

Courtesy M.J. Mac, NBS



Hawaii

Overview

Of the thousands of islands in the world's oceans, none has captured the fancy and dreams of adventure more than those in the central and south Pacific. Even among those magical islands, however, the Hawaiian Archipelago stands out. Mark Twain remarked in *Roughing It*, "They are the loveliest fleet of islands that lies anchored in any ocean."

The Hawaiian Islands are geographically diverse. Stretching over some 2,200 km (364 mi) of ocean, they vary in size from hectares to thousands of square kilometers and in elevation from sun-drenched atolls less than 6 m (20 ft) above sea level up to snow-capped peaks 4,270 m (14,000 ft) high. Rainfall ranges from less than 50 cm (20 in) to more than 1,140 cm (450 in) per year. This diversity of environments and the islands' extreme isolation (more than 4,000 km [2,490 mi] to the nearest continent) have resulted in a spectacular variety of species. The Hawaiian Islands are a true showcase of evolution that has resulted in degrees of endemism (species restricted to a particular area) unmatched anywhere else in the world. Studies show that on Hawaii 46% of mosses, 70% of ferns, 91% of flowering plants, 91% of gymnosperms, 99% of terrestrial mollusks and terrestrial arthropods, 100% of land mammals, and

81% of birds are endemic at the subspecies level (Gagné 1988).

Unfortunately, loss of species in the islands has been staggering, and what remains often occupies but a fraction of its historical range. Seventy percent of the extinctions known to have occurred in the United States took place in Hawaii. The islands have lost more than 50% of their birds (Scott et al. 1986; Scott et al. 1988; Olson and James 1991; Pyle, this section; Jacobi and Atkinson, this section); perhaps 50% of their plants, 90% of their native land snails, and an unknown percentage of their terrestrial insects. Flora and fauna that evolved over millions of years have been devastated in less than 2,000 years since the arrival of humans. But despite huge losses, what remains is spectacular.

Today's unique assemblage of species is rapidly being lost. Twenty-five percent of the U.S. endangered taxa occur in the islands. The reasons for their endangerment are many, but loss of habitat and introduction of non-native species are prominent factors. Both are the result of a steadily increasing human population and the more than 4 million tourists that visit the islands annually. Few visitors realize that the lush lowland vegetation and colorful flowers they marvel at are not native to the islands, but

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[Contents](#)

[◀ Article ▶](#)

[◀ Page ▶](#)

In 1992 the Hawaii State Legislature established a biological survey at Bishop Museum, Hawaii's Museum of Natural and Cultural History. The survey conducts an ongoing natural history inventory of the archipelago and locates, identifies, evaluates, and maintains the reference collections of all native and non-native species of flora and fauna within the state. The survey works in cooperation with other agencies, including the Hawaii Heritage Program, various state agencies, and the National Biological Service.

More than 14,000 terrestrial, 300 freshwater, and 4,000 marine species inhabit Hawaii (Table 1). Bishop Museum maintains the world's largest biological collections for Hawaii (ca. 4,000,000 specimens; Table 2). Through the Hawaii Biological Survey program, and in cooperation with many partner organizations, the museum is organizing information from these collections and associated literature into comprehensive computerized data bases and conducting field surveys to document distributions of these organisms. The resulting information base

Table 1. Terrestrial and freshwater plant and animal species in Hawaii. In addition, another 4,000 marine organisms inhabit Hawaiian waters. Species at risk include those on the federal lists of endangered, threatened, and candidate species (not including marine).

Taxon	Species (no.)	Endemic (%)	Species at risk
Lower plants	>1,800	Few	0
Higher plants	2,143	44	359
Nematodes	>147	Few	0
Mollusks	1,100	95	60
Insects and mites	>8,800	>60	340
Fish	>25	24	1
Amphibians	4	0	0
Reptiles	13	0	0
Birds	131	43	35
Mammals	19	5	0
Total	>14,182		795

Hawaii Biological Survey

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has many applications in conservation, agriculture, forestry, public health, fisheries, and land management.

