undertake an Exposure ranking as the magnitude of exposure for these species should not affect the outcome of the analysis given they do not rely on biotic vectors. However, malthion usage is anticipated to be low as is the probability of the species' range occurring in or near a use area, as described above
We do not anticipate that the use of this pesticide is likely to have species-level effects on *Juglans jamicensis* due to its reliance on abiotic pollination and seed dispersal vectors that will not be affected by malathion exposure. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of *Juglans jamicensis* in the wild.

Assessment Group 9 (*Dicots reliant on outcrossing by biotic pollination vectors, species numbered 16-24*):

After reviewing the current status of the species and the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed is not likely to jeopardize the continued existence of species 16-24, *Chamaecrista glandulosa var. mirabilis*, *Cornutia obovate*, *Crescentia portoricensis*, *Gonocalyx concolor*, *Eugenia haematocarpa*, *Gesneria pauciflora*, *Goetzea elegans*, *Lyonia truncate var. proctorii*, and *Zanthoxylum thomasianum*.

The nine species in this assessment group have a mixture of high and medium vulnerabilities based on their status, distribution, and trends, as shown above. Generally, these species have fewer than 10 populations (with the exception of *Goetzea elegans*, which has 16 populations). Species in this assessment group that are highly vulnerable have total numbers of individuals ranging from as few as about 19, up to about 1,500. Species with medium vulnerability, *Eugenia haematocarpa* and *Goetzea elegans*, are estimated to have 247 and 1,700 individuals, respectively. Information on the number of individuals is unknown for *Chamaecrista glandulosa var. mirabilis* and *Gonocalyx concolor*.

We anticipate a high level of risk to these species posed by the labeled uses across the non-Federal portion of the species' ranges, except for *Crescentia portoricensis*, which is anticipated to have a medium level of risk. The species in this assessment group are biotic outcrossers, meaning reproduction requires the transfer of pollen from one individual plant to another via a biotic pollination vector. *Chamaecrista glandulosa var. mirabilis*, *Eugenia haematocarpa*, *Lyonia truncata var. proctorii*, and *Zanthoxylum thomasianum* rely on insects for pollination. *Cornutia obovate*, *Gonocalyx concolor*, and *Goetzea elegans* use insect pollinators, but also rely on birds for pollination. *Crescentia portoricensis* is pollinated by mammals, and *Gesneria pauciflora* only by birds. The species in this assessment group utilize abiotic (e.g., wind and water) vectors for seed dispersal, therefore we do not anticipate use of malathion within non-Federal portion of their ranges will cause adverse effects to seed dispersers. The exceptions are *Gonocalyx concolor*, which relies on biotic vectors for seed dispersal, and *Goetzea elegans*, which relies on birds and mammals for seed dispersal. Mortality is expected for insect pollinators exposed to malathion on use sites or via spray drift. Some bird pollinators and seed dispersers exposed to malathion on use sites may experience mortality or sublethal effects, depending on the site of exposure and size of the bird. Smaller birds exposed on use sites with higher allowable use rates (e.g., developed, open space developed, orchards and vineyards) have a greater chance of being affected. Exposure to spray drift is not expected to result in effects to bird pollinators or seed dispersers. No effects (mortality or sublethal effects) are expected for mammalian pollinators or seed dispersers from malathion exposure either on use sites or from spray drift. We anticipate adverse effects to species in this assessment group due to the reduction in pollinating insects, and in reduction and sublethal effects to bird seed dispersers, and especially to those species that rely solely on insects for pollination. The level of adverse effect is anticipated to be lower for those species which can rely on abiotic seed dispersers if biotic vectors are less available. However, the conservation measures to be implemented are anticipated to reduce the risk of exposure to pollinators and resultant reproductive effects to this species. For example, new restrictions prohibit application on crops in certain UDLs three days prior to bloom, during bloom, and until petal fall is complete. Given that most pollinating insects are likely to be attracted to crops in bloom and thus more likely to be present in agricultural areas during these times, avoiding application during bloom is anticipated to reduce exposure and resultant mortality of pollinators important for these plants.

