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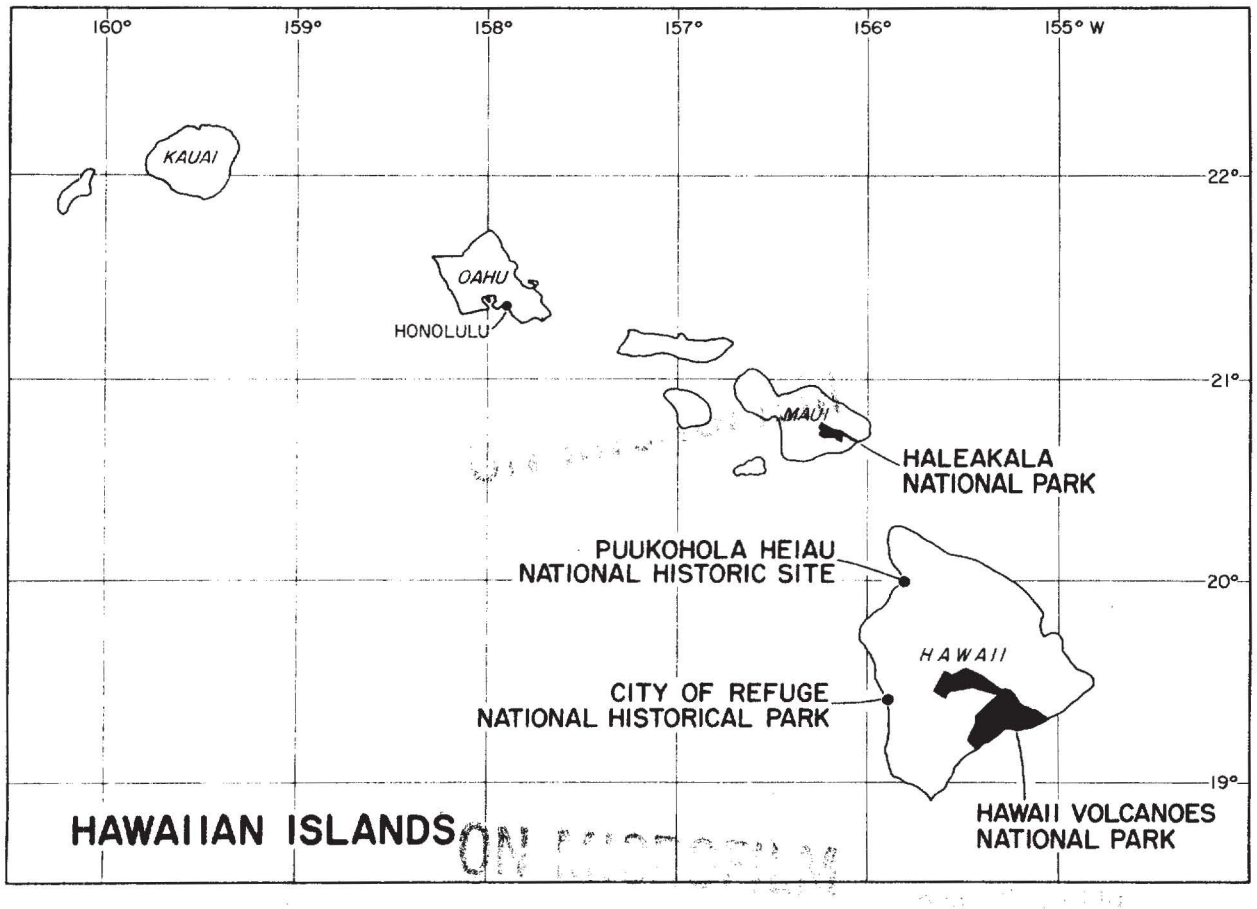
COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT
Hawaii



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The National Park Service and the University of Hawaii signed the memorandum of agreement establishing this Cooperative National Park Resources Studies Unit (CPSU/UH) on March 16, 1973. The CPSU/UH provides a multidisciplinary approach to studies on the biological resources in the National Parks in Hawaii, that is, Hawaii Volcanoes National Park, Haleakala National Park, City of Refuge National Historical Park, and Puukohola Heiau National Historic Site. Through the Unit Director, projects are undertaken in areas identified by park management. These studies provide information for resource management programs. The involvement of University faculty and students in the resource management of the National Parks in Hawaii leads to a greater awareness of the problems and needs of the National Park Service. At the same time, research not directly or immediately applicable to management is also encouraged through the CPSU/UH.

Contribution numbers are assigned as follows. CPSU/UH identifies the Cooperative National Park Resources Studies Unit of the University of Hawaii. This is followed by a three-digit number assigned in sequence to each new project of this CPSU. The fourth digit indicates the report number for that particular project.

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Technical Report 24

HALEAKALA NATIONAL PARK CRATER DISTRICT RESOURCES BASIC INVENTORY: 1976-77

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April 1979

UNIVERSITY OF HAWAII AT MANOA

NATIONAL PARK SERVICE: Contract No. CX 8000 7 0003

Contribution Number CPSU/UH 011/12

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ACKNOWLEDGMENTS

We would like to thank the following people who participated in the field work: J. Beardsley, S. Conant, A. Hara, R. Herat, T. Herat, F. Howarth, C.H. Lamoureux, M. Mitsuda, D. Peterson, R. Rice, G. Teves, and L. Whiteaker.

We would also like to thank Tamotsu Nakata for his patient help with the figures. Appreciation also goes to Jane Nakahara and Deborah Weiner for typing the vegetation lists, Dora Tsuha for typing the study area texts, and Deborah Weiner for editorial assistance.

