

Haleakala, the island lies approximately 11 km (6.7 mi) from East Maui. The highest point is the rim of an extinct volcano at 450 m (1,477 ft) above sea level. The estimated annual precipitation is approximately 50 cm (20 in), with most of it falling from November through March. In addition to the low precipitation, Kahoolawe is the windiest of the Hawaiian Islands (Gon *et al.* 1992).

### Discussion of Plant Taxa

#### *Species Endemic to Maui or Kahoolawe*

*Argyroxiphium sandwicense* ssp. *macrocephalum* (Ahinahina)

*Argyroxiphium sandwicense* ssp. *macrocephalum*, a long-lived perennial and a member of the aster family (Asteraceae), is called the Haleakala silversword. It is a distinctive, globe-shaped rosette plant with a dense covering of silver hairs. This subspecies is distinguished from *A. sandwicense* ssp. *sandwicense* by the shape and ratio of the dimensions of the inflorescence (flowering part of plant), the number of ray florets per head, and the combination of its longer, three-angled leaves; its silvery leaf hairs, which completely hide the leaf surface; and its longer achenes (dry fruits) (Carr 1985, 1999a).

This monocarpic (flowers only once, at the end of its lifetime) plant matures from seed to its final stage in approximately 15 to 50 years. The plant remains a compact rosette until it sends up an erect, central flowering stalk, sets seed, and dies. Flowering occurs from June to September, with annual numbers of flowering plants varying dramatically from year to year. Reliable counts of flowering plants were made in 1935 (217 flowered) and in 1941 (815 flowered). Numbers recorded flowering in recent years have ranged from zero in 1970 to 6,632 in 1991. The environmental stimulus for synchronous flowering is as yet unknown. An apparent relationship of the 1991 mass flowering event to stratospheric alteration by the eruption of Pinatubo Volcano in the Philippines has been considered. Investigations are underway by R. Pharis of the University of Calgary and L.L. Loope of the U.S. Geological Survey—Biological Resources Division (USGS—BRD) to explore whether enhanced flowering is related to increased UV-B radiation caused by temporary reduction of stratospheric ozone. Flying insects, especially native bees, moths, flies, bugs, and wasps, many of which are pollinators, are attracted in large numbers to the giant, aromatic inflorescences. *Argyroxiphium*

*sandwicense* ssp. *macrocephalum* cannot fertilize itself and is reliant on insect pollinators for reproduction. Rarely, hybrids between *A. sandwicense* ssp. *macrocephalum* and *Dubautia menziesii* (naenae) have been observed. Primarily found within Haleakala Crater, especially on Puu o Pele and Puu o Maui cinder cones, these hybrid individuals can flower for several years before dying (Carr 1985; Loope and Crivellone 1986; Loope and Medeiros, *in press*; Service 1997; 57 FR 20772).

Currently, *Argyroxiphium sandwicense* ssp. *macrocephalum* occupies all of its historic range, a 1,000 ha (2,500 ac) area at 2,100 to 3,000 m (6,890 to 9,840 ft) elevation in the crater and outer slopes of Haleakala Volcano, within Haleakala National Park and The Nature Conservancy of Hawaii's (TNCH) Waikamoi Preserve. There are a total of 7 occurrences on Federal and privately owned land, with a total of 39,025 to 44,025 individual plants (Geographic Decision Systems International (GDSI) 2001; Hawaii Natural Heritage Program (HINHP) Database 2001; Loope and Crivellone 1986; Service 1997; TNCH 1998; 57 FR 20772).

The habitat of this species consists primarily of lava flows and otherwise barren, unstable slopes of recent (less than several thousand years old) volcanic cinder cones or in *Deschampsia nubigena* (hair grass) grasslands at elevations between 1,508 and 3,053 m (4,947 and 10,016 ft). Mean annual precipitation is approximately 75 to 250 cm (29.6 to 98.4 in). The substrate has almost no soil development and is subject to frequent formation of ice at night and extreme heating during cloudless days. This species is found in alpine dry shrubland with native species, including *Agrostis sandwicensis* (bent grass), *Dubautia menziesii*, *Leptecophylla tameiameia* (pukiawe), *Silene struthioloides* (catchfly), *Tetramolopium humile* (NCN), or *Trisetum glomeratum* (pili uka) (Service 1997; 57 FR 20772; Robert Hobdy, Hawaii Division of Forestry and Wildlife (DOFAW), pers. comm., 2001).

The threats to this species are loss of pollinators caused by the nonnative Argentine ant (*Iridomyrmex humilis*) and yellow jackets (*Vespula pennsylvanica*); native seed-eating and herbivorous insects such as the tephritid fly (*Trupanea cratericola*); limited natural range, which makes it vulnerable to extinction due to catastrophic events, such as a natural disaster; competition from the nonnative plant species *Verbascum thapsus* (mullein); and human impacts (trampling and site degradation). Although goats (*Capra hircus*) and cattle

(*Bos taurus*) have been removed from the park, they remain a potential threat (Service 1997; 57 FR 20772).

#### *Clermontia samuelii* (Oha wai)

*Clermontia samuelii*, a short-lived perennial in the bellflower family (Campanulaceae), is a terrestrial shrub with elliptical leaves which are sometimes broader at the tips. *C. s.* ssp. *hanaensis* is differentiated from *C. s.* ssp. *samuelii* by the greenish white to white flowers; longer, narrower leaves with the broadest point near the base of the leaves; and fewer hairs on the lower surface of the leaves. This species is separated from other members of this endemic Hawaiian genus by the size of the flowers and the hypanthium (base of flower) (Lammers 1999; Service 2001).

Little is known about the life history of *Clermontia samuelii*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 2001; 64 FR 48307).

Historically, *Clermontia samuelii* has been reported from Haleakala and from Keanae Valley on the windward side to Manawainui on the leeward (southeastern) side of Haleakala. Currently, *C. samuelii* is known from Papanalaoa Point, Kuhiwa Valley, the ridge north of Palike Stream, Kawaipapa, and Mokulehua Gulch. There are 7 occurrences with 309 individual plants on State and Federal lands within Haleakala National Park, Hanawi Natural Area Reserve (NAR), Hana Forest Reserve, and within the East Maui Watershed Partnership (GDSI 2001, HINHP Database 2001, Medeiros and Loope 1989, Service 2001, Warshauer 1998, 64 FR 48307, R. Hobdy, DOFAW, *in litt.* 2000, Ken Wood, National Tropical Botanical Garden (NTBG), *in litt.* 2000).

*Clermontia samuelii* is found at elevations between 723 and 2,244 m (2,372 and 7,362 ft). *Clermontia samuelii* ssp. *hanaensis* is found in wet *Metrosideros polymorpha* (ohia) and *Metrosideros polymorpha-Dicranopteris linearis* (uluhe) forest containing one or more of the following associated native plant species: *Adenophorus tamariscinus* (wahine no mauna); *Broussaisia arguta* (kanawao); *Carex alligata* (NCN); *Cheirodendron trigynum* (olapa); *Cibotium* ssp. (hapuu); *Diplazium sandwichianum* (hoio); *Dubautia* spp. (naenae); *Hedyotis hillebrandii* (manono); *Hedyotis terminalis* (manono); *Melicope clusiifolia* (kolokolo mokihana); *Melicope* spp. (alani); *Peperomia obovatilimba* (ala ala wai nui); *Psychotria mariniana* (kopiko);