We anticipate low exposure within the non-Federal portion of the species' ranges, as described above. The exceptions are *Goetzea elegans* (high anticipated exposure) and *Zanthoxylum thomasianum* (medium anticipated exposure), which we discuss separately below. As described in the Approach to the Analysis of Pacific and Caribbean Island Species, we considered available usage data broadly and determined the relative likelihood of exposure of island species based on their habitat. Additionally, we note that *Cornutia obovate*, *Crescentia portoricensis*, *Gonocalyx concolor*, *Eugenia haematocarpa*, and *Gesneria pauciflora* primarily occur in unpopulated to sparsely populated areas of Puerto Rico and the U.S. Virgin Islands, or in protected areas such as Mona Island. The majority of non-agricultural and agricultural practices that would include the use of malathion also do not occur in these areas due to environmental conditions and lack of suitable agricultural land. Where non-agricultural uses may occur within the action area, we anticipate there will be no overlap with that type of use and the species habitats (Pers. Comm. 2017, Felix Lopez, FWS Puerto Rico ES Field Office). As a result, we anticipate the likelihood of malathion usage to be very small in the ranges of *Cornutia obovate*, *Crescentia portoricensis*, *Gonocalyx concolor*, *Eugenia haematocarpa*, and *Gesneria pauciflora,* given their occurrence in remote or protected areas. Exposure is also anticipated to be low for *Chamaecrista glandulosa var. mirabilis* and *Lyonia*

truncata var. proctorii, given their preferred habitat of forest and open sands respectively. Furthermore, overall, we anticipate low malathion usage as described above. As a result, we expect malathion usage on only a small portion of the range of these species, and the conservation measures to be implemented will reduce pollinator exposure further in these locations. As such, the resulting level of pollinator and seed disperser mortality and resultant reproductive effects will not rise to species-level effects. Therefore, we do not anticipate that the proposed action would appreciably reduce the survival and recovery of *Cornutia obovate*, *Crescentia portoricensis*, *Gonocalyx concolor*, *Eugenia haematocarpa*, and *Gesneria pauciflora*, *Chamaecrista glandulosa var. mirabilis,* and *Lyonia truncata var. proctorii* in the wild.

Goetzea elegans

Goetzea elegans (beautiful goetzea) has a medium level of vulnerability based on its status, distribution and trends, as described above. *Goetzea elegans* is endangered; it is known from 16 populations with a total of about 1,700 individuals. The populations of this species are increasing, and successes in recovery are attributed in part to planting in Commonwealth forests and on private properties with conservation agreements per the Recovery Plan (USFWS 2019).

We anticipate a high level of risk to this species posed by the labeled uses of malathion across the non-Federal portion of its range, as shown above. The species relies on insects and birds as pollination vectors, and on birds and mammals as seed dispersers. As discussed above, we anticipate that malathion usage within the non-Federal portion of the species range will result in a reduction in insects, and a reduction and sublethal effect in birds. These adverse effects would cause a reduction in an individual plant's reproductive success. As described in the Analysis of Pacific and Caribbean Island Species, we considered available usage data broadly and determined the relative likelihood of exposure of island species based on their habitat. *Goetzea elegans* occurs in semi-evergreen seasonal forest. As reported in the 2019 Status Review, the habitat for this species was described as isolated ravines with difficult access and small patches of forest. It is suggested that the presence of these rare and listed plants also indicate that the steep, inaccessible limestone hills or "mogotes" and ravines have served as a refuge from human activities. The presence of this species in forested and inaccessible habitat makes it unlikely to occur in areas that would be exposed to labeled malathion usage. As such, we anticipate a low level of exposure to malathion in the non-Federal portion of the species range. Furthermore, we anticipate the conservation measures described above will further reduce the risk of exposure to both pollinators and seed dispersers and the resultant reproductive effects to this plant species. As a result of this limited exposure, we anticipate a reduced reproductive success of a small number of individuals that is not anticipated to cause species-level effects. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of *Goetzea elegans* in the wild.

