5-YEAR REVIEW
Short Form Summary
Species Reviewed: *Geranium arboreum* (Hawaiian red-flowered geranium)
Current Classification: Endangered

Federal Register Notice announcing initiation of this review:
[USFWS] U.S. Fish and Wildlife Service. 2009. Endangered and threatened wildlife and plants; initiation of 5-year reviews of 103 species in Hawaii. Federal Register 74(49):11130-11133.

Lead Region/Field Office:
Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii

Name of Reviewer(s):
Marie Bruegmann, Plant Recovery Coordinator, PIFWO
Jess Newton, Recovery Program Lead, PIFWO
Assistant Field Supervisor for Endangered Species, PIFWO

Methodology used to complete this 5-year review:
This review was conducted by staff of the Pacific Islands Fish and Wildlife Office of the U.S. Fish and Wildlife Service (USFWS), beginning on March 16, 2009. The review was based on final critical habitat designations for *Geranium arboreum* and other species from the island of Maui (USFWS 2003) as well as a review of current, available information. The National Tropical Botanical Garden provided an initial draft of portions of the review and recommendations for conservation actions needed prior to the next five-year review. The evaluation of Samuel Aruch, biological consultant, was reviewed by the Plant Recovery Coordinator. The document was then reviewed by the Recovery Program Lead and the Assistant Field Supervisor for Endangered Species before submission to the Field Supervisor for approval.

Background:
For information regarding the species listing history and other facts, please refer to the Fish and Wildlife Service's Environmental Conservation On-line System (ECOS) database for threatened and endangered species (http://ecos.fws.gov/tess_public).

Application of the 1996 Distinct Population Segment (DPS) Policy:
This Policy does not apply to plants.

Review Analysis:
Please refer to the final critical habitat designations for *Geranium arboreum* published in the Federal Register on May 14, 2003 (USFWS 2003) for a complete review of the species' status (including biology and habitat), threats, and management efforts. No new threats and no significant new information regarding the species biological status have come to light since listing to warrant a change in the Federal listing status of *G. arboreum*.

At the time of listing in 1992, there were 300 known individuals of *Geranium arboreum* (USFWS 1992). Currently, there are 5 known populations of less than 50 total individuals (Oppenheimer 2009).

All populations of *Geranium arboreum* are on East Maui and occur at elevations above 1,676 meters (5,500 feet) elevation. In the Waiohuli area of the Kula Forest Reserve in 1997, about 30 individuals were seen at 1,859 to 1,951 meters (6,100 to 6,400 feet) elevation, between 50 and 100 individuals were seen in flower at 1,996 meters (6,550 feet) elevation, and about 15 individuals at 1,920 meters (6,300 feet) elevation (Perlman 2009; Wood 2009). Two large populations located in the Kula Forest Reserve that had been fenced by the Hawaii Division of Forestry and Wildlife burned in a fire in January 2007. Two or three individuals survived the fire and were observed in mid-2007, however they were reported dead in 2009 (Oppenheimer 2009).

Below Haleakala Park Headquarters, near Puu Nianiau/Hosmer's Grove, about 20 individuals were seen at 1,900 meters (6,234 feet) elevation in 1992 (Wood 2009). Steve Perlman of the National Tropical Botanical Garden reported between 10 and 15 individuals there at 2,009 meters (6,592 feet) elevation, but in 2005 he reported only a few individuals remaining (Perlman 2009), and in 2009 all plants were confirmed dead (Perlman 2009; Oppenheimer 2009).

In 2009, six individuals of *Geranium arboreum* were observed at Pohakuokala Gulch, below Pohakuokala bridge, off the road to Haleakala National Park at 1,862 meters (6,110 feet) elevation (Perlman 2009). This area belongs to Haleakala Ranch (Oppenheimer 2009).

In the Kula Forest Reserve, along Skyline Road, south of Puu Keokea, a single individual tree, 2-meters (6.5-feet) high, and with a canopy 2.5-meters (8-feet) wide, was seen at 2,021 meters (6,630 feet) elevation in 2009 (Wood 2009). This tree has now been fenced (Oppenheimer 2009).

Haleakala National Park staff has monitored populations on the West Slope and Summit Areas of the Park around 2,134 meters (7,000 feet) elevation for approximately five years. However, the exact numbers of individuals located within the Park have not been reported (Haleakala National Park Resource Management, Vegetation Management 2004, 2005, 2006, 2007).

