

Portulaca sclerocarpa
(Poe)

**5-Year Review
Summary and Evaluation**

**U.S. Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawaii**

5-YEAR REVIEW
Species reviewed: *Portulaca sclerocarpa* (Poe)

TABLE OF CONTENTS

1.0	GENERAL INFORMATION	3
1.1	Reviewers.....	3
1.2	Methodology used to complete the review:.....	3
1.3	Background:.....	3
2.0	REVIEW ANALYSIS	5
2.1	Application of the 1996 Distinct Population Segment (DPS) policy.....	5
2.2	Recovery Criteria.....	5
2.3	Updated Information and Current Species Status	7
2.4	Synthesis.....	19
3.0	RESULTS	21
3.1	Recommended Classification:.....	21
3.2	New Recovery Priority Number:.....	22
3.3	Listing and Reclassification Priority Number:	22
4.0	RECOMMENDATIONS FOR FUTURE ACTIONS	22
5.0	REFERENCES	23
	Signature Page.....	28

5-YEAR REVIEW
***Portulaca sclerocarpa* (Poe)**

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office:

Region 1, Endangered Species Program, Division of Recovery, Jesse D'Elia,
(503) 231-2071

Lead Field Office:

Pacific Islands Fish and Wildlife Office, Loyal Mehrhoff, Field Supervisor, (808)
792-9400

Cooperating Field Office(s):

N/A

Cooperating Regional Office(s):

N/A

1.2 Methodology used to complete the 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 April 8, 2010. The review was based on final critical habitat designation for *Portulaca sclerocarpa* and other species from the islands of Hawaii and Lanai (USFWS 2003a, b), as well as a review of current, available information. The Bernice Pauahi Bishop Museum 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 a recovery biologist and the Plant Recovery Coordinator. The document was then reviewed by the Recovery Program Leader and the Assistant Field Supervisor for Endangered Species before submission to the Field Supervisor for approval.

1.3 Background:

1.3.1 Federal Register (FR) Notice citation announcing initiation of this review:

USFWS. 2010. Endangered and threatened wildlife and plants; 5-year review status of 69 species in Idaho, Washington, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands. Federal Register 75(67):17947-17950.

1.3.2 Listing history

Original Listing

FR notice: USFWS. 1994. Endangered and threatened wildlife and plants; determination of endangered or threatened status for 21 plants from the island of Hawaii, State of Hawaii; final rule. Federal Register 59(43):10305-10325.

Date listed: March 4, 1994

Entity listed: Species

Classification: Endangered

Revised Listing, if applicable

FR notice: N/A

Date listed: N/A

Entity listed: N/A

Classification: N/A

1.3.3 Associated rulemakings:

USFWS. 2003a. Endangered and threatened wildlife and plants; final designation and nondesignation of critical habitat for 46 plant species from the island of Hawaii, Hawaii; final rule. Federal Register 68(127):39624-39761.

USFWS. 2003b. Endangered and threatened wildlife and plants; final designation of critical habitat for three plant species from the island of Lanai, Hawaii; final rule. Federal Register 68(6):1220-1274.

Critical habitat was designated for *Portulaca sclerocarpa*, a multi-island species, on Hawaii Island in a single unit totaling 4,390 hectares (10,848 acres) on Federal lands (USFWS 2003a), and on Lanai in two units totaling 8 hectares (19 acres) on private lands (USFWS 2003b).

USFWS 2012. Endangered and threatened wildlife and plants; listing 38 species on Molokai, Lanai, and Maui as endangered and designating critical habitat on Molokai, Lanai, Maui and Kahoolawe for 135 species. Federal Register 77(112):34464-34775.

Critical habitat revisions are currently being proposed for *Portulaca sclerocarpa* (USFWS 2012).

1.3.4 Review History:

Species status review [FY 2010 Recovery Data Call (August 2010)]:

Undetermined

Recovery achieved:

1 (0-25%) (FY 2007 Recovery Data Call)

1.3.5 Species' Recovery Priority Number at start of this 5-year review:

1.3.6 Current Recovery Plan or Outline

Name of plan or outline: USFWS. 1996. Recovery plan for the Big Island plant cluster. U.S. Fish and Wildlife Service, Portland, Oregon. 201 pages + appendices. Available online at <http://www.fws.gov/pacificislands/recoveryplans.html>.

Date issued: September 26, 1996

Dates of previous revisions, if applicable: N/A

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate?

Yes
 No

2.1.2 Is the species under review listed as a DPS?

Yes
 No

2.1.3 Was the DPS listed prior to 1996?

Yes
 No

2.1.3.1 Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 policy standards?

Yes
 No

2.1.3.2 Does the DPS listing meet the discreteness and significance elements of the 1996 DPS policy?

Yes
 No

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy?

Yes
 No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes

___ *No*

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

 X *Yes*

___ *No*

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?

 X *Yes*

___ *No*

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

A synthesis of the threats (Listing Factors A, B, C, D, and E) affecting this species is presented in Section 2.3.2 and Table 2.

Stabilizing, downlisting, and delisting objectives are provided in the recovery plan for the Big Island plant cluster (USFWS 1996), based on whether the species is an annual, a short-lived perennial (fewer than 10 years), or a long-lived perennial. *Portulaca sclerocarpa* is a short-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* (such as a nursery or arboretum) collection. In addition, a minimum of three populations should be documented on the 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 50 mature individuals per population.

This recovery objective has partially been met.

For downlisting, a total of five to seven populations of *Portulaca sclerocarpa* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered.

This recovery objective has not been met.

For delisting, a total of eight to ten populations of *Portulaca sclerocarpa* should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number,

and secure from threats, with 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before delisting is considered.

This recovery objective has not been met.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Portulaca sclerocarpa has been observed in flower in March, April, June, October, and December (Cuddihy *et al.* 1982; USFWS 1996). The presence of juveniles indicates that pollination and germination are occurring (USFWS 1996, 2002, 2003b; Center for the Environmental Management of Military Lands [CEMML] 2003a). Under greenhouse conditions at the Center for the Environmental Management of Military Lands, germinated seeds were able to set flowers and produced seeds (CEMML 2003a). Pollination vectors, seed dispersal agents, longevity of plants and seeds, and other limiting factors are unknown (USFWS 1996, 2003b).

