Integration and Synthesis Summary for Plants, Pacific Islands
Flowering Plants Assessment Group 10 – Dicots reliant on outcrossing by biotic pollination vectors and can utilize self-fertilization and/or vegetative reproduction

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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 summary for this assessment group also includes 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 this assessment groups 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. All plants in this group 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. Seed dispersal for the species in this group is achieved by biotic (dispersal by animals) and/or abiotic (dispersal by wind, water or gravity) means.

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; HI=Hawaii

Scientific Name	Common Name	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
Cyanea asarifolia	Haha	HI	Endangered	Not Available	Not Available	1 (USFWS, 2009)	This species is restricted to Kauai. (NatureServe, 2015)	20-30 (USFWS, 2009)	No Mention	No Mention	High
Cyanea longiflora	Haha	HI	Endangered	Decreasing since 1996	Not Available	3 (USFWS, 2016)	Currently, only the Waianae occurrences are extant, however, they have declined in numbers of known individuals since the listing (USFWS, 2016).	171 (USFWS, 2016)	No Mention	Loss of bird pollinators (USFWS, 2016)	High
Cyanea recta	Haha	HI	Threatened	Not Available	Not Available	8 (USFWS, 2010)	Endemic to the island of Kauai. In 2003, there was a total of 8 populations, with approximately 198 to 208 individuals, on State and private lands in the following areas: Waioli Valley, the left and right branches of Wainiha Valley, Makaleha Mountains, and Puu Eu, including areas in Halelea Forest Reserve, Kealia Forest Reserve, and the Lihue-Koloa Forest Reserve (USFWS 2003). (USFWS 2010)	1,000-1,500 (USFWS, 2010)	No Mention	No Mention	High
Cyanea undulata	Haha	HI	Endangered	Not Available	Not Available	1 (USFWS, 2003)	The current range is the Wahiawa Drainage of Kauai. (NatureServe, 2015)	28 (USFWS, 2003)	No Mention	Lack of dispersal, germination, and pollination agents (USFWS, 1994)	High

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

Scientific Name	Common Name	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
Kokia drynarioides	Koki`o	HI	Endangered	Stable (USFWS, 2015)	Not Available	2 (USFWS, 2015)	Currently known from the North Kona District of western Hawaii Island. (NatureServe, 2015)	2-8 wild individuals (USFWS, 2015)	No Mention	No Mention	High
Mezoneuron kavaiense	Uhiuhi	HI	Endangered	Short-term trends indicate slight increases (USFWS, 2015)	Not Available	7 (USFWS, 2019)	Endemic to Hawaiian Islands. Its current range includes Kauai, Waianae Mountains of Oahu, and Hawaii. (NatureServe, 2015)	~80 (USFWS, 2019)	No Mention	No Mention	High
Phyllostegia kaalaensis	No common name	HI	Endangered	Unknown	Not Available	1 (USFWS, 2016)	*Phyllostegia kaalaensis* is endemic to the Waianae Mountains of Oahu, where it has been known only since the 1970s (USFWS, 2016).	2 individuals (USFWS, 2016)	No Mention	No Mention	High
Phyllostegia knudsenii	No common name	HI	Endangered	Not Available	Not Available	None currently known (USFWS, 2009)	Unknown (USFWS, 2009)	Not Available	No Mention	No Mention	High
Phyllostegia mollis	No common name	HI	Endangered	Not Available	Not Available	8	Currently, this species is only known from Oahu and Maui. On Oahu, 98 to 118 individuals are found in eight occurrences: south Mohiakea Gulch (5 individuals), Mohiakea Gulch (50 to 70), north Palawai (1), central Kaluaa (1), Huliwai Gulch (2), Waieli (7), Pualii Gulch (16), and Ekahanui (16) (J. Lau, HINHP, pers. comm. 2003; K. Kawelo, U.S. Army, pers. comm. 2003). On East Maui, it is known from Waiopai Gulch (Service 1998a).	~98 - 118	No Mention	No Mention	High
Schiedea obovata	No common name	HI	Endangered	Unknown	Not Available	2 (USFWS, 2016)	Endemic to Waianae Mountains of Oahu (NatureServe, 2015).	389 individuals (USFWS, 2016))	No Mention	No Mention	High
Solanum sandwicense	`Aiakeakua, popolo	HI	Endangered	Not Available	Number of individuals stable, number of populations declining (USFWS, 2009)	5 (USFWS, 2009)	This species was last seen on Oahu in 2000 (USFWS, 2003). It currently occurs in Kokee State Park, Kuia Natural Area Reserve, and Na Pali-Kona Forest Reserve at Kahuamaa Flats, Honopu, Awaawapuhi, Nualolo, Kumuwela Ridge, Kawaiiki, Waialae Valley, and Mokuone Stream (Kauai) (USFWS, 2009).	18 - 20 wild, 446 outplanted	No Mention	No Mention	High
Stenogyne kanehoana	No common name	HI	Endangered	Not Available	Not Available	1 (USFWS, 2013)	Occurs in the southern Waianae Mountains (NatureServe, 2015). The population near the summit of Puu Kanehoa on privately owned land was found dead recently. An additional occurrence in Kaluaa Gulch was discovered in 2000 by Joan Yoshioka of TNCH (USFWS, 2003).	1 (USFWS, 2013)	No Mention	No Mention	High