Finally we would like to thank D. Dunatchik, H. Huntzinger, J.I. Kjargaard, and the other personnel at Haleakala National Park Crater District for their logistical support and other help without which our task would have been much more difficult and time-consuming.

INTRODUCTION

This report covers the second and third phases of field work during the summers of 1976 and 1977 for the Resources Basic Inventory of the Crater District of Haleakala National Park. The first phase, covering 23 localities, was reported on as CPSU/UH Technical Report #9, "Haleakala National Park Resources Basic Inventory 1975: Narrative Report."

Information is presented for 35 localities in the Crater District, including aspect, total cover, general description, substrate, a description of surrounding areas, climate, and number of specimens collected. Landmarks associated with each study area are identified, with grid references, elevation, and other information provided which will enable one to locate an area within 100 feet. In the future, therefore, it should be possible to revisit particular sites so that species presence and abundance can be compared with the present as reported here. Comparisons of this nature can be used to determine the impact of visitors or to evaluate the effects of specific resource management programs, e.g., attempts to reestablish native ecosystems. The quantitative descriptions of the vegetation in each area can also be used in vegetation community analysis programs.

This inventory provides the baseline information for annotated catalogues, to be published separately, for the flowering plants, ferns, bryophytes, lichens, birds, and insects. In addition to the general inventory of the area, special attention has been paid to the identification of natural resource management problems and consideration of their scope. These analyses will be published in a separate technical report at the conclusion of the inventory.

METHODS AND MATERIALS

Seven major transects were sampled in the Crater District (Figure 1). Study areas (Figure 2) were principally confined to these transects. The rationale for studying each site is explained in the text. In order to help readers, Figure 3 shows the location of place names in the Crater District referred to in this report.

At each site, an area typical of the surrounding vascular plant vegetation was chosen. After walking through the area, a consensus of general observations was reached concerning the characteristics of that ecosystem. All species present are recorded in the vegetation lists as follows: (1) species in the highest stratum are listed first, with those taxa in lower strata following; and (2) species within each stratum are listed in decreasing order according to cover. When the cover is the same or simply "+" (present), species are listed alphabetically within groups: Dicotyledons first, then Monocotyledons and Pteridophytes (Ferns). In the few sites where bryophytes and lichens are listed, they follow Pteridophytes.

The site and surrounding area were sampled intensively by the various specialists. Herbarium specimens were collected only where the species identity could not be established or verified in the field, or where the occurrence of a particular species in a given site seemed anomalous.

The inventory of the Crater District was not restricted to these study sites. Areas of interest to particular specialists were also studied, e.g., Hōlua Spring, lava tubes, cliff faces, etc.

The names of flowering plants conform to those in St. John (1973). This usage does not imply that we necessarily agree with that taxonomy; however, it is the most complete list published so far on Hawaiian flowering plants and we have conformed with it to avoid confusion. The Federal Register list of endangered and threatened plants (US Fish and Wildlife Service 1976) and Fosberg and Herbst's (1975) list of rare and endangered species also utilize the names published in St. John's list.

The common and Hawaiian names are taken from Porter (1972), St. John (1973), and Pukui and Elbert (1971). However, because of space limitations we could not list all the variants given for each species, and some names used locally by native-speaking Hawaiians may not be included. Hawaiian orthography is used on Hawaiian words except where they are incorporated into English names, e.g., Haleakala National Park.