Kim and Carr (1990a) studied the reproductive biology and uniform cultivation of 10 native, naturalized, and cultivated taxa of *Portulaca* found in the Hawaiian Islands. They found that all *Portulaca* taxa in Hawaii were self-fertilizing, at least under experimental conditions, since numerous viable seeds were produced from bagged flowers. The *Portulaca* cultivars were the only taxa observed to attract pollinators. The thick-walled, indehiscent capsule of *P. sclerocarpa* required about four weeks to mature, twice as long as most other *Portulaca* taxa; Kim and Carr (1990a) suggested that this modification might be related to the unusual volcanic fumarole habitat the species seemed to favor. The number of seeds in a capsule was very variable, ranging from 6.7 seeds per capsule in *P. molokiniensis* to as high as 232.3 seeds per capsule in *P. sclerocarpa*. Seeds were generally nondormant. Most *Portulaca* taxa flowered six to eight weeks after seed germination, and individuals of most taxa typically flowered and fruited many times during one growing season (Kim and Carr 1990a).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Historically, the first discovery of *Portulaca sclerocarpa* on Lanai was by Robert Hobdy during a survey of Poopoo Islet in April 1982 (Hobdy 1982); unfortunately, the number of individuals observed was not recorded. Up to that point, *P. sclerocarpa* had been considered a Hawaii Island endemic, or a synonym of *P. villosa*. Hobdy's original voucher label itself identifies the plant as *P. villosa* (Bishop Museum 2011). However, Hobdy noted in his report that plants on Poopoo resembled *P. villosa* in general, but had the thickened capsules of *P. sclerocarpa*, and he called it "*Portulaca* species" in his report (Hobdy 1982). The specimen was identified by Bishop Museum staff in 1985 as *P. sclerocarpa* (Bishop Museum 2011). This remains the only natural record of the species outside of Hawaii Island. The Federal listing document (USFWS 1994), recovery plan (USFWS 1996), and critical habitat designation (USFWS 2003b) all record its status as a single population containing 10 individuals. On a subsequent botanical survey on Poopoo Islet in April 2006 (Starr *et al.* 2006), no individuals of *P. sclerocarpa* was found, and the habitat contained many more invasive plants than when first discovered in 1982. Other islets (Kapukalua, Nanahoa, Kiei, Moku Naio, Kaneapua, and Puu Pehe) off the western and southern coast of Lanai were also surveyed, with no sightings of *P. sclerocarpa* (Starr *et al.* 2006).

On Hawaii Island, *Portulaca sclerocarpa* historically occurred in the Kohala Mountains, on the northern slopes of Hualalai, the northwestern slopes of Mauna Loa, and near Kilauea Crater (USFWS 1994, 1996, 2002, 2010b). At the time the species was Federally listed as endangered in 1994, there were 11 extant Hawaii Island populations said to contain 72 to 122 individuals known on private, State, and Federal lands on three cinder cones in the Nohonaohae area; at Pohakuloa Training Area; at Puu Anahulu; near Puu Keanui and Puu Lehua; and in Hawaii Volcanoes National Park (USFWS 1994; CEMML 2003a). When the recovery plan for *P. sclerocarpa* was published in 1996 (USFWS 1996), the 11 populations on Hawaii Island were estimated at over 1,000 individuals. While the estimate was substantially larger than that given in 1994 when the species was listed, it actually represented a dramatic drop in the statewide total.

The population center for *Portulaca sclerocarpa* is the Puhimau geothermal (fumarole) area in Hawaii Volcanoes National Park, where about 4,300 individuals were counted in 1983, but had declined, for unknown reasons, to 970 individuals when observed in 1993 (USFWS 1996, 2002; Hawaii Biodiversity and Mapping Program 2010). These numbers were confirmed by Linda Pratt (U.S. Geological Survey, Pacific Island Ecosystems Research Center, pers. comm. 2011), who has continued to study the natural population at Puhimau. Compared to the 970 individuals counted in 1993, only 300 individuals were counted in 2006, 229 individuals 2008, and only 120 individuals in early 2011; Pratt

cites the most likely factor causing the dramatic population decline is predation of capsules by rodents (probably mice [*Mus* spp.], possibly black rats [*Rattus rattus*]), with changes in heat level in the geothermal zone and an extended drought also possibly implicated. The 1996 recovery plan also noted natural populations at two other locations in Hawaii Volcanoes National Park—on Keanakakoi Crater Rim (less than 10 individuals) and Hilina Pali Road (less than 10 individuals) and a former population along the Footprints Trail in the Kau Desert consisting of fewer than 10 individuals in the 1970s, but no longer observed in the mid-1990s (USFWS 1996). Pratt (pers. comm. 2011) noted that a survey in the cinder fields west of Keanakakoi Crater in 1998 located 304 individuals, 103 individuals of which were tagged for monitoring; a revisit in 2000 located only 51 of the tagged individuals, a mortality rate of approximately 50 percent; another revisit in December 2010 located 30 adults, but also many seedlings. A small natural population along the Hilina Pali Road is no longer present, but a reintroduction site has been established nearby at Kalanaokuaiki Pali (L. Pratt, pers. comm. 2011). The Kau Desert is currently home to fewer than 10 documented natural individuals of *P. sclerocarpa*; the Footprints Trail population documented in the 1970s was revisited in the 1990s and was not found, and is presumed gone (L. Pratt, pers. comm. 2011). In summary, Pratt (pers. comm. 2011) can verify only three extant natural populations at Hawaii Volcanoes National Park (Puhimau, Keanakakoi, and Kau Desert), comprising about 160 total adult individuals.

At the time of critical habitat designation, “more than 900” individuals were estimated in Hawaii Volcanoes National Park (USFWS 2003a). In 1997, 34 individuals were counted on the slopes of Puu Pa (U.S. Army Corps of Engineers 2002). The current status of populations at Nohonaohae, where 72 individuals of *P. sclerocarpa* were discovered in 1982 (Cuddihy *et al.* 1982), needs to be clarified; L. Pratt (*nee* Cuddihy, pers. comm. 2011) has not since revisited the site.