Scientific Name	Common Name	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
Tetramolopium arenarium	No common name	HI	Endangered	Not Available	Not Available	2 (USFWS, 2012)	The only extant locality for the species is on the northwestern side of the U.S. Army's Pohakuloa Training Area (FWS 2012).	12 (8 mature, 4 juveniles) (USFWS, 2012)	No Mention	No Mention	High
Tetramolopium capillare	Pamakani	HI	Endangered	Not Available	Not Available	May be extinct in wild (USFWS, 2018)	Endemic to West Maui. May be extinct in the wild (2018 5-Year Status Review).	May be extinct in wild (USFWS, 2018)	No Mention	No Mention	High
Tetramolopium filiforme	No common name	HI	Endangered	Decreasing (USFWS, 2016)	Not Available	7 (USFWS, 2016)	Current range: northern Waianae Mountains, Oahu; historically no additional range.	~3,500 (USFWS, 2016)	No Mention	No Mention	High
Tetramolopium lepidotum ssp. lepidotum	No common name	HI	Endangered	Declining (USFWS, 2013)	Not Available	1 (USFWS, 2009)	Range includes Waianae Mountains, Oahu. (NatureServe, 2015)	147 (USFWS, 2013)	No Mention	No Mention	High
Tetramolopium remyi	No common name	HI	Endangered	Not Available	Not Available	1 (USFWS, 2011)	*Tetramolopium remyi* was listed as endangered in 1991. At that time, it was known from a single population of 35 plants on Lanai (USFWS 1991). (USFWS, 2011)	<10 (USFWS, 2011)	No Mention	No Mention	High
Tetramolopium rockii	No common name	HI	Threatened	Stable (USFWS, 2016)	Not Available	4 (USFWS, 2016)	*Tetramolopium rockiivar. rockii* remains in two areas: from Kapalauoa to Kahinaakalani on West Molokai, and north of Kalawao on Kalaupapa Peninsula on East Molokai. (USFWS, 1996)	~94,000 (NatureServe, 2015)	No Mention	No Mention	High
Viola kauaiensis var. wahiawaensis	Nani wai`ale`ale	HI	Endangered	Unknown (NatureServe, 2015)	Not Available	1-2 (USFWS 2017, 2019)	Current range: Wahiawa area of Kauai; historically no additional range. Genus widespread in temperate regions of world. Species endemic to Kauai and Oahu, variety endemic to Kauai. Currently, there is one population in the same area of 1 or 2 individuals (PEPP 2017; Walsh 2017, in litt.). Another potential population of more than 100 individuals was discovered at Kawaikini; however, the identity of these plants has not been confirmed (PEPP 2015) (USFWS 2017).	<50 (USFWS 2019);	No Mention	No Mention	High

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

Table 2: Summarizing Data and Information for Risk Ranking

Data Sources: SOS accounts (Appendix C); NA=Not Applicable; HI=Hawaii

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.
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 mortality or sublethal effects are expected for mammalian pollinators or seed dispersers from malathion exposure either on use sites or from spray drift.