Zanthoxylum thomasianum

Zanthoxylum thomasianum (St. Thomas prickly-ash) is highly vulnerable based on its status, distribution, and trends, as shown above. There are five known populations, each consisting of between 6 and 116 individuals. These populations have a wide geographic range, occurring on the islands of St. Thomas and St. John, the municipalities of Coamao, Salinas, and Isabela in Puerto Rico, and in the British Virgin Islands in Gorda Peak National Park on Virgin Gorda (Clubbe et al. 2003 *in* USFWS 2015), and at Hawk's Nest on Tortola (Pascoe 2014 *in 2015 Status Review*). The species' rarity and restricted distribution makes it vulnerable to habitat destruction and modification. Most populations lie within private lands that may be modified, causing damage or even extirpation due to lack of knowledge of the species by land owners. Activities such as road construction may also affect the species by direct impact and by creating an edge effect, which promote the invasion of exotic species. (2015 5-year Status Review). The species is still in danger of extinction throughout all or a significant portion of its range as it remains threatened by habitat destruction or modification and other natural or manmade factors such as hurricanes, landslides, genetic variation, dioecy, and exotic and invasive species (USFWS 2015).

We anticipate a high level of risk to this species posed by the labeled uses of malathion across the non-Federal portion of its range, as shown above. The species relies on insects as its pollination vector. It can utilize abiotic (e.g. wind and water) as well as biotic vectors for seed dispersal. As discussed above, we anticipate that malathion usage within the non-Federal portion of the species range will result in a reduction in insects, and a reduction and sublethal effect in birds. Reduced availability of insects and birds would affect pollination and seed dispersal, and would be expected to cause a reduction in an individual's reproductive success.As described in the Analysis of Pacific and Caribbean Island Species, we considered available usage data broadly and determined the relative likelihood of exposure of island species based on their habitat. *Zanthoxylum thomasianum* is endemic to the Puerto Rican Bank (Puerto Rico and Virgin Islands, except St. Croix), and occurs primarily within the subtropical dry forest and subtropical moist forest zone. These life zones were once extensively deforested for agriculture and charcoal production, but have undergone forest regeneration after agricultural practices have been significantly diminished. The location and distribution of the species in Puerto Rico seem to be associated with small remnants of native vegetation on land that has little agricultural value (2015 5-year Status Review). On the islands of St. John and St. Thomas, St. Thomas prickly-ash was not documented in littoral stands near sea-level, instead it occurs in slopes above the sea spray zone from 30 to 300 m elevation. (2015 5-year Status Review). Based on this description of the species habitat, we anticipate a medium level of exposure within the non-Federal portion of the species range. For the Caribbean Islands, as described above, overall usage and likelihood of exposure is anticipated to be low. Furthermore, we anticipate the conservation measures described above will further reduce the risk of exposure to both pollinators and seed dispersers and the resultant reproductive effects to this plant species. We therefore anticipate that adverse reproductive effects to the small number of

individuals likely to be exposed to malathion would not rise to the level of species-level effects. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of *Zanthoxylum thomasianum* in the wild.

Assessment Group 10 (*Dicots reliant on biotic pollination vectors and able to use self-fertilization or vegetative reproduction at least partially to maintain populations over time, species numbered 25-28)*

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence *Cordia bellonis*, *Peperomia wheeleri*, *Harrisia portoricensis*, and *Trichilia triacantha*.

The species in this assessment group are all highly vulnerable based on their status, distribution, and trends, as shown above, with the exception of *Peperomia wheeleri*, which has a medium level of vulnerability. We do not have information available on the number of populations of the endangered *Cordia bellonis*, but are aware of about 81 individuals occurring within three public forests in Puerto Rico. *Harrisia portoricensis* is threatened, and is known to occur in three discrete and protected islands – Mona, Monito, and Deecheo – with efforts underway to introduce the species into three additional protected areas. The total number of individuals for this species is estimated to be between 20,000 and 50,000, and is considered to be stable. *Trichilia triacantha* is endangered and is found in about 15 populations with a total of only about 162 individuals. *Peperomia wheeleri* is endangered and is known only from Culebra, a small island east of Puerto Rico, in four populations totaling about 1,400 individuals. Its numbers are increasing, which is why it is considered to be less vulnerable than the other species in this assessment group.

We anticipate that risk to the species in this assessment group posed by the labeled uses of malathion across the non-Federal portion of the species' ranges is high, with the exception of *Peperomia wheeleri*, which has a medium level of anticipated risk. We anticipate that malathion usage within the non-Federal portion of the species range will result in a reduction in insects, and sublethal effects to birds. Reduced availability of insects and birds would affect pollination and seed dispersal, and would be expected to cause a reduction in the reproductive success of individuals. Insects are identified as pollination vectors for all of the species in this assessment group; however, these species can also utilize self-fertilization or asexual means for reproduction, this decreasing their reliance on biotic pollination vectors and reducing the risk of reproductive effects caused by pollinator exposure to malathion within the non-Federal portion of their ranges.