At Pohakuloa Training Area, the species occurs in the Kipuka Kalawamauna Endangered Plant Habitat, north and west of Kipuka Alala, and on the 1859 Mauna Kea lava flow (CEMML 2003a). Numbers have never been high at Pohakuloa Training Area, perhaps indicating that the species is at the upper limit of its elevational range there (CEMML 2006). Evans *et al.* (2002) [in Arnett 2002] confirmed the presence of 26 individuals at seven sites; together with four known localities that were not visited, a total estimate of 30 to 40 individuals at 11 sites was made. In 2003, known individuals of *P. sclerocarpa* were confined to Areas of Species Recovery 24, 25, and 28 (southwest of Kipuka Kalawamauna, northwest of Kipuka Alala), but *P. sclerocarpa* was subsequently discovered in eight additional Areas of Species Recovery and disappeared from Areas of Species Recovery 25 and 28 (CEMML 2008).

A 2007 survey discovered 10 individuals in the vicinity of Kipuka Kalawamauna, but 8 of 34 individuals known prior to 2007 could not be relocated, resulting in a net gain of two individuals (36 total); given the small sample size and lack of long-term data, a realistic prognosis for this species at Pohakuloa Training Area is difficult to make (CEMML 2008).

In 2002, 19 extant populations containing about 1,000 individuals were estimated on Hawaii Island: one at Puu Pa on private land; two at Nohonaohae on private land; nine at Puu Anahulu on private, State, and Federal lands (Pohakuloa Training Area); three on private land at Keauhou; and four on Federal land at Hawaii Volcanoes National Park (USFWS 2002). As of 2010, there were an estimated 12 extant populations statewide of *Portulaca sclerocarpa* containing more than 3,000 individuals (USFWS 2010a). In light of the population declines at Hawaii Volcanoes National Park, statewide numbers are probably closer to 200 natural individuals, with about the same number of surviving reintroductions.

Portulaca sclerocarpa can be difficult to locate in the field because of its prostrate growth habit and small size; although its flowers are showy, they are rarely found open (Shaw 1997). Thus, more intensive surveys may uncover further populations. A report of *P. sclerocarpa* from Mahana Bay at South Point on Hawaii Island in the annual report of the Plant Extinction Prevention Program (2009) was apparently made in error, and should have been referred to *P. villosa*, which historically is known from the area (S. Perlman, National Tropical Botanical Garden, pers. comm. 2011).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

No new information.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Portulaca sclerocarpa is a fleshy, short-lived perennial herb in the portulaca family (Portulacaceae) with a tuberous taproot that becomes woody with maturity. The species is endemic to Hawaii Island and an islet off the coast of Lanai (USFWS 1994, 2002). *Portulaca sclerocarpa* was first collected during the United States Exploring Expedition of 1840 and 1841 and was described by Asa Gray in 1854 (USFWS 1994; CEMML 2003a). The species was accepted by Hillebrand (1888), but Geesink (1969) chose to synonymize it under the closely related Hawaiian endemic, *P. villosa* (as *P. pilosa* subsp. *villosa*), remarking that the essential characters separating the two species—indehiscent, thick walled

capsule in *P. sclerocarpa*; circumscissile, thin walled capsules in *P. villosa*—were not of taxonomic importance. Wagner *et al.* (1999) resurrected *P. sclerocarpa*, citing both the morphological differences and their distinctive geographical and ecological ranges. The confusing nature of species limits in this situation is exhibited in Hillebrand (1888), where he regards the distribution of *P. sclerocarpa* as including Lanai, Maui, Kahoolawe, and Hawaii, and in Medeiros *et al.* (1986), which regards both *P. sclerocarpa* and *P. villosa* as present on the south slopes of Haleakala, Maui.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

The somewhat disjunct population of *Portulaca sclerocarpa* on Poopoo Islet off the coast of Lanai left unclear whether the capsule features actually define a natural assemblage of populations, in which case the Lanai population would apparently represent a colonization from Hawaii Island (Wagner *et al.* 1999). Another possibility was that thick-walled indehiscent capsules were easily derived and represented the result of parallel evolution, a situation that needs further study (Wagner *et al.* 1999). Consistently high pollen stainability and the production of seeds in the hybrid *P. sclerocarpa* x *P. villosa* indicates a very close relationship between these two species (Kim and Carr 1990b).

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Starr *et al.* (2006) revisited Poopoo Islet off of Lanai 24 years after Hobdy (1982) discovered *Portulaca sclerocarpa* and described the vegetation as dominated by native plants, although natives constituted only 45 percent of the species encountered. The endemic grass *Panicum xerophilum* (kakonakona) formed a thick cover over most of the area, interspersed with *Sida fallax* (ilima) (Hobdy 1982). In their April 2006 visit, Starr *et al.* (2006) reported that the vegetation was now dominated by introduced vegetation, primarily *Cenchrus ciliaris* (buffel grass), along with *Cenchrus echinatus* (sandbur), *Portulaca oleracea* (pigweed), *Merremia aegyptia* (hairy merremia), *Chloris virgata* (feather fingergrass), *Conyza bonariensis* (hairy horseweed), and *Lantana camara* (lantana).

On Hawaii Island, *Portulaca sclerocarpa* grows on weathered Mauna Kea soils, cinder cones, or geologically young lavas in montane dry shrubland. The species is typically found on bare cinder, near steam vents, and in open *Metrosideros polymorpha* (ohia) dominated woodlands, at 351 to 2,274 meters (1,150 and 7,460 feet) elevation (Wagner *et al.* 1999;

USFWS 2002). Associated native plant taxa are *Sophora chrysophylla* (mamane), *Melanthera venosa* (nehe), *Myoporum sandwicense* (naio), and *Dodonaea viscosa* (aalii) (USFWS 2002).