Scientific Name	Common Name	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
Cyanea asarifolia	Haha	HI	Yes (12%)	Medium	Biotic - Asexual, Self-pollinating	Abiotic, Bird, Mammal	Unknown	Insect, Bird	0.00	Medium
Cyanea longiflora	Haha	HI	Yes (12%)	Medium	Biotic - Asexual, Self-pollinating	Abiotic, Bird, Mammal	No	Insect, Bird	14.86	High
Cyanea recta	Haha	HI	Yes (12%)	Medium	Biotic - Asexual, Self-pollinating	Abiotic, Bird, Mammal	Unknown	Insect, Bird	0.00	Medium
Cyanea undulata	Haha	HI	Yes (12%)	Medium	Biotic - Asexual, Self-pollinating	Abiotic, Bird, Mammal	Unknown	Insect, Bird	0.00	Medium
Kokia drynarioides	Koki`o	HI	Yes (12%)	Medium	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	Unknown	Insect, Bird	0.00	High
Mezoneuron kavaiense	Uhiuhi	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	No	Insect	10.78	Medium
Phyllostegia kaalaensis	No common name	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	Unknown	Insect	28.66	High
Phyllostegia knudsenii	No common name	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	unknown	Insect	0.00	High
Phyllostegia mollis	No common name	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	No	Insect	31.81	High
Schiedea obovata	No common name	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	Unknown	Insect	37.29	Medium
Solanum sandwicense	`Aiakeakua, popolo	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Biotic	Unknown	Insect	5.71	Medium
Stenogyne kanehoana	No common name	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	Unknown	Insect	35.72	Medium
Tetramolopium arenarium	No common name	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	unknown	Insect	8.40	Medium
Tetramolopium capillare	Pamakani	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	Unknown	Insect	0.00	Medium
Tetramolopium filiforme	No common name	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	No	Insect	25.93	Medium
Tetramolopium lepidotum ssp. lepidotum	No common name	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	Unknown	Insect	11.75	High
Tetramolopium remyi	No common name	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	No	Insect	0.00	High

Scientific Name	Common Name	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
Tetramolopium rockii	No common name	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Biotic	Unknown	Insect	2.27	High
Viola kauaiensis var. wahiawaensis	Nani wai`ale`ale	HI	Yes (12%)	High	Biotic - Asexual, Self-pollinating	Abiotic, Insect	Unknown	Insect	0.00	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 been recently provided by EPA and will be implemented as part of the Action. These measures will apply to all species in this assessment group 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 further reducing the risk of reproductive effects to the species. We summarize the new measures and our related assumptions below.

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.

Residential use label changes: New restrictions to the method and frequency of application for residential use of malathion are anticipated to significantly 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. We anticipate this measure will further reduce exposure to biotic pollinators and seed dispersers, thus decreasing the risk of impacts to reproduction and sub-lethal impacts to the plant itself.