Peperomia wheeleri and *Harrisia portoricensis* depend on biotic vectors to disperse seeds, including insects and birds. *Cordia bellonis* and *Trichilia triacant* are able to utilize abiotic vectors (e.g., wind and water) in addition to biotic vectors for seed dispersal, reducing the risk of reproductive effects caused by seed disperser exposure to malathion within the non-Federal portion of their ranges. We therefore anticipate adverse effects to the species in this assessment group related to decreased reproductive success of individuals within each species.

As described in the Analysis of Pacific and Caribbean Island Species, we considered available usage data broadly and determined the relative likelihood of exposure of island species based on their habitat. *Peperomia wheeleri* is found in both semi-evergreen seasonal open forest (Culebra) and subtropical wet forest (Isabela). *Harissia portocensus* occurs in subtropical dry forest, cactus forest, plateau forest, depression forest, cliffside forest, and plateau scrub vegetation types (USFWS Recovery Plan, 1996). *Trichilia tricantha* occurs in deciduous and semi-evergreen seasonal forests of the subtropical dry forests. *Cordia bellonis* Subtropical wet forest, subtropical moist forest, and subtropical lower montane wet forest (EPA, 2016) We anticipate that these species will have a low level of exposure to malathion given the habitats they occur in, with the exception of *Cordia bellonis* which we anticipate will have a medium level of exposure. For the Caribbean Islands, overall usage and likelihood of exposure is anticipated to be low, as described above.
We therefore anticipate that adverse reproductive effects to the small number of individuals likely to be exposed to malathion usage by the proposed action would not result in species-level effects for *Peperomia wheeleri*, *Harissia portocensus*, and *Trichilia tricantha*.

Cordia bellonis, which is highly vulnerable, is at high risk posed by the proposed action, and is anticipated to have a medium level of exposure. This species *Peperomia wheeleri*,and *Harrisia portoricensis*,are anticipated to have very low levels of usage since the FWS Puerto Rico Field Office (Pers. Comm. 2017, Felix Lopez) described them as occurring in unpopulated to sparsely populated areas of Puerto Rico and the U.S. Virgin Islands, or in protected areas such as Mona Island. The majority of non-agricultural and agricultural practices that would include the use of malathion also do not occur in these areas due to environmental conditions and lack of suitable agricultural land. Where non-agricultural uses may occur within the action area, we anticipate there will be no overlap with that type of use and the species habitats. As a result, while we anticipate adverse effects due to the loss of insect and bird pollinators and seed dispersers and the resultant loss of individuals' reproductive success, we do not expect that these adverse effects will cause species-level effects due to the low likelihood of exposure

in the areas where these species occur. Therefore, we do not anticipate the action would appreciably reduce survival and recovery of *Cordia bellonis*, *Peperomia wheeleri*, *Harrisia portoricensis*, and *Trichilia triacantha* in the wild.

Assessment Group 11 (*Dicots reliant on biotic pollination vectors, other reproductive mechanisms unknown, species numbered 29-53):*

After reviewing the current status of the species, the environmental baseline for the action area, the effects of the proposed registration of malathion, and the cumulative effects, it is the Service's biological opinion that the registration of malathion, as proposed, is not likely to jeopardize the continued existence of the plant species assessment group 11.

The 25 species within this assessment group are all highly vulnerable based on their status, distribution, and trends, as described above, with variable levels of risk to individuals or species posed by exposure to malathion, and mostly with low levels of anticipated exposure to malathion, as described below.

Subgroup: High vulnerability, low to high risk, extremely low anticipated exposure based on preferred habitat type

The ten species in this subgroup numbered **32, 33, 36, 39, 40, 44, 46, and 49-51** are all highly vulnerable, have anticipated risk at medium or high levels posed by the labeled uses of malathion across the non-Federal portion of the species' ranges, and are anticipated to have low levels of exposure to malathion within the non-Federal portions of their ranges. They are grouped together here due to additional information related to their likely exposure provided by the FWS' Puerto Rico Field Office, which we will discuss along with the species' vulnerability and risk factors below before our conclusion.