Within the Kipuka Kalawamauna, *P. sclerocarpa* grows on Mauna Kea flows more than 10,000 years old; on the southwestern part of Pohakuloa Training Area it is found on 3,000 to 4,000 year old pahoehoe lava flows; it is also found on a portion of the 1859 aa lava flow. Associated plant communities at Pohakuloa Training Area are barren lava, sparse *Metrosideros* treeland, open *Metrosideros* tree land with sparse shrub understory, open *Metrosideros* treeland with dense shrub understory, intermediate *Metrosideros* mixed treeland, and *Myoporum* shrubland (Shaw 1997).

2.3.1.7 Other:

No new information.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Threats:

- Ungulate degradation of habitat on Hawaii Island (USFWS 1994, 1996, 2002, 2010b; Shaw 1997)
 - Feral goats (*Caprus hircus*)
 - Feral pigs (*Sus scrofa*)
 - Feral sheep (*Ovis aries*)
- Established ecosystem-altering invasive plant species degradation of habitat on Hawaii Island (USFWS 1994, 1996, 2002, 2010b; Shaw 1997)
 - *Pennisetum setaceum* (fountain grass)
 - *Andropogon virginicus* (broomsedge)

Current conservation efforts:

- Ungulate exclosure – As of 2009, fenced units at Pohakuloa Training Area containing *Portulaca sclerocarpa* included the Kipuka Kalawamauna East Fence Unit (U.S. Army Garrison 2009). Additionally, an effort is underway to complete Large Fence Units around the concentration of federally listed plant species on the west and southwest side of Pohakuloa Training

Area; these contiguous fence units will enclose about 7,921 hectares (19,572 acres) and consist of 101 kilometers (63 miles) of fencing to protect the greatest number of threatened and endangered plants and their habitats from the destructive impact of feral ungulates and other feral animals (U.S. Army Garrison 2009). The existing 1.2-meters (4.0-foot) Kipuka Kalawamauna East Fence Unit will be retrofitted to 1.8-meters (6-foot) once the Large Fence Units are completed in 2011 or 2012 to ensure adequate protection of the *P. sclerocarpa* population inside the fence from ungulates (CEMML 2008).

- Ungulate control – Ungulates are controlled within fenced enclosures at Pohakuloa Training Area (USFWS 2003a; U.S. Army Garrison 2009)
- Ecosystem-altering invasive plant species control – The USFWS’s Biological Opinion of 2003 required that weed control be conducted around all individuals of *Portulaca sclerocarpa* growing at Pohakuloa Training Area (USFWS 2003a; U.S. Army Garrison 2009; CEMML 2008).

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

This is not a threat.

2.3.2.3 Disease or predation:

Threats:

- Ungulate predation or herbivory – Although there was no ungulate browsing recorded during the 2007 monitoring (CEMML 2008) and it had been stated (USFWS 1996, 2002; Shaw 1997) that no browsing by ungulates had ever been observed, the possibility was raised that eight individuals not relocated in 2007 were actually victims of ungulate herbivory; that is, given the small stature of this species, instead of minor damage to individuals from ungulates, the whole plant may have been consumed and all evidence wiped clean. This theory was supported by the fact that only three of nine Areas of Species Recovery units were protected with fences (total of 9 individuals), and six of the eight missing individuals were located in Areas of Species Recovery at the time unprotected from ungulates (CEMML 2008). Fencing was not required by the 2003 USFWS Biological Opinion, nor was it a management goal for *Portulaca sclerocarpa* prior to 2008.
- Rodent predation or herbivory:

- During 2007, mice (*Mus Spp.*) were documented eating seed capsules in the propagation facility, and rats (*Rattus sp.*) chewed and broke off branches of greenhouse specimens at Pohakuloa Training Area (CEMML 2008).
- Linda Pratt (pers. comm. 2011) noted that the prime threat to individuals at the once-large Puhimau Crater population in Hawaii Volcanoes National Park appeared to be predation of capsules by rodents (probably mice, and possibly black rats).
- Invertebrate predation or herbivory – On Poopoo Islet, Lanai, the major threats to *Portulaca sclerocarpa* are herbivory by the larvae of a nonnative sphinx moth (*Hyles lineata*) (USFWS 2003b, 2010b)

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Threats:

- Lack of adequate hunting regulation in areas with ungulates – The lack of adequate ungulate control and the existence of established hunting programs in areas where *Portulaca sclerocarpa* occurs outside of Hawaii Volcanoes National Park continue to threaten this species.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Threats:

- Ungulate trampling on Hawaii Island (USFWS 1994, 1996, 2002, 2010b; Shaw 1997)
 - Feral goats
 - Feral pigs
 - Feral sheep
- Established invasive plant species competition on Poopoo Islet, Lanai (Starr *et al.* 2006; USFWS 2003b, 2010b)
 - *Cenchrus ciliaris* (buffel grass)
 - *Cenchrus echinatus* (sandbur)
- Military activities – On Hawaii Island, habitat disturbance and damage to plants as a result of military exercises (USFWS 1994, 1996, 2002, 2010b; Shaw 1997)
- Fire – On Hawaii Island (USFWS 1994, 1996, 2002, 2010b; Shaw 1997) and Lanai (USFWS 2003b)

- Human disturbance – Ease of access onto the islet by boat was also cited as a potential threat due to inadvertent dispersal of introduced species by humans (Starr *et al.* 2006).
- Drought – Extended drought conditions in the Hawaiian Islands may also be implicated in the population’s current decline (L. Pratt, pers. comm. 2011).
- Low numbers (USFWS 1996, 2002; Plant Extinction Prevention Program 2010)
- Climate change may pose a threat to this species. 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.

