

SEAs Provide Ecosystem Focus For Management and Research

By J.T. Tunison, C.P. Stone and L.W. Cuddihy

Located in the southeastern portion of the most recently formed island in the Hawaiian chain, Hawai'i Volcanoes NP contains two of the most active volcanoes in the world, Mauna Loa and Kilauea. It also supports ecosystems of special importance in the study of evolutionary processes. Native groups such as lobeliads, the silversword alliance, honeycreepers and drosophila provide outstanding examples of adaptive radiation, endemism, genetic change over time, the biology of small populations, and the disharmonic results of colonization via long-distance dispersal.

The Natural Resources

A steep rainfall gradient (25 to 350 mm), a broad elevational range (sea level to 4,100 m) and variations in soil and topography account for a rich assemblage of living forms. Six major ecological zones are encompassed in the 87,940 ha of Hawai'i Volcanoes (Fig. 1). The *coastal lowlands* zone includes a number of vegetation types such as lowland mesic and dry forest, native scrub, pili grassland, grasslands dominated by exotic species, and coastal strand, and forms a band to 300 m elevation. The *submontane seasonal* zone includes such vegetation types as open 'ohi'a woodland, 'ohi'a/woodland scrub, 'ohi'a/native fern, and open lama forest. It is located from 300-900 m in elevation. The *montane rain forest* is largely tree fern or hapu'u/'ohi'a or 'ohi'a/tree fern and extends from 400 to 1,500 m. The *montane seasonal* zone contains mesic 'ohi'a/soapberry and mesic koa/'ohi'a/soapberry forest, koa parkland, native grasslands, and native shrublands, and is located between 1,000-2,000 m. The *subalpine* and vegetated portions of the *alpine* zones are characterized by native scrub dominated by a'ali'i and pukeawe. Recent lava flows and underground lava tubes represent additional important, but simpler, ecosystems.

The park contains current or potential habitat for seven and probably eight species of endangered birds, include the 'i'o, 'akepa, 'akiapola'au, Hawai'i creeper, o'u, nene, dark-rumped petrel, and Newell's shearwater, and habitat for one endangered bat. Native flowering plants number 248 species, (95 percent endemic, 43 of which are candidates for threatened or endangered status). Fifty-three additional species considered rare occur in the park.

The Threats

Hawai'i Volcanoes NP contains some of the least altered vegetation in the state; however, biological threats to native or near-native ecosystems from within the park and from adjacent lands are legion, and deterioration of park ecosystems continues.

Introduced ungulates have been especially disruptive. Feral goats have devastated much of the coastal lowlands zone in the past 200 years, depleting native species and favoring the spread of exotic plants. Although nearly eliminated from most of the park, goats still are present on adjacent lands and in the unfenced subalpine and alpine zones above 2,000 m. Feral pigs open up understory in wet and mesic forest to numerous alien plants and spread such invasive species as banana poka and strawberry

guava. Control efforts in 57 km² of fenced pig habitat are succeeding, but this is only about 25 percent of feral pig habitat in the park. Other exotic animals include the black rat, feral cat, small Indian mongoose, house mouse, the Japanese white-eye (a bird), the yellowjacket wasp, and the night-biting mosquito.

Over 40 (of 475) introduced plants in the park are aggressive enough to threaten native ecosystems. In Hawai'i, non-native plants invade not only typical weedy habitats such as roadsides and man-made clearings, but also native or near-native plant communities. Besides directly displacing native plant species, non-native plants degrade native vegetation by changing fire, nutrient cycling, and water-soil regimes of Hawaiian ecosystems (Smith 1985).

The most serious exotic plant threats are firetree, banana poka, strawberry guava, kahili ginger, fountain grass, broomsedge and bush beardgrass, molasses grass, and kikuyu grass. Firetree invaded the park in the early 1960s and has spread over 12,200 ha of montane rainforest and submontane seasonal environments. Because of its nitrogen-fixing properties, even low densities may threaten native ecosystems by altering nutrient cycling in an area. Banana poka, an exotic vine capable of smothering native trees, increased 18-fold in the park from 1971 to 1981 (Warshauer et al. 1983). Strawberry guava and kahili ginger may form single species vegetation layers in rainforest and continue to spread even when feral pigs have been removed.