The majority of the species in this subgroup have five or fewer populations, though some possess up to approximately 23 sub-populations. The total known number of individuals for species in this subgroup are as few as six to 465. Species' experts have been searching for Cook's holly (*Ilex cookii*, species number 39), however, the species has not been seen since 1970. Although pesticides and/or pollinator loss are not mentioned as specific threats to any of these species, they remain highly vulnerable due to their status as endangered and their very low numbers. Additionally, many of these species are known from a single location.

We anticipate that risk to the species in this subgroup posed by the labeled uses of malathion across the non-Federal portion of the species' ranges is a mixture of low to high. Species number 32, *Calyptranthes thomasiana*, is the only species in this subgroup with an anticipated low level of risk. This species utilizes mammals as pollination vectors, and we do not anticipate mortality or sublethal effects to mammals within the non-Federal portion of the species range from exposure to malathion. Additionally, this species is able to utilize abiotic vectors (e.g., wind and water) in addition to biotic vectors for seed dispersal. We therefore do not anticipate that malathion usage will adversely affect this species' reproductive success.

All of the species in this subgroup with an anticipated high level of risk (numbered 33, 36, 44, and 49-51) rely on insects as their sole pollination vector. They are all able to utilize abiotic and biotic vectors for seed dispersal. We anticipate that malathion usage within the non-Federal portion of the species range will result in a reduction in insects, which would negatively affect pollination, and to a lesser extent seed dispersal, and would therefore be expected to cause a reduction in the reproductive success of individuals of the species.

In addition, we do not anticipate that the adverse effects to individuals will cause species-level effects due to the very low likelihood of exposure to malathion within the non-Federal portion of the species' ranges. The species in this subgroup have varying habitats at low risk of exposure, including subtropical and subtropical dry forest life zones; within the El Yunque National Forest; in the limestone hill region of northwestern Puerto Rico on steep hills; and within areas that were once agricultural, but have since been abandoned and are in stages of reforestation. Based on descriptions of species occurrences and habitat types, the non-Federal portion of the species habitats in this subgroup are unlikely to overlap with agricultural uses. Additionally, the FWS Puerto Rico Field Office provided further information indicating that these species primarily occur in unpopulated to sparsely populated areas of Puerto Rico and the U.S. Virgin Islands, or in protected areas such as Mona Island. The majority of non-agricultural and agricultural practices that would include the use of the registered product also do not occur in these areas due to environmental conditions and lack of suitable agricultural land. Where non-agricultural uses may occur within the action area, we anticipate there will be no overlap with that type of use and the species habitats. As a result, their exposure to malathion is extremely unlikely to occur. Furthermore, in the Caribbean Islands, overall usage and likelihood of exposure is anticipated to be low, as described above. We further discuss our assumptions and analysis of usage data on Federal lands and in the Caribbean Islands in the Usage section of the Biological Opinion.

Due to the extremely low likelihood that individuals within these species will be exposed to malathion usage per the label, we expect that adverse effects to individuals of these species will not cause species-level effects. Therefore, we do not anticipate the action would appreciably reduce survival and recovery of these species in the wild.

Subgroup: High vulnerability, medium to high risk, low exposure based on preferred habitat type

The twelve species in this subgroup numbered **34, 35, 37, 38, 41-43, 45, 47, 48, 52, and 53** are all highly vulnerable, as discussed above, have anticipated risk at medium or high levels posed by the labeled uses of malathion across the non-Federal portion of the species' ranges, and are anticipated to have low levels of exposure to malathion within the non-Federal portions of their ranges.

The species within this subgroup are highly vulnerable, based on their status, distribution, and trends, as described above. Population trends for the species in this subgroup were either noted to be unavailable, or as increasing. The number of populations within this subgroup ranges from 2 to 16, and most have fewer than 10. The majority of the species in this subgroup have five or fewer populations, but range up to about 23 subpopulations. Total numbers of individuals range from about 45 up to over 4,000. Many of the species are known only from one or two localities.