Table 3: Summary of Conclusions

Number	Scientific Name	Common Name	Vulnerability ranking	Risk ranking	Potential Exposure ranking	Species Conclusion (J, NJ)
1	*Mezoneuron kavaiense*	Uhiuhi	High	High	Medium	NJ
2	*Tetramolopium arenarium*	No common name	High	High	Medium	NJ
3	*Tetramolopium capillare*	Pamakani	High	High	Medium	NJ
4	*Tetramolopium lepidotum ssp. lepidotum*	No common name	High	High	Medium	NJ
5	*Tetramolopium remyi*	No common name	High	High	Medium	NJ
6	*Viola kauaiensis var. wahiawaensis*	Nani wai`ale`ale	High	High	Medium	NJ
7	*Cyanea longiflora*	Haha	High	Medium	Low	NJ
8	*Cyanea asarifolia*	Haha	High	Medium	Low	NJ
9	*Cyanea recta*	Haha	High	Medium	Low	NJ
10	*Cyanea undulata*	Haha	High	Medium	Low	NJ
11	*Kokia drynarioides*	Koki`o	High	Medium	Low	NJ
12	*Phyllostegia kaalaensis*	No common name	High	High	Low	NJ
13	*Phyllostegia knudsenii*	No common name	High	High	Low	NJ
14	*Phyllostegia mollis*	No common name	High	High	Low	NJ
15	*Schiedea obovata*	No common name	High	High	Low	NJ
16	*Solanum sandwicense*	`Aiakeakua, popolo	High	High	Low	NJ
17	*Stenogyne kanehoana*	No common name	High	High	Low	NJ
18	*Tetramolopium filiforme*	No common name	High	High	Low	NJ
19	*Tetramolopium rockii*	No common name	High	High	Low	NJ

*NJ = No Jeopardy; J = Jeopardy

Rationale for Species Conclusions

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 in this assessment group.

For these species, we anticipate their high vulnerabilities, medium to high levels of risk to individuals or species, and medium to low levels of anticipated exposure to malathion within their ranges based on their habitat type, 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 Pacific 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 Pacific Islands as a whole, this usage is also anticipated to be low (~5% 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 95% 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 Pacific 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).

While we expect some individual plants in this assessment group will experience reduced growth due to direct exposure to malathion, we do not anticipate this reduction in growth would have species-level effects.

Species numbered 1-2 and 4-6: These species all have high vulnerabilities based on their status, distribution and trends, high risk posed by labeled uses across their ranges, and have medium anticipated exposure to malathion within their ranges based on their habitat type. Estimated usage of malathion within these species' ranges is anticipated to be low (<5% as an upper bound for malathion) as described above.

The high vulnerability determination for species within this subset is mostly attributed to their status as endangered species, small numbers of populations and individuals, restricted ranges, and in at least one case (i.e., species number 4) declining population trends. All plant species in this subset have an estimated 12-147 individuals in the wild across 1-2 populations, with the exception of species number 1, which has 7 populations. Loss of pollinators is not known to be a threat for any of these species.

We anticipate high risk to individuals for species within this subset if exposed to malathion across the non-Federal portion of their ranges. Risk is related to reproduction through effects to pollinators and/or seed dispersers. Like all species in this assessment group, species 1-2 and 4-6 need to achieve outcrossing (pollen transfer between individuals) at least partially, in order to reproduce successfully and maintain their populations over time. Species within this subset use insect vectors to accomplish outcrossing and pollination, and insect pollinators are expected to experience high levels of mortality across the non-Federal portions of their ranges from exposure to malathion, as indicated in Table 2 (Effects to Pollinators column). These species rely on both abiotic (e.g., wind and water) and biotic (e.g., insect, bird, mammal) vectors for seed dispersal, giving these species the capability to reproduce successfully even in the absence of a portion of its biotic seed dispersal vectors. Thus, we anticipate adverse effects to individuals of the species in this subset is related mainly to the loss of a portion of their pollinators, and also to the loss of seed dispersers, both of which would result in reduced reproductive success of the affected individual plants.

Within this subset, only ranges for species 2 and 6 overlap with federal lands. Although the range for species 2, *Tetramolopium arenarium*, overlaps with federal lands by 14.86 percent, the only extant locality for the species is on federal lands on the northwestern side of the U.S. Army's Pohakuloa Training Area (USFWS 2012).