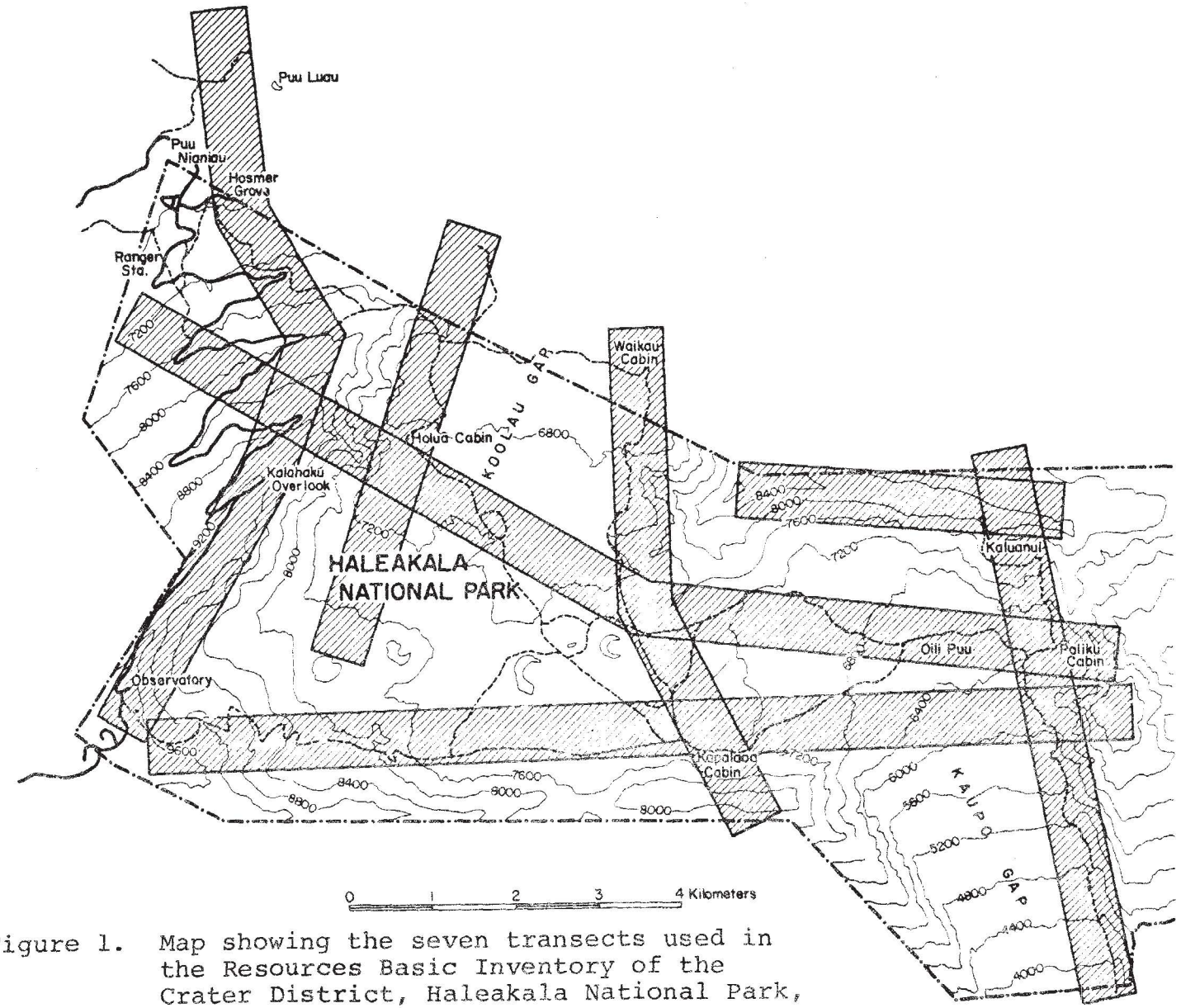

Figure 1. Map showing the seven transects used in the Resources Basic Inventory of the Crater District, Haleakala National Park, Maui, 1975-1977.

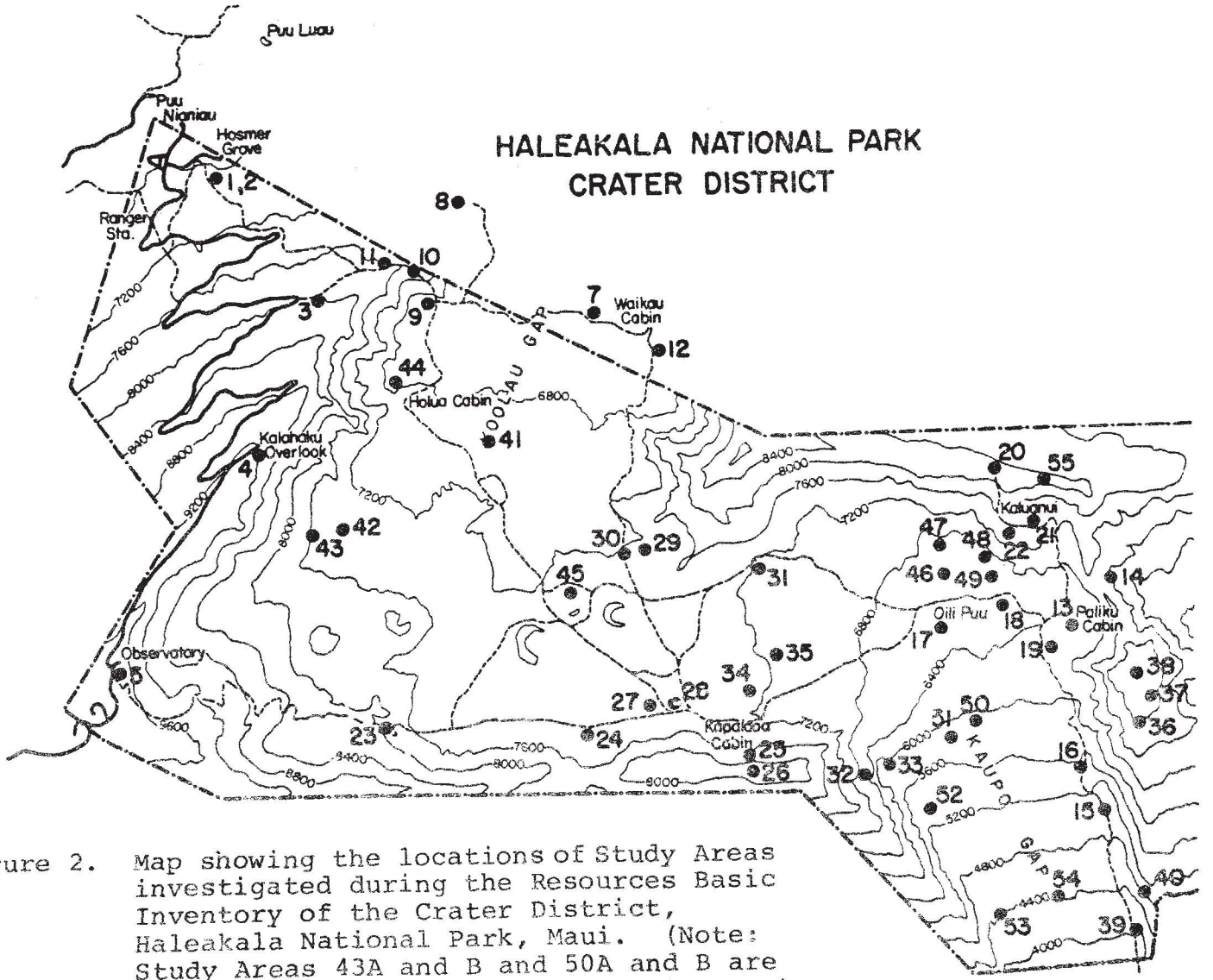

Figure 2. Map showing the locations of Study Areas investigated during the Resources Basic Inventory of the Crater District, Haleakala National Park, Maui. (Note: Study Areas 43A and B and 50A and B are too close to differentiate on this map.)