Fountain grass, broomsedge and bush beardgrass have spread dramatically in the last 25 years. Fountain grass occurs over 7,000 ha in the coastal lowlands and is spreading into upland plant communities, invading new lava flows and thus disrupting primary succession in some of the most intact systems in the park. Fire-adapted broomsedge and bush beardgrass have colonized openings in stands of native trees and shrubs in most of the submontane seasonal and much of the coastal lowlands. They have radically altered natural fire regimes by raising fuel loadings. Fires now are unnaturally intense, large, and frequent, and fire now favors non-native over native plants.

Approaches to Management, Research, and Interpretation

In Hawaiian systems, active management is often needed to protect and perpetuate ecosystems. Building a fence and abandoning an area may result in continued ecosystem degradation caused by invasive species. Native organisms on remote islands are notoriously vulnerable to invasive biota for several reasons. Because they evolved without them, natives are not adapted to diverse and/or severe stresses. For example, Hawaiian plants that developed in the absence of ungulates usually lack thorns, chemical defenses, sturdy stems, or adequate resprouting to survive ungulate foraging. Furthermore, populations of native species on islands are often present in localized and small populations, vulnerable to minor upsets in natality and mortality rates.

In addition, the close adaptation to stable local

environmental conditions that occurs in tropical and subtropical areas can be severely affected by the ability of invaders to change microclimates or nutrient cycling. Finally, the effects of invaders are compounded by human disturbances to which island endemics are not adapted.

Parkwide control efforts currently are hampered by our lack of knowledge about the ecological roles of introduced species. Ubiquitous introduced birds (e.g. the Japanese white-eye and red-billed leiothrix); small mammals and invertebrates have been little studied. If we are to manage for natural processes, we need to know more about the roles of important alien animals in native and near-native systems.

A reasonable emphasis would seem to be more focus on management, research and interpretation in the most intact ecosystems remaining. Resources are not sufficient to restore ecosystems dominated by alien plants and animals. Nor is support adequate even to understand and interpret these areas. Present or anticipated funding cannot support the control of establishment and dispersal of such invasive plant species as fountaingrass and fire tree by conventional and chemical means throughout the park, let alone restore systems to near-native structure and processes.

Feral goat control in much of the park has been tremendously successful. However, removal of the exotic plant communities now present in former goat range in much of the park lowlands will probably have to await biocontrol (Gardner and Smith 1985) or considerable funding increases. Restoration also may require seeding and planting of native species in some areas. Feral pig control, expensive and long-term, is succeeding in nine management units, but is sometimes followed by considerable alien plant invasion. Areas chosen for feral pig elimination should have good restoration potential; the data base to choose areas amenable to both pig control and ecosystem restoration is now accumulating.

Special Ecological Areas

Hawai'i Volcanoes NP recently has begun to emphasize Special Ecological Areas (SEAs), a strategy designed to protect, manage, understand, and interpret the most important biological sites in the park. SEAs are selected on the basis of representativeness or uniqueness of a vegetation type, intactness, species richness, presence of rare species, and potential for interpretation and research.

To date, six areas ranging in size from 12 to 2,700 ha have been selected and 12 additional areas nominated (Fig. 2; Table 1). Initial treatments of exotic plants have been completed in four of these areas and research and monitoring activities are underway or planned in others. Interpretation via one nature trail is ongoing, and other areas are routinely used for interpretation to individuals or small groups. Much more interpretation is needed. Some advantages of the SEA approach as we see them, are:

1. SEAs serve as a focus for control of introduced plants that cannot be controlled at present on a parkwide basis. Depending upon funding levels and characteristics of the species involved, buffer zones