As of 2010, the total number of individuals of *Geranium arboreum* is less than 50 individuals in perhaps five populations on East Maui. In 2009, Oppenheimer stated there are 15 plants in Haleakala Ranch and Kula Forest Reserve. There are a few other individuals located within Haleakala National Park and The Nature Conservancy Waikamoi Preserve. The Nature Conservancy and Haleakala National Park both reported recent dramatic declines in population numbers (Oppenheimer 2009).

In the Kula Forest Reserve *Geranium arboreum* grows in *Sophora chrysophylla* (mamane) – *Metrosideros polymorpha* (ohia) subalpine forest with *Asplenium* spp.

(spleenwort), *Astelia menziesiana* (kaluaha), *Carex* sp. (no common name [NCN]), *Coprosma ernodeoides* (aiakanene), *C. montana* (pilo), *Deschampsia nubigena* (hairgrass), *Dodonaea viscosa* (aalii), *Dryopteris wallichiana* (io nui), *Dubautia menziesii* (naenae), *D. platyphylla* (naenae), *Leptecophylla tameiameiae* (pukiawe), *Luzula hawaiiensis* (wood rush), *Myrsine lessertiana* (kolea lau nui), *Pellaea ternifolia* (kalamoho lau lii), *Pteridium aquilinum* var. *decompositum* (kilau), *Rubus hawaiiensis* (akala), and *Vaccinium reticulatum* (ohelo) (Oppenheimer 2009; Perlman 2009; Wood 2009).

At Haleakala National Park, just below park headquarters at Hosmer's Grove, *Geranium arboreum* grows in a small gulch above the highway in *Sophora chrysophylla* subalpine dry shrubland and *Metrosideros polymorpha — Leptecophylla* subalpine shrubland with *Coprosma ernodeoides, Deschampsia nubigena*, *Dodonaea viscosa*, *Dryopteris wallichiana*, *Dubautia menziesii*, *Geranium cuneatum* subsp. *tridens* (nohoanu), *Leptecophylla tameiameiae*, *Morelotia gahniiformis* (NCN), *Pteridium aquilinum* var. *decompositum* (kilau), *Rubus hawaiiensis*, and *Vaccinium reticulatum* (Perlman 2009; Wood 2009).

In the Kula Forest Reserve, along Skyline Road, south of Puu Keokea, the habitat is *Sophora chrysophylla* subalpine shrub with *Carex wahuensis* (NCN), *Deschampsia nubigena*, *Dodonaea viscosa*, *Dryopteris wallichiana*, *Leptecophylla tameiameiae*, *Osteomeles anthyllidifolia* (ulei), *Pellaea ternifolia* (kalamoho lau lii), and *Pteris cretica* (oali) (Wood 2009).

At Pohakuokala the habitat is remnant subalpine forest and pasture with *Sophora chrysophylla*, *Metrosideros polymorpha*, *Leptecophylla tameiameiae*, *Dubautia menziesii*, *Vaccinium reticulatum*, *Dryopteris wallichiana*, *Coprosma ernodeoides*, *Rubus hawaiiensis*, and *Myrsine lessertiana* (Perlman 2009).

On East Maui where *Geranium arboreum* is found, the threats include feral ungulates such as pigs (*Sus scrofa*), deer (*Axis axis*), goats (*Capra hircus*), and cattle (*Bos taurus*) which disturb the ground and uproot plants (Listing Factors A and D); fire (Listing Factor E); and invasive introduced plant species such as *Ageratina adenophora* (sticky snakeroot), *A. riparia* (billy goat weed), *Bidens pilosa* (beggartick), *Epilobium billardierianum* (willow herb), *Geranium homeanum* (NCN), *Holcus lanatus* (common velvet grass), *Lythrum maritimum* (loosestrife), *Oenothera stricta* (evening primrose), *Passiflora tarminiana* (banana poka), *Pennisetum clandestinum* (Kikuyu grass), *Rubus niveus* (Mysore raspberry), *R. argutus* (blackberry), *Senecio madagascariensis* (fireweed), and *Sporobolus indicus* (West Indian dropseed) which alter the habitat and compete for resources (Listing Factor E) (Oppenheimer 2009; Perlman 2009; Wood 2009).