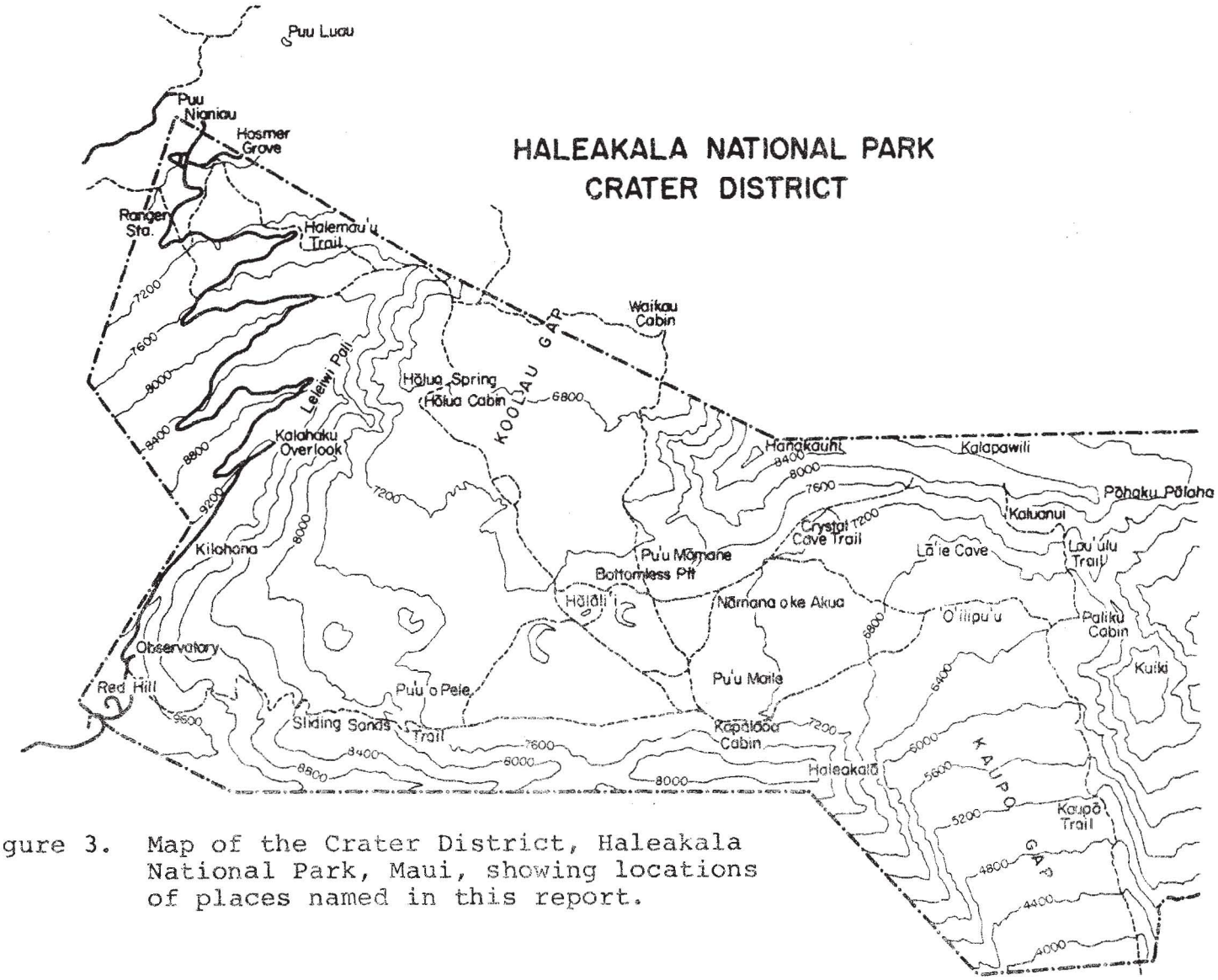

Figure 3. Map of the Crater District, Haleakala National Park, Maui, showing locations of places named in this report.

STUDY AREA #23

Map reference: 156° 13' 49" W
20° 42' 42" N

Date studied: 17 June 1976

Location: Sliding Sands Trail about one-half mile west of Pu'u o Pele.

Elevation: 8100 ft (2470 m)

Aspect: East-facing, inner western slope of Haleakalā Crater.

Total vascular plant cover: <1%

General description: The study area is situated on a gentle slope on uneven terrain of lava formations and ash. Very few plants are found in this barren volcanic landscape. The area appears very dry, but when the surface cinders are removed from certain areas the ground is damp. In such areas the moss *Ceratodon purpureus* can be seen. This area can be considered representative of many high elevation volcanic areas in the Crater. Most of the very sparse vegetation is confined to the rocky lava outcrops.

Substrate: Lava formations with a cinder veneer, interspersed with large areas of ash.

Surrounding area: Much more cover is found south of the study site proper, toward the base of the south wall of the Crater (facing north). The vegetation on the talus slopes of the north-facing wall, and the alluvium below, differs from that of the study site in diversity and cover. Present toward the talus base, and not in the study site, are *Eupatorium adenophorum*, *Coprosma ernodeoides*, *C. montana*, *Vaccinium reticulatum*, and *Styphelia tameiameiae*. The difference in vegetation in the two areas is probably related to the availability of water. The talus is exposed to runoff from the cliff face.

Climate: The climate is harsh and dry. Rarely is this part of the Crater exposed to fog rising from either the Ko'olau or Kaupō Gaps, and rainfall is low, not more than 40 inches (100 cm) per year.

Rationale for studying area: This area was chosen as being representative of the high elevation ecosystem present on barren lava fields in the southwestern portion of the Crater. It also forms part of a transect from Palikū to the Observatory.