We anticipate that risk to the species in this subgroup posed by the labeled uses of malathion across the non-Federal portion of the species' ranges is medium for species numbered 34, 35 and 53, and high for all others. The species within this subgroup rely solely on insects for pollination, with the exception of species number 34, for which we do not have information on pollinator species, and species number 53, which utilizes insects as pollination vectors but may also utilize abiotic vectors (e.g., wind and water). The species within this subgroup rely on a range of seed dispersal vectors. Species number 34 relies solely on birds; species 35 utilizes abiotic vectors; species numbered 37, 38, 42, 43, 47, 52, and 53 use both abiotic and biotic vectors; species numbers 41 and 48 utilize insects, birds, and mammals; and species number 48 relies solely on mammals. We anticipate that, where exposure occurs, malathion usage within the non-Federal portion of the species' ranges will result in mortality to insects, and mortality and sublethal effects in birds, which would negatively affect pollination and seed dispersal and would therefore be expected to cause a reduction in the reproductive success of individuals of these species. However, conservation measures will be implemented that we anticipate willreduce the risk of exposure to pollinators and resultant reproductive effects to this species . For example, residential uses of malathion are now limited to two applications per year (reduced from as many as necessary) and to spot treatments only, reducing the application footprint and likelihood of spray drift within developed and open space developed areas. The reduced application footprint and likelihood of spray drift are a result of the allowable application methods for spot treatment (such as the use of hand-pump sprayers, which are not capable of producing broadcast use) and low amounts of chemical used.

In addition, we do not anticipate that the adverse effects to individuals related to reduced reproductive success will cause species-level effects due to the anticipated low level of exposure of the species in this subgroup to malathion within the non-Federal portion of the species' ranges. The species in this subgroup have varying habitats at low risk of exposure. Plants occurring in forests, on cliffs or sand dunes and in bogs were assumed to have 'low' likelihood for malathion exposure. Malathion is not registered for use in forests and we assumed there would also be low likelihood for spray drift within a forest given its physical structure and ability to block drift. Cliffs, sand dunes and bogs on the islands tend to be isolated physically from other land use areas, thus we assumed there would be less likelihood for malathion exposure from direct use and spray drift. We further informed our analysis of the effects of the proposed action with available information on usage. In the Caribbean islands, overall usage and likelihood of exposure is anticipated to be low, as described above. Moreover, we anticipate the conservation measures described above will further reduce the risk of exposure to both pollinators and seed dispersers and the resultant reproductive effects to the plant species. For example, residential uses of malathion are now limited to two applications per year (reduced from as many as necessary) and to spot treatments only, reducing the application footprint and likelihood of spray drift within developed and open space developed areas.

Due to the low likelihood that individuals of the species in this subgroup will be exposed to malathion usage, we expect that adverse effects to individuals of these species will not result in species-level effects. Moreover, we anticipate the conservation measures will further reduce the likelihood of exposure of the species and its pollinators and seed dispersers. Therefore, we do not anticipate the action would appreciably reduce survival and recovery of these species in the wild.

Subgroup: High vulnerability, high risk and medium to high exposure

Catesbaea melanocarpa (species 29), Solanum drymophilum (species 30), and *Stahlia monosperma (species 31)* have high vulnerabilities based on their status, distribution and trends, high risk posed by the labeled uses across their ranges, and high or medium exposure based on preferred habitat type.

Species number 29, *Catesbaea melanocarpa:*

C. melanocarpa is a small, spiny shrub endemic to very limited areas of St. Croix in the U.S. Virgin Islands and Puerto Rico. This species has high vulnerability based on its status, distribution and trends. In 2018, there were an estimated 535 individuals across three populations located on St. Croix, U.S. Virgin Islands (522 individuals on a private farm); Guánica, Puerto Rico (12 individuals on protected land); and Peñuelas, Puerto Rico (1 individual on private lands) (2018 5-year Status Review). A fourth population in Punta Melones, Puerto Rico, appears to have disappeared between 2011 and 2018. The population of 12 individuals at the Guánica Commonwealth Forest in Puerto Rico remains relatively protected at this time (2018 5- year Status Review). The Service designated an area in Halfpenny Bay near Christiansted in St. Croix as critical habitat for the species in 2007. The population in St. Croix continues to be threatened by land clearing and unregulated harvesting of hay. In addition, the 2018 5-year Status Review reports the St. Croix population is now partially surrounded by row crop agriculture.