Due to the lack of robust use and usage data for the Pacific Islands, we further refine our analysis by considering the habitats the species are known or assumed to occupy (Table 3 Potential Exposure Ranking column). We are able to more easily estimate exposure to malathion for species that occur within habitat types that place them either at a lower likelihood of exposure (e.g., within forested areas where malathion is not approved for usage and where drift from any adjacent application areas is less likely to enter) or at a higher likelihood of exposure (e.g., within or adjacent to pastures or agricultural land); however, the medium category is more difficult to discern. A medium ranking was assigned to species found in shrubland or grassland and to those species without precise habitat descriptors that provided indication of either low or high anticipated exposure. A medium level of anticipated exposure indicates that it is likely that individuals of these species, and most importantly their pollinators and biotic seed dispersal vectors, will be exposed to malathion within some non-Federal portion of their ranges. The species within this subset are anticipated to have a medium level of exposure to malathion because some individuals for each species may occur in shrublands or on flats and ridges. However, because we anticipate usage to be low (e.g., <5%, as noted above), the likelihood of exposure of individuals to the effects of malathion are further reduced, 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.

While we anticipate that the proposed action will result in adverse effects to small numbers of individuals over the duration of the proposed action, we do not anticipate species-level effects for species 1-2 and 4-6 because the species included in this subgroup have the benefit of multiple populations and/or larger numbers of individuals; exposure and effects are likely to be further reduced due to the conservation measures that will be implemented. Species number 2, *Tetramolopium arenarium*, has few individuals, but the remaining extant population is entirely on Federal lands (USFWS 2012) where we anticipate malathion usage to be low. We therefore do not anticipate that the proposed action would appreciably reduce survival and recovery of these species in the wild.

Species numbered 7-19: These species all have high vulnerabilities based on their status, distribution and trends, high or medium risk posed by labeled uses across the non-Federal portions of their ranges, and have low anticipated exposure to malathion within their ranges based on their habitat type. Estimated usage of malathion within these species' ranges is anticipated to be low (<5% as an upper bound for malathion) as described above.

All but two species within this subset are Federally Endangered, the exceptions being species number 9 and 19, which are Federally Threatened. The number of estimated populations for each species ranges from one to eight, and the number of estimated individuals for each species ranges from about 1 to 94,000. No information on number of individuals or populations is currently known for *Phyllostegia knudsenii* (species 13). Loss of pollinators

is noted as a threat for *Cyanea longiflora* (species 7) and *Cyanea undulata* (species 10). In the case of *Cyanea longiflora* (species 7), the loss of pollinators is due to the near-extirpation of the long-billed, nectar-feeding native Hawaiian birds that are the presumed pollinators of this species within the Waianae Mountains (Makua Implementation Team 2003) (USFWS, 2016).

We anticipate high or medium risk to individuals for species numbered 7-19 if exposed to malathion across the non-Federal portion of their ranges. Risk is related to reproduction through effects to pollinators and/or seed dispersers. Like all species in this assessment group, species in this subset need to achieve outcrossing (pollen transfer between individuals) at least partially, in order to reproduce successfully and maintain their populations over time. Species 12-19 use insect vectors and species 7-11 use insect and bird vectors to accomplish outcrossing and pollination. Insect and bird pollinators for species 7-19 are anticipated to experience medium or high levels of mortality across the non-Federal portions of the plant species' ranges from exposure to malathion, as indicated in Table 2 above (Effects to Pollinators column). These species rely on both abiotic (e.g., wind and water) and biotic (e.g., insect, bird, mammal) vectors for seed dispersal (except for species number 16 which only relies on biotic seed dispersers), giving most of these species the capability to reproduce successfully in the absence of a portion of their biotic seed dispersal vectors, albeit at a reduced level than when biotic seed dispersal vectors are available. Thus, we anticipate adverse effects to individuals of the species in this subset related mainly to the loss of a portion of their pollinators, and also to the loss of a portion of their seed dispersers, both of which would result in reduced reproductive success of the affected individual plants.