Number of specimens collected:

Flowering plants	2
Ferns	0
Bryophytes	2
Lichens	13

VEGETATION OF STUDY AREA #23

Stratum	Species	Common Name	% Cover	Height	Status
1 m	*Railliardia menziesii* Gray	Na'ena'e	+	0.75-1.0 m	E
<1 m	*Hypochaeris radicata*[1] L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Silene hawaiiensis Sherff	. . . . .	+		E
	Agrostis sandwicensis[1] Hbd.	Hawaiian bent	+	0.3 m	E
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.75 m	E
	Trisetum glomeratum[1] (Kunth) Trin. in Steud.	Pili-uka, mountain pili, he'u-pueo	+	0.3 m	E

NOTE: % Cover: + = presence

Status: E = Endemic, I = Indigenous, X = Exotic

[1]Flowering.

STUDY AREA #24

Map reference: 156° 12' 44" W
20° 42' 37" N

Date studied: 17 June 1976

Location: Alluvial wash 1.6 miles (2.6 km) west of Kapalaoa on Sliding Sands—Kapalaoa Trail.

Elevation: 7300 ft (2225 m).

Aspect: Slight north-facing slope. The study area is a transition zone between the talus slopes of the south Crater wall, and the floor of the Crater.

Total vascular plant cover: 40%

General description: This is an area dominated by It is relatively level and there is a small intermittent stream which runs through the area. There are a few silverswords present, one of which was blooming, and several of which showed signs of browsing.

Substrate: Loose, uncompacted alluvial cinder, with small (less than 20 cm diameter) rocks.

Surrounding area: South of the study area on the north-facing southern wall of the Crater is typical native scrub. North of the site are recent lava flows. East and west are areas similar to the study site.

Climate: The climate of this study site is dry, as fog does not normally cover this portion of the Crater except when the cloud cover on the south slopes spills over the Crater rim. Rainfall averages about 40 inches (100 cm) per year.

Rationale for studying area: This area was considered fairly typical of the alluvial areas dominated by *Pteridium*. Such areas can be contrasted with scrub on the talus slopes, Crater wall, and Crater floor. *Pteridium*-dominated areas on the Crater wall are similar in composition to this site though the substrate and slope differs; however, in each of the areas where *Pteridium* is the dominant species, the substrate is loose and somewhat unstable. The area is also part of a transect running from the Palikū area to the Observatory.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	0
Lichens	4

VEGETATION OF STUDY AREA #24

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m	*Coprosma montana* Hbd.	Pilo	+	1.5 m	E
<1 m	*Pteridium aquilinum* (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	20	0.5 m	E
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	15	0.5 m	E
	Argyroxiphium sandwicense[1] DC.	Hinahina, 'āhinahina, silversword	+	0.5-.75 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Agrostis sandwicensis Hbd.	Hawaiian bent	+	0.3 m	E
	Trisetum glomeratum (Kunth) Trin. in Steud.	Pili-uka, mountain pili, he'u-pueo	+	0.3 m	E
	Grimmia haleakalae Reichardt	Moss	+	.01 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1]One small plant flowering.

STUDY AREA #25

Map reference: 156° 11' 15" W
20° 42' 25" N

Date studied: 18 June 1976

Location: Slopes behind Kapalaoa Cabin between the cabin and Pu'u Haleakalā.

Elevation: 7400-7600 ft (2260-2320 m).

Aspect: North-facing slopes of south Crater wall.

Total vascular plant cover: 60%

General description: The lower slopes of the southern, inner wall of Haleakalā Crater are rather steep and vegetated with the various shrubby species found throughout the Park. The vegetation in the area is heavily damaged by goats, and goat trails are found around virtually every plant. Goats move down the slopes from Pu'u Haleakalā and the leeward area outside the Park to the Crater floor, where they graze. They were also seen obtaining water from the Kapalaoa water tanks both near the cabin and on the hill.

Substrate: The substrate consists of loose soil with rock outcroppings and is fairly unstable. It is not possible to walk without dislodging rocks and causing soil to slip. Constant use by goats is certainly very damaging in this respect.

Surrounding areas: The surrounding areas on the slopes are similar in terms of substrate, exposure, and species composition. On inaccessible rock outcroppings silverswords (*Argyroxiphium*) are present, and a fern, *Cystopteris* sp., was found in a sheltered area under a rocky overhang above the study area.

Climate: The climate of this site is dry with an annual rainfall averaging 40 inches (100 cm) per year and with very little fog interception.

Rationale for studying area: The vegetation of this area was considered to be fairly typical of the scrub found on the southern Crater wall. This scrub can be compared with scrub found elsewhere in Haleakala National Park. The area formed part of a transect from Pu'u Māmane to Kapalaoa and beyond.

Number of specimens collected:

Flowering plants	1
Ferns	0
Bryophytes	18
Lichens	32

VEGETATION OF STUDY AREA #25

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m[1]	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	20	1.0-1.5 m	I
	Coprosma montana Hbd.	Pilo	15	1.0-2.0 m	E
	Sophora chrysophylla[2] (Salisb.) Seem.	Māmane, māmani	+	2.0-3.0 m	E
<1 m	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	15	0.5 m	E
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	10	0.2 m	E
	Holcus lanatus L.	Yorkshire fog, velvetgrass	5	0.3 m	X
	Epilobium cinereum A. Rich.	Willow herb, pūkāmole	+	0.1 m	X
	Eupatorium adenophorum[2] Spreng.	Maui pā-makani, white thoroughwort	+	0.5 m	X
	Fragaria chiloensis (L.) Duch.	'Ōhelo-papa, Hawaiian strawberry	r	0.1 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Oenothera stricta Ledeb. in Link	Evening primrose	+	0.2 m	X
	Railliardia menziesii[2] Gray	Na'ena'e	+	0.5 m	E
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Tetramolopium humile (Gray) Hbd.	Alpine tetramolopium	r	0.1 m	E
	Vaccinium reticulatum Sm.	'Ōhelo	+	0.5-1.0 m	E
	Luzula hawaiiensis Buch.	. . . . .	+	0.1 m	E

NOTE: % Cover: + = presence, r = rare in Study Area #25.
Status: E = Endemic, I = Indigenous, X = Exotic

[1] *Dodonaea* absent.
[2] On rocky outcroppings.