The species has a high level of risk posed by labeled uses of malathion across the non-Federal portion (about 98%) of its range. The species relies on biotic pollination by insects, as shown above, and bees and wasps are thought to be the primary pollinators (2018 5-year Status Review). Insect pollinators are expected to experience high levels of mortality across the non-Federal portions of the species range from exposure to malathion. The species relies on both abiotic and biotic vectors for seed dispersal, giving the species the capability to reproduce successfully even in the absence of a portion of its biotic seed dispersal vectors. The role of birds as dispersers needs further research (Morgan and Zimmerman 2017 *in* 2018 5-year Status Review). We anticipate adverse effects to the species related mainly due to the loss of pollinating insects, and also to the loss of seed dispersal species, both affecting reproductive success. We also expect that individuals of these species will experience reduced growth due to direct exposure to malathion within their ranges, where exposure occurs.
We anticipate high exposure to malathion based on its current habitat, where it is found primarily in pasture, agricultural, cultivated or other disturbed areas. These habitat types are more likely to experience malathion application, as they correspond to registered malathion use types. Although the species is typically found in forests in Puerto Rico (13 individuals) where anticipated exposure to malathion is low, the largest population is found in St. Croix on the dry coastal plain in dry thicket scrub, dominated by grasses and patches of trees and shrubs. The site where the species is found in St. Croix is also an agricultural track that experiences periods of intense grazing. Additionally, hay harvesting has been observed in close proximity to the population in St. Croix on land designated as critical habitat (Yrigoyen, USFWS, pers. obs., 2018 in 2018 5-year Status Review). In order to address anticipated pollinator mortality from malathion exposure and resultant reproductive effects to the species, a label restriction specific to this species will be implemented in addition to the general conservation measures described above. This species-specific measure does not allow malathion application within the range of the species, plus 100 feet beyond the range to account for potential spray drift from applicators adjacent to the range. While the exact amount of spray drift reduction from the extra 100 feet around the range will vary depending on the traits of the ecosystem as well as the application method, based on AgDRIFT modeling, we anticipate spray drift reductions ranging from 82 to 90%. Together, these measures are anticipated to substantially reduce the pollinator exposure and thus mortality of these taxa from malathion application within and immediately surrounding the range of this species, substantially reducing reproductive effects to this species.

Given the conservation measures to be implemented and the anticipated reduction in pollinator exposure and reproductive effects, we do not anticipate these effects will result in species-level effects. Therefore, we do not anticipate that the proposed action would appreciably reduce survival and recovery of *C. melanocarpa* in the wild.

Species number 30, the Erubia, *Solanum drymophilum*, is a spiny shrub endemic to Puerto Rico. The latest Status Review from 2015 states it can be found in three locations, Piedras del Collado, Arecibo (partially in Rio Abajo Commonwealth Forest) and near PR-140 in the Florida region. However, the status and distribution of populations and individuals has not been systematically re-evaluated since 1992. At that time, there were approximately 150 individuals in the Peidras del Collado area, >50 in Arecibo and an unknown number in the Florida region. Captive propagation and outplanting have been attempted in Rio Abajo Commonwealth Forest, but the status of these plants is unknown. Other attempts at outplanting have been unsuccessful. Specific species of pollinators and seed dispersers for this plant are unknown. It is assumed pollinators are mainly insects based on known pollinators of other species in the genus Solanum. Seed dispersers are thought to be biotic and most likely birds based on fruit type. Insect pollinators are anticipated to experience mortality if exposed to malathion. Avian seed dispersers exposed to malathion on use sites may experience mortality or sublethal effects, depending on the site of exposure and size of the bird. Smaller birds exposed on use sites with higher allowable use rates (e.g., developed, open space developed, orchards and vineyards) have a greater chance of being affected. Exposure to spray drift is not expected to result in effects to avian seed dispersers. As a result, we anticipate adverse effects to this species due to the reduction in pollinating insects and seed dispersing birds that would result in reduced reproductive success. However, conservation measures will be implemented that are anticipated to reduce the risk of exposure to pollinators and resultant reproductive effects to this species, as described above. For example, residential uses of malathion are now limited to two applications per year (reduced from as many as necessary) and to spot treatments only, reducing the application footprint and likelihood of spray drift within developed and open space developed areas. The reduced application footprint and likelihood of spray drift are a result of the allowable application methods for spot treatment (such as the use of hand-pump sprayers, which are not capable of producing broadcast use) and low amounts of chemical used.