Insect-bored holes were observed in the flowers of *Geranium arboreum* observed near Puu Nianiau (Perlman 2009). Slugs (unidentified species), rats (*Rattus* spp.), and ants (unidentified species) also threaten these plants by eating plant parts and seeds (Listing

Factor C) (Perlman 2009). A loss of native pollinators may also be a problem preventing reproduction of this species (Listing Factor E) (Perlman 2009).

Climate change may also pose a threat to this species (Listing Factors A and E). However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013.

In addition to all of the other threats, species like *Geranium arboreum* that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks (Listing Factor E). The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1992).

The Haleakala National Park staff reintroduced 26 individuals on the West Slope Area from 44 cuttings collected in 2004. Fourteen individuals were reintroduced in the same area in 2005 with good results of survivorship. Similarly, 23 individuals were reintroduced in the same area in 2006 with good results of survivorship. Fifteen individuals were reintroduced in 2007 in the Front country Area, with poor survivorship, and 7 individuals in 2008 in the Front country-Summit District with fair survivorship (Haleakala National Park Resource Management, Vegetation Management 2005, 2006, 2007, 2008; Haleakala National Park Resource Management 2004). In 2008, Haleakala National Park reported 12 individuals growing in their nursery, with 7 individuals reintroduced into Honomanu Gulch from plants propagated from 5 Waikamoi Gulch founders (Haleakala National Park 2008). Currently, there are 29 individuals in the Haleakala National Park nursery (Haleakala National Park 2010).

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for the Maui plant cluster (USFWS 1997), based on whether the species is an annual, a short-lived perennial (fewer than ten years), or a long-lived perennial. *Geranium arboretum* is a long-lived perennial, and to be considered stabilized, which is the first step in recovering the species, the taxon must be managed to control threats (*e.g.*, fenced) and be represented in an *ex situ* (off-site) collection. In addition, a minimum of three populations should be documented on islands where they now occur or occurred historically. For the species to be considered stable, each of these populations must be naturally reproducing and increasing in number, with a minimum of 25 mature individuals per population.

The interim stabilization goals for this species have not been met. No population contains more than 25 mature individuals (Table 1), and all threats are not being managed (Table 2). Therefore, *Geranium arboreum* meets the definition of endangered as it remains in danger of extinction throughout its range.

Recommendations for Future Actions:

- Further studies are needed to clarify by what mechanisms predators of this species are affecting its ability to regenerate in the wild, and to mitigate these threats.
- Monitor known populations and collect any available seed for genetic storage and reintroduction.
- Fence all known populations to provide protection from the negative impacts of feral ungulates.
- Control invasive introduced plant species around known populations.
- Control rats in the vicinity of these populations.
- Develop and implement methods to control ants and slugs.
- Propagate to augment the existing populations.
- Establish additional populations within protected suitable habitat.
- Develop and implement a wildfire management plan.
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.

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Table 1. Status of *Geranium arboreum* from listing through 5-year review.

Date	No. wild indivs	No. outplanted	Stability Criteria identified in Recovery Plan	Stability Criteria Completed?
1992 (listing)	300	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
1997 (recovery plan)	300	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
2003 (critical habitat)	158	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No
2010 (5-year review)	<50	54	All threats managed in all 3 populations	No (Table 2)
			Complete genetic storage	No
			3 populations with 25 mature individuals each	No: no population contains 50 mature individuals

Table 2. Threats to *Geranium arboretum*.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – habitat modification and herbivory	A, C, D	Ongoing	No
Rats – herbivory	C	Ongoing	No
Slugs – herbivory	C	Ongoing	No
Ants – herbivory	C	Ongoing	No
Fire	E	Ongoing	No
Loss of pollinators and seed dispersers	E	Ongoing	No
Invasive introduced plants	A, E	Ongoing	No
Climate change	A, E	Increasing	No
Small population size	E	Ongoing	Partially: seed collected and reintroductions at Haleakala

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SIGNATURE PAGE for 5-YEAR REVIEW of *Geranium arboretum* (Hawaiian red-flowered geranium)

Pre-1996 DPS listing still considered a listable entity? N/A

Recommendation resulting from the 5-year review:

_____ Delisting
_____ Reclassify from Endangered to Threatened status
_____ Reclassify from Threatened to Endangered status
__X__ No Change in listing status

Field Supervisor, Pacific Islands Fish and Wildlife Office

Date 6/29/11