Continued on page 12

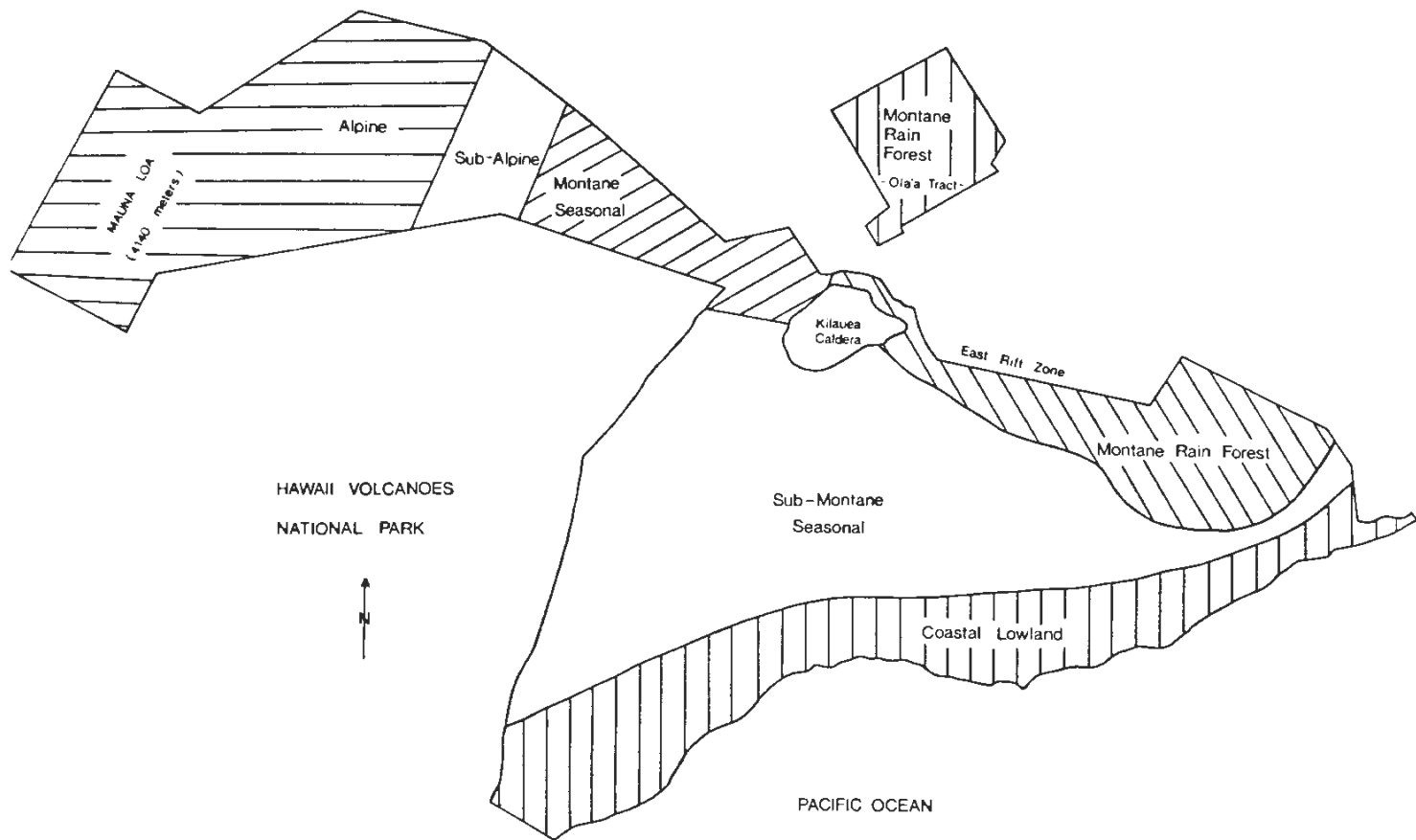


Fig. 1. Ecological zones, *Hawai'i Volcanoes National Park*.