STUDY AREA #26

Map reference: 156° 11' 15" W
20° 42' 16" N

Date studied: 18 June 1976

Location: Top of ridge behind Kapalaoa Cabin, and to the south of the ridge line.

Elevation: 8400 ft (2560 m).

Aspect: South-facing slope on the southern wall of Haleakalā Crater.

Total vascular plant cover: 60%

General description: The study site is very heavily disturbed by goats. The vegetation consists of the common scrub species, and is not unlike scrub areas elsewhere in the Park. The continuous presence of goats in this area is evident.

Substrate: Substrate consists of block rock interspersed by a thin soil.

Surrounding area: The upper slopes of the mountain on the interior of the Crater behind Kapalaoa Cabin have much the same vegetation as that of the lower slopes (Study Area #25). In places where the substrate is very unstable and consists of loose gravel *Pteridium* is dominant, and the shrub species present elsewhere are absent. There are barren areas of rock outcroppings distributed throughout the upper parts of the slope. The remainder of the surrounding areas have a similar vegetation to the study site.

Climate: The climate here is dry with about 40 inches (100 cm) of rain per year and little exposure to fog.

Rationale for studying area: The Park boundary extends outside the Crater down the southern slopes of Haleakalā a few hundred feet and a sampling of the area on the exterior of the Crater was needed to compare with areas within the Crater. The area also formed part of a transect from Pu'u Māmane to beyond Kapalaoa Cabin.

Number of specimens collected:

Flowering plants	6
Ferns	0
Bryophytes	1
Lichens	16

VEGETATION OF STUDY AREA #26

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	30	1.0-1.5 m	I
	Coprosma montana Hbd.	Pilo	20	1.5 m	E
<1 m	*Pteridium aquilinum* (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	10	0.3 m	E
	Vaccinium reticulatum Sm.	'Ōhelo	5	0.5-0.75 m	E
	Cirsium vulgare (Savi) Tenore	Pua-kala, bull thistle, spear thistle	+	0.3 m	X
	Compositae indet.	. . . . .	+	0.1 m	
	Eupatorium adenophorum Spreng.	Maui pā-makani, white thoroughwort	+	0.2 m	X
	Gnaphalium purpureum L.	Purple cudweed	+	0.1 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Polycarpon tetraphyllum (L.) L.	Allseed	+	0.05 m	X
	Agrostis avenacea Gmel.	He'u-pueo	+	0.2 m	X

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #27

Map reference: 156° 11' 32" W 20° 42' 37" N Date studied: 19 June 1976

Location: In *Deschampsia* grassland off Kapalaoa–Sliding Sands Trail, 350 yards (320 m) west of Kapalaoa Cabin.

Elevation: 7250 ft (2200 m).

Aspect: Level, exposed area.

Total vascular plant cover: 40%

General description: The study area is situated on level ground and vegetated with a tussock grassland. There is much evidence of grazing by goats which move down the slopes of the southern Crater wall into this and adjoining Crater regions. No shrubs are present in the grassland and the exotic composite *Hypochaeris* is found under virtually every clump of *Deschampsia*. If not browsed the *Deschampsia* would provide 100% cover from the overlap of the tussocks.

Substrate: Deep cinder-ash substrate.

Surrounding area: The study area is surrounded to the north, east, and west by rather barren lava flows. South of the area is the southern wall of Haleakalā Crater which is vegetated with a mixed scrub.

Climate: Dry area with approximately 40 inches (100 cm) rain per year and little fog interception.

Rationale for studying area: This pocket of *Deschampsia* is one of the best developed native grassland areas in the central Crater region and it was surveyed so that it could be compared with adjacent areas and other *Deschampsia* grasslands. The area is part of the transect running from the Palikū area to the Observatory.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	0
Lichens	0

VEGETATION OF STUDY AREA #27

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis*[1] (Skottsb.) Skottsb.	. . . . .	35	0.5 m	E
	Hypochaeris radicata[2] L.	Hairy cat's ear, gosmore	5	0.1 m	X
	Erodium cicutarium (L.) L'Hér. ex Ait.	Heron's bill, filaree	r	0.1 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Aira caryophyllea L.	Silver hairgrass	+	0.1 m	X
	Bromus rigidus[3] Roth	Ripgutgrass	+	0.2 m	X
	Festuca megalura[3] Nutt.	Foxtail fescue	+	0.1 m	X

NOTE: % Cover: + = presence, r = rare in Study Area #27.
Status: E = Endemic, I = Indigenous, X = Exotic

[1]Blooming.
[2]Found under *Deschampsia*.
[3]Along trail.

STUDY AREA #28

Map reference: 156° 11' 32" W 20° 42' 41" N Date studied: 19 June 1976

Location: Lava field between *Deschampsia* meadow (Study Area #27) and Kapalaoa Cabin.

Elevation: 7250 ft (2200 m).

Aspect: Exposed uneven terrain.

Total vascular plant cover: <1%

General description: The study area is a barren lava field typical of many areas in the Crater. Only a few scattered plants are seen in this area.

Substrate: A veneer of ash over an 'a'ā flow.