We anticipate medium exposure to this species based on its preferred habitat of open or disturbed sites with poor soils and exposed topography, though this species has also been found in openings within forests, which could further reduce exposure. In addition, there is a low probability that the species range will overlap with or occur in the proximity of a malathion agricultural use site on the Caribbean islands, as described above, so it is unlikely malathion usage will occur in or near this species' range. Thus, based on the low level of exposure expected, we do not anticipate the reductions in pollinator or seed disperser numbers and resulting reduction in reproductive capacity for this species to rise to the level of species-level effects. Moreover, we anticipate the conservation measures will further reduce the likelihood of exposure of the species and its pollinators and seed dispersers. Therefore, we do not anticipate the action would appreciably reduce survival and recovery of *Solanum drymophilum* in the wild.

Species number 31 *Stahlia monosperma*, , has a high vulnerability based on its status, distribution, and trends, as described above. This species is listed as threatened, and its populations are increasing due to knowledge of more naturally occurring populations than previously reported, and an increased number of individuals in the wild. It is known to have nine populations, and over 2,000 individuals have been planted in at least 18 municipalities throughout Puerto Rico over the past 13 years (as of 2014). There are about 200 known individuals of this species in the wild. Threats to *Stahlia monosperma* include habitat modification and fragmentation associated with urban development, lack of natural recruitment occurring in natural populations (suggesting problems of seed dispersal), hurricanes and climate change, human-induced fires, invasive species, and small natural populations with limited geographic distributions. (2014 5-year Status Review).
We anticipate a high level of risk to the species posed by labeled uses of malathion across the non-Federal portions (~88%) of the species range, as shown above. This species utilizes insects as pollination vectors, and can use both abiotic (e.g., wind and water) and biotic vectors for seed dispersal, most likely giving the species the capability to reproduce successfully even in the absence of a portion of its biotic seed dispersal vectors. Insect pollinators are expected to experience high levels of mortality across the non-Federal portions of the species range from exposure to malathion. We anticipate adverse effects to the species related mainly to the loss of pollinator insects, but also to the loss of seed dispersal species, both affecting reproductive success. However, conservation measures will be implemented that are anticipated to reduce the risk of exposure to pollinators and resultant reproductive effects to this species, as described above. For example, residential uses of malathion are now limited to two applications per year (reduced from as many as necessary) and to spot treatments only,

reducing the application footprint and likelihood of spray drift within developed and open space developed areas. The reduced application footprint and likelihood of spray drift are a result of the allowable application methods for spot treatment (such as the use of hand-pump sprayers, which are not capable of producing broadcast use) and low amounts of chemical used.
We do not anticipate that the adverse effects to individuals will cause species-level effects due to anticipated medium exposure to malathion within the non-Federal portion of the species' ranges, low expected malathion usage, and the occurrence of 80% of the natural population within protected areas: Punta Ventana, Vieques National Wildlife Refuge (VNWR), Punta Guaniquilla, and Punta Picua. *S. monsperma* grows within the subtropical dry forest along the south-southwest coast of Puerto Rico, most of Vieques Island, all of Culebra Island and the northeastern most part of Puerto Rico. Individuals grow in brackish, seasonally flooded wetlands in association with mangrove communities and along creeks. This species is also known to occur within developed areas. The Service conducted a site visit to the population along Road PR 307 (Boquerón Country Club), where the individuals are found along a creek in the middle of a residential development project, and found that all individuals (17) are still present and alive (2014 5-year Status Review). Based on descriptions of species occurrences and habitat types, the non-Federal portion of the species habitat may have some overlap with agricultural uses. However, in the Caribbean islands, overall usage and likelihood of exposure is anticipated to be low, as described above.

Based on the low level of exposure expected we do not anticipate the reductions in pollinator or seed disperser numbers and resulting reduction in reproductive capacity for this species to rise to the level of species-level effects. Moreover, we anticipate the conservation measures will further reduce the likelihood of exposure of the species and its pollinators and seed dispersers. Therefore, we do not anticipate the action would appreciably reduce survival and recovery of *Stahlia monosperma* in the wild.