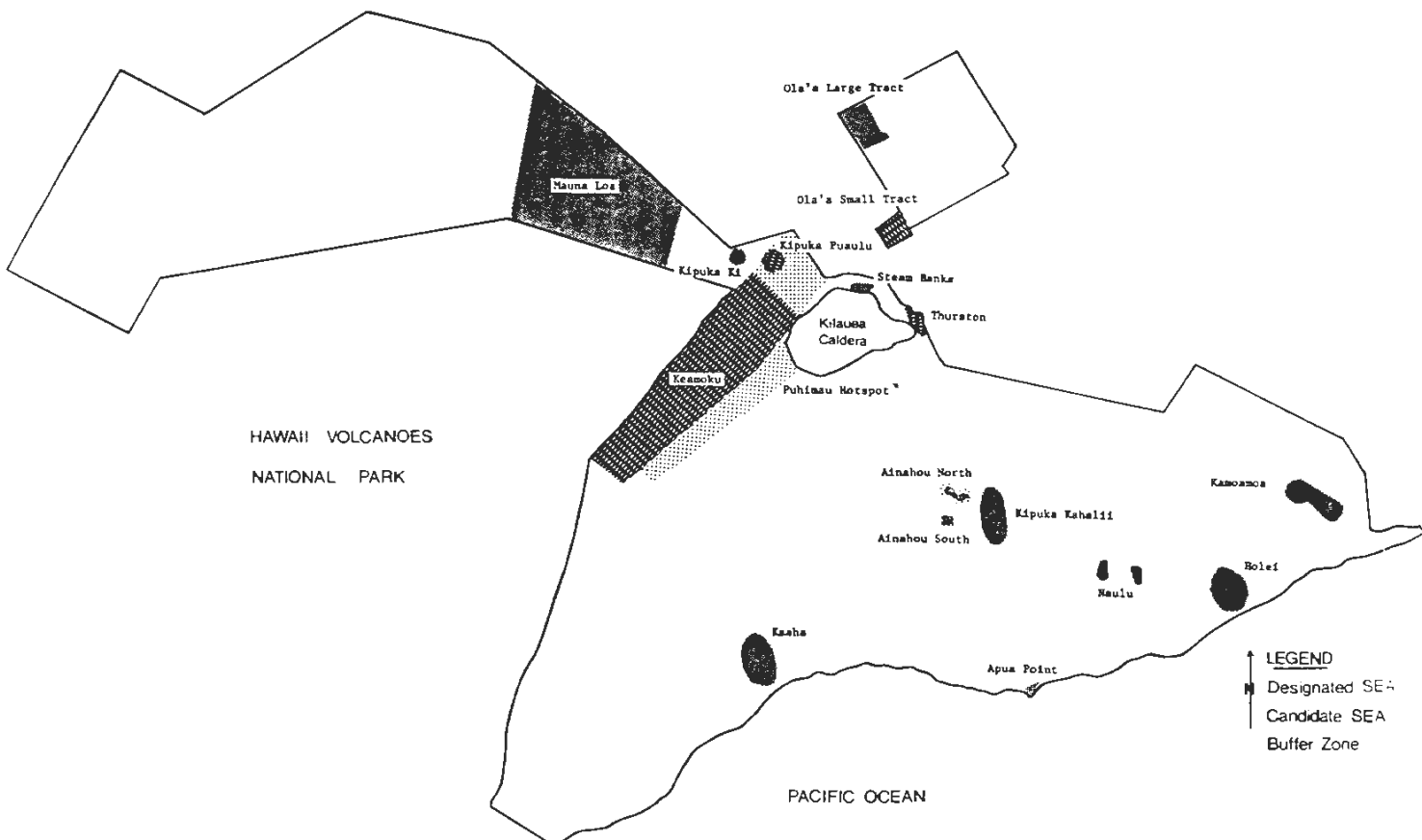


Fig. 2. Locations of proposed Special Ecological Areas within *Hawai'i Volcanoes National Park* as of November 1985.

SEAs Provide

Continued from page 10

can be set up around SEAs to reduce dispersal of weeds that threaten them. Buffer zones may include neighboring ranches and forests, but for highly localized exotics, smaller zones may be sufficient. As funds become available, exotic plant control efforts can be expanded, but protection of the most intact systems is the primary focus.

2. Biological understandings can be gained through long-term monitoring and research in our most valuable representative and unique areas. Permanent plots, transects, weather stations, etc. can be established and data gathered over long periods in SEAs and in similar areas subject to less intensive management. What we learn from these key ecosystems can be applied to decisions about other parts of the park.

3. Interpretive activities too can be focused on distinct areas. In this way, the best biological systems can be shared with the public to promote understanding, appreciation, and funding. The public can be informed about the ongoing management and research efforts necessary to preserve the ecosystems they are viewing.

4. Feral ungulates are no longer present, have been present in minimal numbers for a long time, or are the focus of intensive control in SEAs. Thus, one of the most disruptive forces is minimized, and some healing of disturbed areas is under way.

5. Exotic plant control in SEAs is more feasible than in many parts of the park because of the dominance of native species. Exotic plants are localized and control therefore less difficult. Labor-intensive initial plant control often can be handled by volunteer groups. Park staff can provide low-level followup.

6. SEAs will serve as an increasingly important focus for recolonizations, plantings, and translocations of missing ecosystem components from elsewhere. For example, birds, plants, or invertebrates found in other more threatened ecosystems may sometimes be missing in SEAs. As ecosystems become more intact, natural processes, albeit under somewhat altered climatic and other man-influenced conditions should function insofar as possible. Self-sustaining systems should thus become more likely.

7. Restoration and control programs can be extended to more difficult areas outside SEAs as knowledge increases and funding becomes available. Some restoration projects may not ever be feasible, and use of less intensively managed buffer zones may be more realistic. However, native biota preserved in SEAs may be increasingly important in colonizing less intensively managed areas nearby.