Surrounding area: There is a *Deschampsia* grassland (Study Area #27) west of this site, and the south wall of the Crater is south of the site. North and east the terrain and vegetation are similar to the study site.

Climate: Dry area with approximately 40 inches (100 cm) rain per year and little fog interception.

Rationale for studying area: This barren area was chosen as a study site because it is typical of much of the Crater region in the general vicinity, and can be compared with adjacent vegetated areas. It also constitutes another segment of the transect from the Palikū area to the Observatory.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	0
Lichens	0

VEGETATION OF STUDY AREA #28

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Eupatorium adenophorum* Spreng.	Maui pā-makani, white thoroughwort	+	0.1 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Oenothera stricta Ledeb. in Link	Evening primrose	+	0.1 m	X
	Railliardia menziesii Gray	Na'ena'e	+	0.75 m	E
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Tetramolopium humile Gray (Hbd.)	Alpine tetramolopium	+	0.05 m	E
	Agrostis sandwicensis Hbd.	Hawaiian bent	+	0.2 m	E
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.5 m	E
	Trisetum glomeratum (Kunth) Trin. in Steud.	Pili-uka, mountain pili he'u-pueo	+	0.2 m	E
	Asplenium trichomanes L.	'Owāli'i, spleenwort	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #29

Map reference: 156° 11' 27" W 20° 43' 35" N Date studied: 19 June 1976

Location: East slopes of Pu'u Māmane cinder cone.

Elevation: 7500 ft (2300 m)

Aspect: East-facing slope of cinder cone.

Total vascular plant cover: 65%

General description: The study site is an open slope of the Pu'u Māmane cinder cone. Goat damage is fairly extensive and quite obvious from the lack of undergrowth, absence of lower branches on the māmane, and abundance of fecal pellets. These observations are in direct constrast to the western slopes of Pu'u Māmane (Study Area #30) where fecal pellets are fewer, the undergrowth denser, and the māmane shrubs have branches which reach to the ground. Also, in contrast with the western slope, the only persistent shrub is pūkiawe.

Not all of the differences between the east and west side of Pu'u Māmane can be attributed to goats. The west side is frequently immersed in clouds which are forced up the Ko'olau Gap by the tradewinds. Due to topographical features the clouds sweep across Pu'u Māmane's west face only and then move into the central Crater area. Thus the area is subjected to frequent fog drip and dramatically cooler temperatures at times which may in part account for the different vegetation on the east and west slopes. However, the impact of goats should not be minimized. The eastern slopes with their more rigorous climate are more susceptible to the negative impact of goats. The area does not have the potential to recover rapidly because its productivity is so much lower.

A comparison of Study Areas #29 and #30 is very instructive in evaluating the impact of feral goats in the Crater District. The carrying capacity (the number of animals that a given area can support on a continuous basis) of two seemingly similar areas can be dramatically different when their productivity and consequent regenerative capacity are marginal. Very small differences in their environmental parameters can have a dramatic effect on their capacity to respond to disturbance.

Substrate: Cinder.

Surrounding area: The western slope of Pu'u Māmane (Study Area #30) is described elsewhere. The vegetation of the ridge extending from Pu'u Māmane to Hanakauhi is similar to that of this study site, though it may be even more barren. Pu'u Māmane is surrounded by fairly barren lava flows to the northwest, west, south, and southeast, and by Hanakauhi to the north and east.

STUDY AREA #29--Continued

Climate: Usually exposed but not infrequently in contact with clouds in the upper part of Ko'olau Gap. Moisture from cloud interception has not been measured.

Rationale for studying area: This area was examined so that it could be compared with the west side of this Pu'u (Study Area #30). The east side is joined by a ridge to Hanakauhi, and it appears that the goat populations there frequently come down and graze this side of Pu'u Māmane. The area forms part of a transect from Kilohana to Palikū.

Number of specimens collected:

Flowering plants	1
Ferns	0
Bryophytes	0
Lichens	0

VEGETATION OF STUDY AREA #29

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	5	1.5 m	I
<1 m	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	35	.5 m	E
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	20	.2 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	5	0.1 m	X
	Festuca megalura Nutt.	Foxtail fescue	5	0.1 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Carex macloviana D'Urv. var. *subfusca* (W. Boott) Kuek.	St. Malo's sedge	+	0.1 m	I

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #30

Map reference: 156° 11' 36" W
20° 13' 37" N

Date studied: 19 June 1976

Location: West side of Pu'u Māmane.

Elevation: 7500 ft (2300 m).

Aspect: West-facing slope.

Total vascular plant cover: 85%

General description: This site is a well-developed māmane scrub forest on well-drained cinder cone. It is one of the best-developed māmane forests in the Crater, due in part to the age of Pu'u Māmane (which is thought to be older than the other cones in the Crater) and in part to the exposure of this Pu'u to precipitation and cloud from Ko'olau Gap. The great number of exotic species present is probably also due in part to the greater precipitation in this area than in other Crater regions.

Substrate: Cinder.

Surrounding area: The west side of this Pu'u (Study Area #31) is more sparsely vegetated due in part to the effects of goats. Pu'u Māmane itself is surrounded on the north and east by Hanakauhi, and elsewhere by rather barren lava.

Climate: Usually exposed, but not infrequently in contact with clouds from Ko'olau Gap.

Rationale for studying area: This area was studied as a representative of a well-developed *Sophora* stand in the Crater. Study Area #29, which has been more severely influenced by goat activity, can be contrasted with this area. It also forms part of a transect from Palikū to Kilohana.

