

The Haleakala silversword (*Argyroxiphium sandwicense* ssp. *macrocephalum*) was near extinction in the 1920's because of human vandalism and browsing by goats and cattle. The plant has increased under protection and deserves attention as the most dramatic conservation success story of the Hawaiian Islands.

The silversword is a distinctive, globe-shaped rosette plant with rigid (sword-like), succulent leaves densely covered by silver hairs. When a plant flowers at the end of its life, it produces a spectacular flowering stalk 0.5-2.0 m (1.6-6.4 ft) tall, typically with hundreds of maroon sunflowerlike flower heads. This plant receives more attention from visitors to Haleakala National Park than any other plant or animal because of its striking appearance and restricted distribution.

The Haleakala silversword is endemic to a 1,000-ha (2,471-acre) area at 2,100- to 3,000-m (6,890- to 9,843-ft) elevation in the crater and outer slopes of Haleakala Volcano, within Haleakala National Park, Maui, Hawaii. It is the most famous member of the endemic Hawaiian silversword alliance, perhaps the premier example of evolutionary adaptive radiation in plants. This morphologically diverse group comprises 28 species of herbs, vines, shrubs, trees, and rosette plants in three genera that evolved in the Hawaiian Islands from a North American tarweed (Asteraceae: Madiinae) ancestor (Robichaux et al. 1990; Baldwin et al. 1991). The monocarpic (flowers only once, at the end of its lifetime) silversword matures from seed to its final flowering stage in about 15-50 years. The plant remains a compact rosette until it sends up an erect, central flowering stalk, sets seed, and dies.

In 1992 this taxon was given threatened status by the U.S. Fish and Wildlife Service because of its extremely limited range and precarious life cycle. The other subspecies of *A. sandwicense* (ssp. *sandwicense*), endemic to Mauna Kea on the island of Hawaii, is federally listed as endangered, with fewer than 100 naturally occurring individuals.

## Population Trends

The strikingly beautiful Haleakala silversword has always aroused the curiosity of human visitors to Haleakala Volcano. In pre-park days, plants were often removed by travelers to Haleakala Volcano as proof that the party had reached the summit, a practice that eventually seriously affected the silversword population. Browsing by feral goats and domestic cattle was also a significant factor in the silversword decline, but it was not a species preferred by these animals. By the 1920's, silversword numbers were so depleted that the Maui Chamber of Commerce sent a petition to Washington, DC, requesting that a serious effort be made to save the species (Loope and Crivellone 1986).

The first reliable quantitative information on silversword numbers is from the summer of 1935. In that year, Ranger S.H. Lamb tallied 1,470 plants (88 of which were flowering) on a single cinder cone (Ka Moa o Pele) within Haleakala Crater (Lamb 1935). Because about 217 plants were flowering within the crater at that time (Lamb 1935), a reasonable estimate of the total population is about 4,000 individuals.

Because silversword plants occur on otherwise barren cinder, fairly accurate counts are possible. Two studies since 1935 illustrate the trend of the silversword population over about 60 years of protection. Methods are described in the original reports (Kobayashi 1973, 1993; Loope and Crivellone 1986).

On Ka Moa o Pele, a single cinder cone where the largest number of plants were in 1935, the silversword population had increased from 1,470 to 6,528 plants as of 1991 (Fig. 1).

Elsewhere in Haleakala Crater, the silversword has increased in numbers and extent, large local populations having developed in areas where few plants occurred in 1935. A census of the entire silversword population has been attempted four times since 1971, with the following results: 1971: 43,262 (Kobayashi 1973); 1979-80: 35,000 (Kobayashi 1993); 1982: 47,640 (Loope and Crivellone 1986); and 1991:

## Haleakala Silversword

by  
**Lloyd L. Loope**  
**Arthur C. Medeiros**  
*National Biological Service*



Haleakala silversword  
(*Argyroxiphium sandwicense* ssp.  
*macrocephalum*).

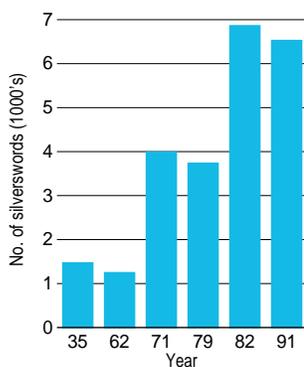


Fig. 1. Number of silversword plants counted by investigators on a single cinder cone, Ka Moa o Pele, within Haleakala Crater (Loope and Crivellone 1986; Kobayashi 1993).

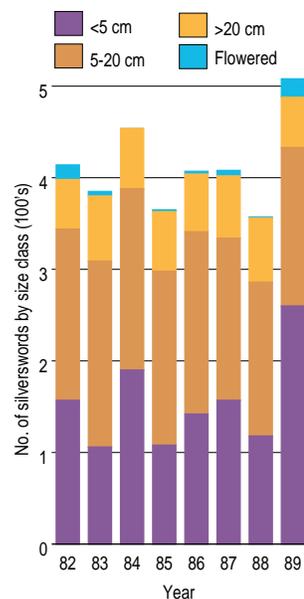


Fig. 2. Number by diameter classes of Haleakala silversword in fixed monitoring plots, 1982-89. Summary of data from eleven 5 m x 20 m (16.4 x 65.6 ft) plots in representative sites in Haleakala Crater (Loope and Medeiros 1994).