Current conservation efforts:

- Captive propagation protocol development – At Pohakuloa Training Area, seeds are surface-sown on a 1:1 vermiculite/perlite mix, and were reported to germinate readily, usually starting in three weeks. Plants are ready for reintroductions in six to eight months (CEMML 2006).
- Captive propagation for reintroduction and translocation:
 - Seeds from Pohakuloa Training Area are collected for storage at the National Seed Storage Laboratory at Colorado State University, and occasionally used for seed germination tests (USFWS 2003a).
 - National Tropical Botanical Garden (2010) reported 3,950 seed in controlled propagation from Hawaii Volcanoes National Park. In 2011 there were no seeds in storage reported (National Tropical Botanical Garden 2011).
 - In 2011, no seeds or propagules were reported from Pohakuloa Training Area (2011). In 2010, Pohakuloa Training Area (2010) reported 41 seeds in storage from Pohakuloa Training Area, representing 10 wild individuals [in previous years, Pohakuloa Training Area (2008, 2009) totals were: 2009, 700 seeds in controlled propagation, representing 7 wild individuals; 2008, 5,200 seeds in controlled propagation from Pohakuloa Training Area, representing 11 wild individuals].
 - Hawaii Volcanoes National Park (2010) reported 500 seeds in controlled propagation from Puhimau [in 2007, Hawaii Volcanoes National Park reported 9,000 seeds in controlled

propagation/research from Puhimau, representing fewer than 20 individuals. In 2011, Hawaii Volcanoes National Park (2011) reported 54 cuttings in propagation and 1,000 seeds in storage.

- Volcano Rare Plant Facility (2011) reported two individuals in controlled propagation.
- In 2010, Center for Conservation Research and Training Seed Storage Facility (2010) reported no seed storage.
- In 2010, Harold L. Lyon Arboretum (2010) reported no micropropagation efforts.
- At Pohakuloa Training Area, seeds from all known Pohakuloa Training Area sites were represented in the collection (CEMML 2006, 2008). The vast majority of seed was being collected from individuals growing in the Pohakuloa Training Area propagation facility because of the small size of the wild population; about 25,000 seeds were in storage at the end of 2005 (CEMML 2006).
- Reintroduction / translocation protocol development – Pohakuloa Training Area houses a climate-controlled greenhouse and a plant holding compound to acclimate plants scheduled for reintroduction to conditions more similar to those they will encounter in the wild (USFWS 2003a).
- Reintroduction / translocation site identification – The U.S. Army’s reintroduction goal is to increase numbers and distribution of rare plant taxa in their known historic range; besides reintroductions at Pohakuloa Training Area, an immediate goal is to establish two off-site, easily accessible reintroduction sites per species to serve as genetic storage, and to learn and understand species-specific habitat preferences. A site is deemed suitable if 50 percent or more of the plants survive and at least 50 percent healthy vigor is achieved (U.S. Army Garrison 2009).
- Reintroduction / translocation site selection – For *P. sclerocarpa*, the U.S. Army’s three main off-installation reintroduction sites are Koaia Tree Sanctuary, Kipuka Oweowe, and Puuwaawaa Cone Unit, all located on State lands managed by the Department of Land and Natural Resources, Division of Forestry and Wildlife (CEMML 2008; U.S. Army Garrison 2009).
- Reintroduction / translocation implementation:
 - Although reintroduction was not a requirement of the Biological Opinion (CEMML 2008), Pohakuloa Training Area reintroduced 116 individuals (25 at Kipuka Oweowe, 91 at Puuwaawaa cone) in 2007 and 9 individuals at the

Kona Veterans Cemetery in 2009 (Pohakuloa Training Area 2007, 2009). Previously, 25 reintroduced individuals in 2007 brought the total number of *P. sclerocarpa* reintroductions to 215 individuals at six sites since 2002, although reintroductions at four sites between 2002 and 2004 were unsuccessful, with no surviving individuals (CEMML 2008).

- Linda Pratt (pers. comm. 2011) described the reintroduction of over 2,000 individuals at various sites by Hawaii Volcanoes National Park staff (Kalanaoquaiki Pali, Footprints Trail, Crater Rim, Hilina Pali Road);
 - The Volcano Rare Plant Facility (2011) reported 17 individuals were reintroduced at Manuka, representing a single wild individual.
- Reintroduction / translocation population management and monitoring – As of 2010, only about 100 individuals out of the 2,000 individuals reintroduced at Hawaii Volcanoes National Park still survived, a mortality rate of approximately 95 percent. Most of the survivors from the reintroductions were located at Kalanaoquaiki Pali (L. Pratt, pers. comm. 2011).
 - Compliance and enforcement – The U.S. Army’s Pohakuloa Training Area land stewardship is governed by the Sikes Act of 1997, which statutorily requires all military installations with land and/or water suitable for the conservation and management of natural resources to complete an Integrated Natural Resources Management Plan (INRMP), to be updated every five years, which integrates implementation of the installation’s mission with stewardship of the natural resources found there (USFWS 2003a). At Pohakuloa, the USFWS is a major cooperator in the implementation of this INRMP. Stewardship of *Portulaca sclerocarpa* and other endangered plants at Pohakuloa Training Area was mandated in the USFWS’s 2003 Biological Opinion for Routine Military Training and Transformation of the 2nd Brigade 25th Infantry Division (Light) (USFWS 2003c), and the U.S. Army’s Integrated Natural Resources Management Plan (U.S. Army Garrison 2009). In 2003, the USFWS published a Biological Opinion for the Pohakuloa Training Area; among their requirements were construction of large-scale fence units to protect endangered species habitat, ungulate control within the fence units, and annual monitoring, weed control, threat management, and reintroduction guidelines (USFWS 2003c).
 - Alliance and partnership development – Involved in the development and execution of the Pohakuloa Implementation Plan, another requirement of the 2003 Biological Opinion, are 20

biologists from 11 organizations/agencies representing the U.S. Army; USFWS; U.S. Forest Service; National Park Service; U.S. Geological Service; Research Corporation, University of Hawaii; Center for Environmental Management of Military Lands, Colorado State University; Volcano Rare Plant Facility; State of Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife; and Rana Productions (U.S. Army Garrison 2009). Among their tasks are the following: identify action areas for species management; estimate the minimum viable population for rare taxa at Pohakuloa Training Area; determine definitions of success for population viability of rare taxa; develop reintroduction and augmentation protocols for rare plant taxa; determine how to achieve the greatest possible genetic representation for each plant taxon; determine and execute habitat improvements (*e.g.*, control of invasive nonnative plants, feral ungulates, rodents, invertebrates, dust, etc.); and develop an invasive plant management plan to reduce and control the threats of incipient weeds and enhance habitat quality (U.S. Army Garrison 2009). All of these endeavors highlight the efforts to protect rare plants at Pohakuloa Training Area.