All of the species in this subset occur in a variety of habits including forests, sand dunes, or cliff faces. While we anticipate some adverse effects to individuals of these species caused mainly by a reduction in insect and bird pollinators and also by a reduction in biotic seed dispersers, malathion is not registered for use in forests where many of these species are found. We assume there would also be low levels of spray drift within a forest given its physical structure and ability to block drift. Cliffs and sand dunes on the islands tend to be isolated physically from other land use areas; thus we assumed there would be less potential for malathion exposure from direct use and spray drift. As a result, we anticipate a low exposure to malathion usage within the non-Federal portions of their ranges for this subset of species. Furthermore, we anticipate usage to be low (e.g., <5%, as noted above), further reducing the likelihood of exposure individuals to the effects described above. Moreover, we anticipate the conservation measures described above will reduce the risk of exposure to both pollinators and seed dispersers and the resultant reproductive effects to the plant 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.

While we anticipate that the proposed action will result in adverse effects to small numbers of individuals over the duration of the proposed action, we do not anticipate species-level effects for species numbered 7-19 due to the low levels of anticipated exposure to malathion within their ranges. We expect the conservation measures that will be implemented will further reduce the likelihood of exposure and effects to these species. We therefore do not anticipate that the proposed action would appreciably reduce survival and recovery of these species in the wild.

Species number 3, *Tetramolopium capillare* (Pamakani):

Pamakani is a short-lived perennial shrub in the sunflower family (Asteraceae) and is known only from the western side of the island of Maui. The Pamakani has a high vulnerability based on its status, distribution, and trends. In 2012, it was estimated that fewer than 200 individuals existed in the wild (USFWS 2012 5-year Status Review). However, the most recent 5-year Status Review in 2018 states the species may be extinct in the wild as there are currently no known occurrences in existence. Furthermore, there are no recent collections for this species and to our knowledge, it is not represented in any *ex situ* collection (USFWS 2018). The species range does not overlap with Federal lands. This species was last observed on wet cliff (Kauaula), dry cliff, and lowland dry (Ukumehame) ecosystems in the mountains of west Maui in 2003. Surveys in 2006, 2008, 2009 and 2010 failed to find any individuals (Final Critical Habitat designation 2016, 5-Year Status Review 2012). In 2016, seven units of critical habitat in three ecosystems (lowland dry, dry cliff and wet cliff) were designated for this species based on the last known sites of occurrence and in areas of habitat considered favorable to its existence. The areas designated as critical habitat are composed mainly of protected state lands (approximately 80%), while the remaining areas are privately owned. Some of the privately owned areas are under conservation management through the West Maui Mountains Watershed Partnership and Partners for Fish and Wildlife Agreements (Final Critical Habitat designation 2016).

The Pamakani has a high level of risk posed by labeled uses of malathion across its range. Details of this species life history are unknown, though while reproduction may occur by self-fertilization and/or vegetative methods, the species is likely pollinated by insects, based on pollinators of other members of the sunflower family. This species may rely on both abiotic and biotic vectors for seed dispersal. Although continued pollination by insects is important for many species capable of self-fertilization to maintain genetic diversity, especially in small populations, that information is not available for this species. Insect pollinators are expected to have a high level of mortality across the species range from exposure to malathion. We anticipate adverse effects to the species related mainly to the loss of pollinator species, and to the loss of seed dispersal species, both affecting reproductive success.

We anticipate a medium level of exposure to individual plants and their pollinators from malathion within the species range (Table 3). This ranking was assigned to species found in shrubland or grassland and those species without habitat descriptors that provided indication of either low or high exposure.

However, this species may be extinct in the wild and in the event this species is rediscovered in the future, it would most likely be in areas of designated critical habitat, the majority of which is either protected or under conservation management (where we anticipate a low level of exposure to malathion for this species and its pollinators). Additionally, to date, propagation and re-introduction efforts have not been successful and there are no plants or seeds in collections that could be used for propagation, further decreasing the likelihood of exposure to future re-introduced populations during the duration of this consultation (5-year Status Review, 2018). Furthermore, we anticipate usage to be low (e.g., <5%, as noted above), reducing the likelihood of exposure of individuals and avian pollinators to the effects described above. As such, we do not anticipate species level effects to the Pamakani and do not anticipate that the proposed action would appreciably reduce survival and recovery of the Pamakani in the wild.