#### For further information:

Lloyd L. Loope  
National Biological Service  
Haleakala National Park  
PO Box 369  
Makawao, Maui, HI 96768

64,800 (Kobayashi 1993). The current population of Haleakala silversword is about 16 times larger than the estimated population in 1935.

Annual trends in 11 fixed plots, 5 m x 20 m (16.4 x 65.5 ft), from 1982 through 1989, suggest occurrence of substantial annual fluctuations in the recruitment and survival of seedlings (Loope and Crivellone 1986; Loope and Medeiros 1994; Fig. 2).

## Data on Silversword Flowering

The Haleakala silversword flowers 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; Loope and Crivellone 1986). Numbers recorded in recent years have ranged from zero in 1970 to 6,632 in 1991. The environmental stimulus for flowering or nonflowering of silversword within a given annual flowering season is still unknown. An apparent relationship of the 1991 mass flowering event to stratospheric alteration by the eruption of Pinatubo Volcano in the Philippines is intriguing.

## Threats

As a result of management within Haleakala National Park, the most serious former threats to the Haleakala silversword have been virtually eliminated: human vandalism and browsing by goats and cattle. To date, no introduced plant species competes significantly with silversword. Cooperative interagency efforts are being made to exclude the non-native mullein (*Verbascum thapsus*) and fountain grass (*Pennisetum setaceum*) from becoming established on Maui; since these plants occupy similar habitat on other Hawaiian Islands, they might compete with silverswords.

The greatest threat to the silversword appears to be potential loss of endemic pollinators because of the invasion of silversword habitat by the Argentine ant (*Iridomyrmex humilis*). This ant species occupies two disjunct areas between 2,070 m (6,792 ft) and 2,850 m (9,351 ft) elevation in Haleakala National Park, with a total area of 175 ha (432 acres; Cole et al. 1992). Because queens are unable to fly, the spread of this species is relatively slow. This alien ant species negatively affects the locally endemic arthropod fauna (Cole et al. 1992), including pollinators that evolved in the absence of ant predation. A marked expansion in the ant's range was noted in 1993, especially at higher elevations (Medeiros et al. 1994). Unless this ant species is controlled, it could cause potentially catastrophic effects on locally endemic biota, including the silversword, which

is associated with several endemic insect species (Loope and Crivellone 1986) and which requires cross-pollination for successful seed set (Carr et al. 1986). Experimental control efforts are under way.

## Trends

Recovery of the Haleakala silversword is one of the most dramatic single-species conservation success stories known. The primary factor contributing to its decline, human vandalism, was effectively addressed by the National Park Service beginning in the 1930's. Over the past 60 years the species has steadily recovered through protection within Haleakala National Park. It is increasing in numbers and expanding its range. Continued protection from human vandalism and feral ungulates, such as goats and cattle, is essential, and potential threats from the Argentine ant and alien plants must be addressed. Given the plant's limited range and precarious life cycle, the long-term prognosis for survival of this species appears remarkably favorable.

## References

- Baldwin, B.G., D.W. Kyhos, J. Dvorak, and G.D. Carr. 1991. Chloroplast DNA evidence for a North American origin of the Hawaiian silversword alliance. *Proceedings of the National Academy of Science* 88:1840-1843.
- Carr, G.D., E.A. Powell, and D.W. Kyhos. 1986. Self-incompatibility in the Hawaiian Madiinae (Compositae): an exception to Baker's rule. *Evolution* 40:430-434.
- Cole, F.R., A.C. Medeiros, L.L. Loope, and W.W. Zuehlke. 1992. Effects of the Argentine ant (*Iridomyrmex humilis*) on the arthropod fauna of high-elevation shrubland, Haleakala National Park, Maui, Hawaii. *Ecology* 73:1313-1322.
- Kobayashi, H.K. 1973. Ecology of the silversword, Haleakala Crater, Hawaii. Final Rep. HALE-N-3. 124 pp.
- Kobayashi, H.K. 1993. Census report on the Haleakala silversword *Argyroxiphium sandwicense* dc. (Compositae) ssp. *macrocephalum* (Gray) Meyrat for 1980 and 1991. Hawaii Natural History Association and Haleakala National Park. 12 pp.
- Lamb, S.H. 1935. First progress report, silversword project, March 1935. Second progress report, silversword project, July 1935. National Park Service.
- Loope, L.L., and C.F. Crivellone. 1986. Status of the silversword in Haleakala National Park: past and present. Cooperative National Park Studies Unit, University of Hawaii at Manoa, Department of Botany, Tech. Rep. 58. 33 pp.
- Loope, L.L., and A.C. Medeiros. 1994. Impacts of biological invasion on the management and recovery of rare plants in Haleakala National Park, Maui, Hawaii. Pages 143-158 in M. Bowles and C.J. Whelan, eds. *Restoration of endangered species*. Cambridge University Press, Cambridge, UK.
- Medeiros, A.C., F.R. Cole, and L.L. Loope. 1994. Patterns of expansion of an invading Argentine ant (*Iridomyrmex humilis*) population in Haleakala National Park, Maui, Hawaii. (Abstract) *Bull. of the Ecological Society of America* 75:150-151.
- Robichaux, R.H., G.D. Carr, M. Liebman, and R.W. Pearcy. 1990. Adaptive radiation of the silversword alliance (Compositae: Madiinae): ecological, morphological, and physiological diversity. *Annals of the Missouri Botanical Garden* 77:64-72.