In 1992 and 1993, the Hawaii Biological Survey:

- published a summary list of the more than 8,600 species of Hawaiian insects and related arthropods;
- produced a catalog of Hawaiian land snails, including nearly 1,000 species;
- continued progress on the book series *Reef and Shore Fauna of Hawaii*, with another volume nearing completion; and
- began a collaborative project with the Smithsonian Institution and local agencies to create a data base of specimens of Hawaiian plants. Other plant projects in progress include a manual of cultivated plants in Hawaii (2,500 species treated in detail, with an additional 10,000 species evaluated); a manual of marine algae; and an updated, electronic bibliography of Hawaiian plants.

A five-stage process was developed to implement the biological survey. For each major group of plants and animals, the process involves developing a computerized literature data base; preparing summary lists of species names (checklists) based on the literature, col-



Courtesy D. Polhemus, Bishop Museum

Megalagrion pacificum, a damselfly in a genus endemic to the Hawaiian Islands.

lections, and consultation with experts; creating a data base of specimen information in our collections; creating data bases of information from other collections and other sources or establishing computer linkage to this information; and filling gaps and updating information through field surveys.

Table 2. The comprehensive collections of Bishop Museum are a core resource for the Hawaii Biological Survey. This chart indicates the relative sizes of the Hawaiian collections, plus related materials from the Pacific region and elsewhere that provide the context for understanding the Hawaiian biota.

Group	Hawaiian collections	Total collections	%
Plants (including algae, etc.)	175,000	500,000	35
Marine invertebrates	250,000	500,000	50
Mollusks	3,000,000	6,000,000	50
Insects and mites	500,000	13,000,000	4
Fish	15,000	130,000	12
Terrestrial vertebrates	20,000	85,000	24
Library		100,000	
Archives		1,100,000	

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are instead a diverse collection of alien invaders that pose the biggest threat to the integrity of Hawaii's native ecosystems.

The alien species that have had the greatest impact on Hawaii's fragile flora and fauna, however, are the ungulates (e.g., pigs, goats, sheep, and cattle), which have devastated the native plants that evolved in the absence of grazers and browsers and thus had lost any protective mechanisms they might have had. Pigs have been particularly damaging, rooting through the understory, devastating large tracts of land, and creating a seedbed for alien plants and severe erosion, especially on the steep slopes of older islands. Elimination of alien species and prevention of invasion by new non-native species are the first conservation priority in Hawaii (Stone and Scott 1985; Stone et al. 1992).

Status and trends of the amazingly diverse insects of Hawaii are described by Howarth et al. (this section). The case for using species of picture wing flies as monitors for change and evolution is made by Foote and Carson (this section), while the dramatic recovery of a plant, the Haleakala silversword (Loope and Medeiros, this section), gives hope that other species can respond to recovery efforts. There are lessons to be learned not only from our failures, but also from successes such as the silversword.

Interest in the plants and animals of Hawaii has rekindled in the last 20 years. Private, state, and federal biologists have sought to document the occurrence and abundance of species and have mounted an impressive attempt to save the remaining characters in this hotbed of evolution (see Vol. 38 of *BioScience* and Culliney 1988 for

a review). To gain more information about Hawaii's resources, the state legislature formed the Hawaii Biological Survey in 1992, whose mission and scope are described in this section (Allison et al.).

References

- Culliney, J.L. 1988. Islands in a far sea. Sierra Club Books, San Francisco, CA. 410 pp.
- Gagné, W.C. 1988. Conservation priorities in Hawaiian natural systems. *BioScience* 38(4):264-271.
- Olson, S.L., and H.F. James. 1991. Descriptions of thirty-two new species of birds from the Hawaiian Islands; Part I, Non-passeriformes. *Ornithological Monographs* 45:1-88.
- Scott, J.M., C.B. Kepler, C. vanRiper, and S.I. Fefer 1988. Conservation of Hawaii's vanishing avifauna. *BioScience* 38 (4):238-253.
- Scott, J.M., S. Mountainspring, F.L. Ramsey, and C.B. Kepler. 1986. Forest bird communities of the Hawaiian Islands: their dynamics, ecology and conservation. *Studies in Avian Biology* 9. 431 pp.
- Stone, C.P., C.W. Smith, and J.T. Tunison. 1992. Alien plant invasions in native ecosystems of Hawaii management and research. University of Hawaii Press, Honolulu. 887 pp.
- Stone, C.P., and J.M. Scott, eds. 1985. Hawaii's terrestrial ecosystems: preservation and management. University of Hawaii Press, HI. 584 pp.

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

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

Courtesy A.C. Medeiros, NBS