- Fire protection – In 2003, the Pohakuloa Training Area completed an Integrated Wildland Fire Management Plan to reduce the threat of wildfires (CEMML 2003b). In June 2012, Pohakuloa Training Area drafted a revision of their 2003 Integrated Wildland Fire Management Plan (CEMML 2012)..
- Surveys / inventories – Field surveys to identify new populations of threatened and endangered plant species in previously unsurveyed areas and areas of suitable habitat were conducted at Pohakuloa Training Area (USFWS 2003a; U.S. Army Garrison 2009)
- Population viability monitoring – The USFWS’s Biological Opinion of 2003 required that monitoring be conducted around all individuals of *Portulaca sclerocarpa* growing at Pohakuloa Training Area (USFWS 2003c). Although its known locations and total numbers at Pohakuloa Training Area have historically been low, *P. sclerocarpa* was treated as a species of secondary urgency for management [Priority 3 in the Pohakuloa Training Area system: plant species with 1,000 to 2,000 individuals and/or 10 to 20 populations remaining statewide], since Pohakuloa Training Area contained only a small percentage of the known individuals, the bulk being primarily found in Hawaii Volcanoes National Park. Instead, *P. sclerocarpa* was monitored in Pohakuloa Training Area only when found in proximity to higher priority rare taxa provided more intensive management until 2005, when monitoring specifically for *P. sclerocarpa* was initiated (CEMML 2006).

More recently still, a major decline in the population at Hawaii Volcanoes National Park necessitated an upgrade of the Pohakuloa Training Area populations to Priority 1 status: plant species with fewer than 500 individuals and/or 5 or fewer populations remaining statewide (CEMML 2008). More intensive quarterly monitoring was planned to assess plant health, condition, and threats (CEMML 2008).

- Competitive invasive plant species control – The USFWS’s Biological Opinion of 2003 required that weed control be conducted around all individuals of *Portulaca sclerocarpa* growing at Pohakuloa Training Area (USFWS 2003a, c; U.S. Army Garrison 2009; CEMML 2008).

2.4 Synthesis

Hawaii Volcanoes National Park and Pohakuloa Training Area are home to the majority of extant individuals of *Portulaca sclerocarpa*. Both institutions have instituted excellent programs to control threats to rare plant taxa, including fencing, ungulate control, weed management, and maintaining propagation and reintroduction programs. In spite of these recovery actions, the interim stabilization goals for this species have only been partially met. Although, the Puhimau fumarole population contains more than 50 reproducing wild individuals, the population is not considered stable as numbers have plummeted from more than 4,000 individuals in 1983 to just over 120 individuals in 2011. The Keanakakoi population is also declining and does not contain 50 mature individuals. The reintroduction site at Kalanaokuaiki Pali however does contain more than 50 mature individuals, but it is too soon to tell whether the reintroduced population will actually persist for more than 5 years or experience heightened mortality, as witnessed at the majority of the other reintroduction sites at Hawaii Volcanoes National Park. No populations at Pohakuloa Training Area contain more than 50 individuals (Table 1). The majority of the populations at Pohakuloa Training Area are fenced and managed to control threats (Table 2), however not all threats are being controlled. Therefore, *Portulaca sclerocarpa* meets the definition of endangered as it remains in danger of extinction throughout its range.

Table 1. Status of *Portulaca sclerocarpa* from listing through 5-year review.

Date	No. wild individuals	No. outplanted	Stabilization Criteria identified in Recovery Plan	Stabilization Criteria Completed?
1994 (listing)	~10 on Lanai; 72–122 on Hawaii Island	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	No
1996 (recovery plan)	~10 on Lanai; >1,000 on Hawaii Island	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	Partially
2003 (critical habitat)	~10 on Lanai; ~1,000 on Hawaii Island	0	All threats managed in all 3 populations	No
			Complete genetic storage	No
			3 populations with 50 mature individuals each	Partially
2012 (5-year review)	0 on Lanai; ~200 on Hawaii Island	~200 on Hawaii Island	All threats managed in all 3 populations	Partially (see Table 2)
			Complete genetic storage	Partially
			3 populations with 50 mature individuals each	Partially

Table 2. Threats to *Portulaca sclerocarpa* and ongoing conservation efforts.

Threat	Listing factor	Current Status	Conservation/ Management Efforts
Ungulates – Degradation of habitat, herbivory, trampling	A, C, D, E	Ongoing	Partially: Ungulate exclosure and control at Pohakuloa Training Area
Ecosystem-altering invasive plant species degradation of habitat,	A	Ongoing	Partially: Ecosystem-altering invasive plant species control at Pohakuloa Training Area
Rodent predation or herbivory – Rats and mice	C	Ongoing	No
Invertebrate predation or herbivory	C	Ongoing	No
Established invasive plant species competition	E	Ongoing	Partially: Weeds controlled at Pohakuloa Training Area
Drought	E	Ongoing	No
Fire	E	Ongoing	Partially: Fire protection at Pohakuloa Training Area
Military activities	E	Ongoing	Partially: Compliance and enforcement and alliance and partnership development
Human disturbance	E	Ongoing	No
Low numbers	E	Ongoing	Partially: Captive propagation for reintroduction and translocation, Reintroduction / translocation implementation, monitoring, population viability monitoring, and surveys/ inventories
Climate change	A, E	Increasing	No

3.0 RESULTS

3.1 Recommended Classification:

Downlist to Threatened

Uplist to Endangered

Delist

Extinction

Recovery

Original data for classification in error

No change is needed

3.2 New Recovery Priority Number:

Brief Rationale:

3.3 Listing and Reclassification Priority Number:

Reclassification (from Threatened to Endangered) Priority Number: _____

Reclassification (from Endangered to Threatened) Priority Number: _____

Delisting (regardless of current classification) Priority Number: _____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Captive propagation for genetic storage and reintroduction:
 - Utilize vegetative and seed sources of *P. sclerocarpa* from as wide array of sources, if possible, for future reintroductions to ensure the greatest possible genetic representation.
 - Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage.
- Reintroduction / translocation implementation:
 - Continue efforts by Hawaii Volcanoes National Park and Pohakuloa Training Area to establish appropriate *ex situ* reintroduction sites to achieve additional viable populations.
 - Continue to reintroduce the species back into its known historical range.
- Reintroduced / translocated population management and monitoring – Monitor current reintroduction sites for successful establishment and recruitment to better determine optimum reintroduction habitats for the species.
- Ungulate exclosure:
 - Complete the large fence units at Pohakuloa Training Area to prevent further ungulate damage to the species and reduce degradation of its habitat.
 - Monitor existing fences for any signs of breaching.
- Ungulate control – Continue to protect all populations against browsing and disturbances from feral ungulates.
- Established ecosystem-altering invasive plant species control – Continue to control established ecosystem-altering invasive plant species around all populations.
- Competitive invasive plant species control – Continue to control established invasive plant species around all populations that compete with the species.
- Predator / herbivore control – Control rodents around existing populations.

- Surveys / inventories – Continue to conduct intensive surveys in suitable habitat for new individuals of *Portulaca sclerocarpa*. *Portulaca sclerocarpa* can be difficult to spot in the field, as it is low-growing and inconspicuous when not in flower.
- Population viability monitoring:
 - Continue to annually monitor population structure, vigor, demography, and phenology to better understand how to manage the species.
 - Increase monitoring and management at the Poopoo Islet population on Lanai, which appears in danger of extirpation.
- Fire protection – Continue to implement fire management plans for all wild and reintroduced populations.
- Invertebrate control research –Determine methods to control herbivory by nonnative sphinx moths on Poopoo Islet.
- Site / area / habitat protection – Develop and implement effective measures to reduce the impacts of drought, human disturbance on Poopoo Islet, and military activities.
- Alliance and partnership development – Continue to work with the U.S. Army Garrison, Department of Forestry and Wildlife, National Park Service, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species.
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.

5.0 REFERENCES

Bishop Museum. 2011. Herbarium Pacificum database. Available online at <http://nsdb.bishopmuseum.org/>. Accessed April 2011.

Center for Conservation Research and Training Seed Storage Facility. 2010. Seed bank inventory. Honolulu, Hawaii. Microsoft Access database. Unpublished.

[CEMML] Center for the Environmental Management of Military Lands, Colorado State University. 2003a. Programmatic biological assessment for transformation of the 2nd Brigade 25th Infantry Division (light), U.S. Army, Island of Hawaii. Colorado State University, Fort Collins, Colorado, prepared for the U.S. Army Corps of Engineers, Honolulu District, Hawaii. 376 pages.

[CEMML] Center for the Environmental Management of Military Lands, Colorado State University. 2003b. Integrated wildland fire management plan, Pohakuloa and Oahu Training Areas, U.S. Army, Hawaii and 25th Infantry Division (light). 22 August 2003. 436 pages.

[CEMML] Center for the Environmental Management of Military Lands, Colorado State University. 2006. Report of the ecosystem management at Pohakuloa Training Area,

- Island of Hawaii; July 2003 - December 2005. U.S. Army Garrison, Pohakuloa Training Area, Hawaii. 144 pages.
- [CEMML] Center for the Environmental Management of Military Lands, Colorado State University, Pohakuloa Training Area Natural Resources Staff. 2008. Report for the ecosystem management program Pohakuloa Training Area, Island of Hawaii, year 2007. U.S. Army Garrison, Pohakuloa Training Area, Hilo, Hawaii. 85 pages + appendices.
- [CEMML] Center for the Environmental Management of Military Lands, Colorado State University. 2012. Draft integrated wildland fire management plan, U.S. Army Garrison, Hawaii. June 2012. 139 pages + appendices.
- Cuddihy, L.W., J.A. Davis, and S.J. Anderson. 1982. A botanical survey of twelve cinder cones in South Kohala, island of Hawaii. Department of Land and Natural Resources, Division of Forestry and Wildlife, Hilo, Hawaii. 61 pages.
- Evans, S., D. Faucette, S. Henderson, K. Kawakami, L. Schnell, and D. Scott. 2002. Annual report for the ecosystem management program, Pohakuloa Training Area, island of Hawaii. Environmental Office of Pohakuloa Training Area, Hawaii. 144 pages.
- Geesink, R. 1969. An account of the genus *Portulaca* in Indo-Australia and the Pacific (Portulacaceae). *Blumea* 17:275-301.
- Harold L. Lyon Arboretum. 2010. Micropropagation database. Honolulu, Hawaii. Unpublished.
- Hawaii Biodiversity and Mapping Program. 2010. Element occurrence record: *Portulaca sclerocarpa*. 34 pages. Unpublished.
- Hawaii Volcanoes National Park. 2007. Controlled propagation report to U.S. Fish and Wildlife Service. Volcano, Hawaii. Unpublished.
- Hawaii Volcanoes National Park. 2010. Controlled propagation report to U.S. Fish and Wildlife Service. Volcano, Hawaii. Unpublished.
- Hawaii Volcanoes National Park. 2011. Controlled propagation report to U.S. Fish and Wildlife Service. Volcano, Hawaii. Unpublished.
- Hillebrand, W. 1888. Flora of the Hawaiian Islands: a description of their phanerogams and vascular cryptogams. Carl Winter, Heidelberg, Germany; Williams & Norgate, London; B. Westermann & Co., New York. 673 pages.
- Hobdy, R. 1982. The vegetation of Poopoo Islet, Lanai. Department of Land and Natural Resources, Division of Forestry and Wildlife, Maui County, Hawaii. 2 pages. Unpublished.