It is possible that Special Ecological Areas may become islands of native organisms in a sea of exotics. However, we believe that considerable native biota will survive in many areas of the park outside SEAs, particularly if disturbance is minimized there through management. Hawaii's native ecosystems are by no means a paradise lost, given adequate support and well-planned and active stewardship.

Valuable gene pools outside of SEAs cannot be abandoned and SEAs may be inadequate in size or number for indefinite perpetuation of processes such as succession, colonization, and evolution (Quinn et al. 1985). For example, many remote areas cannot receive the emphasis SEAs can, but are nonetheless vital for survival of native biota. Continued support for

Continued on page 13

Table 1.
Ecological zone, vegetation type, and size of Special Ecological Areas to date in Hawai'i Volcanoes National Park.

Ecological Zone	Vegetation Type	SEA	Hectares
Coastal Lowland	Pili grassland	Holei	200
	Native scrub, lava, mesic forest	Kamoamoa	300
	Pili grassland	Ka'aha	200
	Strand	Apua Pt.	50
Submontane seasonal	Dry 'ohi'a woodland scrub	Ainahou North	12
	Dry 'ohi'a woodland	Ainahou South	33
	'Ohi'a scrub	Keamoku	2,700
	'Ohi'a scrub/woodland	Kipuka Kahali'i	150
	Dry lava forest	Naulu	50
	'Ohi'a/native fern	Steam banks	50
	Sparsely vegetated Thermal	Puhimau	
		Hot Spot	6
Montane	Hapu'u/'ohi'a	'Ola'a (large tract)	283
Rain Forest	Hapu'u/'ohi'a	'Ola'a (small tract)	141
	'Ohi'a/hapu'u	Thurston	10
Montane	Mesic 'ohi'a/soapberry forest	Kipuka Puauulu	33
	(Buffer zone)		560
	Mesic koa/'ohi'a/soapberry forest	Kipuka Ki	50
	Mountain parkland	Mauna Loa	3,300
Subalpine	Native scrub	Mauna Loa	1,000
Alpine	Native scrub	Mauna Loa	1,000



A forest scene on the edge of Naulu, at 50 ha, one of the smallest SEAs in Hawai'i Volcanoes. It was selected because it represents a relatively intact remnant of native lowland dry forest and contains several rare tree species such as the endemic lily, halepepe.

attention to natural resources other than those in SEAs is critical.

One may argue that a program of parkwide management, research, and interpretation is the optimum strategy. However, this is not possible, because of funding constraints. Most of the progress in resources management in Hawai'i's parks has been made by dividing problems into manageable pieces and, with adequate support, attacking them in stages. We believe that such an approach also will lead to more effective management through better ecological understandings over short and long periods. Special Ecological Areas are an appropriate and timely step in that direction.

Tunison is NPS Resource Management Specialist at Hawai'i Volcanoes NP; Stone is an NPS Research Scientist; Cuddihy is an NPS Biological Technician.

Literature Cite

- Gardner, D.E., and C.W. Smith. 1985. Plant biocontrol quarantine facility at Hawaii Volcanoes. Park Science 6(1):3-4.*
- Quinn, J.F., C. van Riper III, R. Karban, G. Robinson, and S.P. Harrison. 1985. Conservation strategies: Island biogeography and the design of nature reserves. Research notes. Park Science 6(1):6-9.*
- National Park Service 1975. Master Plan. Hawaii Volcanoes Natl. Park. U.S. Dept. Interior. 75 pp.*
- Smith, C.W. 1985. Impact of alien plants on Hawai'i's native biota. pp. 180-250 in C.P. Stone and J.M. Scott (eds.), Hawai'i's Terrestrial Ecosystems: Preservation and Management. Honolulu: Coop. Natl. Park Resour. Stud. Unit, Univ. Hawaii.*
- U.S. Fish and Wildlife Service. 1980. Endangered and threatened wildlife and plants: review of*

plant taxa for listing as endangered or threatened species. December 15, 1980. Fed. Register 42(242):82480-82569.

Warshauer, F.R., J.D. Jacobi, A.M. LaRosa, J.M. Scott, and C.W. Smith. 1983. The distribution, impact and potential management of the introduced vine, Passiflora mollissima (Passifloraceae), in Hawaii. Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit Tech. Rep. 48.