- Kim, I., and G.D. Carr. 1990a. Cytogenetics and hybridization of *Portulaca* in Hawaii. *Systematic Botany* 15(3):370-377.
- Kim, I., and G.D. Carr. 1990b. Reproductive biology and uniform culture of *Portulaca* in Hawaii. *Pacific Science* 44(2):123-129.
- Medeiros, Jr., A.C., L.L. Loope, and R.A. Holt. 1986. Status of native flowering plant species on the south slope of Haleakala, East Maui, Hawaii. Cooperative National Park Resources Studies Unit, University of Hawaii at Manoa, Department of Botany, Honolulu, Hawaii. 230 pages.
- National Tropical Botanical Garden. 2010. Controlled propagation report to U.S. Fish and Wildlife Service. Kalaheo, Hawaii. Unpublished.
- National Tropical Botanical Garden. 2011. Controlled propagation report to U.S. Fish and Wildlife Service. Kalaheo, Hawaii. Unpublished.
- Plant Extinction Prevention Program. 2009. Annual Report for Plant Extinction Prevention Program, fiscal year 2009 (July 1, 2008-June 30, 2009), Plant Extinction Prevention Program. 115 pages. Unpublished.
- Plant Extinction Prevention Program. 2010. Plant extinction prevention program annual report, fiscal year 2010 (July 1, 2009-June 30, 2010). 122 pages. Unpublished.
- Pohakuloa Training Area. 2007. Controlled propagation report to U.S. Fish and Wildlife Service. Pohakuloa, Hawaii. Unpublished.
- Pohakuloa Training Area. 2008. Controlled propagation report to U.S. Fish and Wildlife Service. Pohakuloa, Hawaii. Unpublished.
- Pohakuloa Training Area. 2009. Controlled propagation report to U.S. Fish and Wildlife Service. Pohakuloa, Hawaii. Unpublished.
- Pohakuloa Training Area. 2010. Controlled propagation report to U.S. Fish and Wildlife Service. Pohakuloa, Hawaii. Unpublished.
- Pohakuloa Training Area. 2011. Controlled propagation report to U.S. Fish and Wildlife Service. Pohakuloa, Hawaii. Unpublished.
- Shaw, R.B. 1997. Rare plants of Pohakuloa Training Area, Hawaii. Center for Ecological Management of Military Lands, Fort Collins, Colorado. Unnumbered pages.
- Starr, F., K. Starr, and K. Wood. 2006. Lanai offshore islets botanical survey. Department of Land and Natural Resources, Division of Forestry and Wildlife, Honolulu. 57 pages. Unpublished.

- U.S. Army Corps of Engineers. 2002. Phase II former Waikoloa maneuver area and nansay sites engineering evaluation/cost analysis, July 1, 2002. Available online at <<http://www.poh.usace.army.mil/env/Docs/EECA/Ch02.pdf>>. Accessed 9 April 2011.
- U.S. Army Garrison. 2009. Draft Integrated Natural Resources Management Plan (INRMP), U.S. Army Garrison, Hawai‘i, Pohakuloa 2010-2014. Unpublished.
- [USFWS] U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; determination of endangered or threatened status for 21 plants from the island of Hawaii, State of Hawaii; final rule. Federal Register 59(43):10305-10325.
- [USFWS] U.S. Fish and Wildlife Service. 1996. Recovery plan for the Big Island plant cluster. U.S. Fish and Wildlife Service, Portland, Oregon. 201 pages + appendices. Available online at <<http://www.fws.gov/pacificislands/recoveryplans.html>>.
- [USFWS] U.S. Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants; designations of critical habitat for plant species from the Island of Hawaii, Hawaii; proposed rule. Federal Register 67(102):36968-37106.
- [USFWS] U.S. Fish and Wildlife Service. 2003a. Endangered and threatened wildlife and plants; final designation and nondesignation of critical habitat for 46 plant species from the island of Hawaii, Hawaii; final rule. Federal Register 68(127):39624-39761.
- [USFWS] U.S. Fish and Wildlife Service. 2003b. Endangered and threatened wildlife and plants; final designation of critical habitat for three plant species from the island of Lanai, Hawaii; final rule. Federal Register 68(6):1220-1274.
- [USFWS] U.S. Fish and Wildlife Service. 2003c. Biological opinion of the U.S. Fish and Wildlife Service for routine military training and transformation of the 2nd brigade 25th infantry division (light) U.S. Army installations, Island of Hawaii. Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. Unpublished.
- [USFWS] U.S. Fish and Wildlife Service. 2010a. Rare plant tracking database. Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii. Unpublished.
- [USFWS] U.S. Fish and Wildlife Service. 2010b. Hakalau Forest National Wildlife Refuge draft comprehensive conservation plan and environmental assessment, U.S. Fish and Wildlife Service, Hilo, Hawaii. Available online at <<http://www.fws.gov/hakalauforest/planning.html>>.
- Volcano Rare Plant Facility. 2011. Controlled propagation report to U.S. Fish and Wildlife Service. Volcano, Hawaii. Unpublished.
- Wagner, W.L., D.R. Herbst and S.H. Sohmer. 1999. Manual of the flowering plants of Hawaii, revised edition. University of Hawaii and Bishop Museum Press, Honolulu, Hawaii. 1,918 pages.

Personal communications

- Pratt, Linda. 2011. Botanist, U.S. Geological Survey, Pacific Island Ecosystems Research Center. E-mail to Clyde Imada, Bishop Museum, dated April 15, 2011. Subject: Status of *Portulaca sclerocarpa* natural populations and outplantings at Hawaii Volcanoes National Park.
- Perlman, Steve. 2011. Botanist, National Tropical Botanical Garden, Kalaheo, Hawaii. E-mail to Clyde Imada, Bishop Museum, dated April 7, 2011. Subject: Location of *Portulaca sclerocarpa* at South Point, Hawaii.

Signature Page
U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Portulaca sclerocarpa* (Poe)

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

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By:

Chelsie Javar, Fish and Wildlife Biologist
Vickie Caraway, Fish and Wildlife Biologist
Marie Bruegmann, Plant Recovery Coordinator
Jess Newton, Endangered Species Recovery Program Leader
Assistant Field Supervisor for Endangered Species

Field Supervisor, Pacific Islands Fish and Wildlife Office

 Jess Newton for

Date 8/28/2012