Number of specimens collected:

Flowering plants	6
Ferns	0
Bryophytes	13
Lichens	27

VEGETATION OF STUDY AREA #30

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m	*Sophora chrysophylla* (Salisb.) Seem.	Māmane, māmani	25	2.0-3.0 m	E
	Coprosma montana Hbd.	Pilo	20	2.0 m	E
	Styphelia tameiameiae[1] (Cham.) F.Muell.	Pūkiawe	3	1.0-1.5 m	I
	Railliardia menziesii Gray	Na'ena'e	2	1.0 m	E
<1 m	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	15	0.75 m	E
	Holcus lanatus L.	Yorkshire fog, velvetgrass	15	0.25 m	X
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	5	0.2 m	E
	Festuca megalura Nutt.	Foxtail fescue	1	0.2 m	X
	Cerastium vulgatum L.	Larger mouseear chickweed, nehine-hāuli	+	0.1 m	X
	Epilobium cinereum A. Rich.	Pūkāmole, willow herb	+	0.1 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Polycarpon tetraphyllum (L.) L.	Allseed	+	0.1 m	X
	Silene gallica L.	Small-flowered catchfly	+	0.1 m	X
	Stenogyne crenata[2] Gray	Crenate-leaved stenogyne	+	3.0 m	E
	Aira caryophyllea L.	Silver hairgrass	+	0.1 m	X

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1]Occurring toward margins and east side of Pu'u Māmane.
[2]Vine in māmane tree, listed as rare and endangered in Federal Register (1976), and Fosberg and Herbst (1975).

VEGETATION OF STUDY AREA #30--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Bromus rigidus* Roth	Ripgutgrass	+	0.2 m	X
	Poa pratensis L.	Kentucky bluegrass	+	0.1 m	X
	Trisetum glomeratum (Kunth) Trin. in Steud.	Pili-uka, mountain pili, he'u-pueo	+	0.2 m	E

STUDY AREA #31

Map reference: 156° 11' 07" W 20° 43' 21" N Date studied: 19 June 1976

Location: Nāmana o ke Akua.

Elevation: 7325 ft (2230 m).

Aspect: The terrain is uneven and several different orientations were considered in the study area.

Total vascular plant cover: 75%

General description: The study area is apparently heavily disturbed by goats but also often frequented by nēnē geese. A decadent *Sophora* forest (only old trees present) with *Deschampsia* understory similar to that found along the south-facing wall of Haleakalā Crater in the lower part of the Crystal Cave Trail is found in the crater of Nāmana o ke Akua. Various scrubby species form an association on the northern extension of the study site.

Substrate: Part of the study area is a cinder cone, and the northern part of the site appears to be an older substratum of lavas rather than cinder.

Surrounding area: Nāmana o ke Akua is surrounded on the east, south, and west by rather barren lava fields. To the north it joins with the north wall of Haleakalā Crater where a decadent *Sophora* forest is found. A few plants of the rare *Chenopodium oahuense* var. *discosperma* ('āheahea, 'āweoweo) are found where the northeastern point of Nāmana o ke Akua intersects with the Palikū-Holua Trail. The only Maui locality for the moss *Orthotrichum diaphanum* Brid. is in this area. Goat disturbance is evident on the north wall of the Crater in the Crystal Cave region, and goats from there come to the study area.

Climate: The area is in the central Crater region which receives approximately 40 inches (100 cm) rain per year.

Rationale for studying area: This vegetated area in the central Crater region was studied so that comparison could be made with adjacent barren areas and similar vegetated areas elsewhere in the Park.

Number of specimens collected:

Flowering plants	5
Ferns	0
Bryophytes	3
Lichens	14

VEGETATION OF STUDY AREA #31

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m	*Coprosma montana* Hbd.	Pilo	5	2.0 m	E
	Sophora chrysophylla (Salisb.) Seem.	Māmane, māmani	5	2.0-3.0 m	E
	Styphelia tameiameiae (Cham.) F.Muell.	Pūkiawe	5	1.0 m	I
	Dodonaea eriocarpa Sm.	'A'ali'i ku-ma-kua	+	1.0-2.0 m	E
	Osteomeles anthyllidifolia[1] (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	1.5 m	E
	Santalum haleakalae[1] Hbd.	'Ili-ahi, Haleakalā sandalwood	+	3.0 m	E
<1 m	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	50	0.5 m	E
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	10	0.3 m	E
	Anagallis arvensis L.	Scarlet pimpernel	+	0.1 m	X
	Cerastium vulgatum L.	Larger mouseear chickweed, nehine-hāuli	+	0.1 m	X
	Cirsium vulgare (Savi) Tenore	Pua-kala, bull thistle, spear thistle	+	0.3 m	X
	Epilobium cinereum A. Rich.	Pūkāmole, willow herb	+	0.2 m	X
	Eupatorium adenophorum Spreng.	Maui pā-makani, white thoroughwort	+	0.5-1.0 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Lapsana communis[1] L.	Nipplewort	+	0.2 m	X

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1]Located on the northern extension of Nāmana o ke Akua cinder cone.

VEGETATION OF STUDY AREA #31--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Oenothera stricta* Ledeb. in Link	Evening primrose	+	0.2 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Silene gallica L.	Small-flowered catchfly	+	0.1 m	X
	Sisymbrium officinale (L.) Scop.	Hedge mustard	+	0.25 m	X
	Bromus rigidus Roth	Ripgutgrass	+	0.2 m	X
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.2 m	X
	Poa pratensis L.	Kentucky bluegrass	+	0.1 m	X
	Trisetum glomeratum (Kunth) Trin. in Steud.	Pili-uka, mountain pili, he'u-pueo	+	0.2 m	E
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I

STUDY AREA #32

Map reference: 156° 10' 04" W
20° 42' 23" N

Date studied: 20 June 1976

Location: Cliff face above stream bed--upper west Kaupō Gap.

Elevation: 6200 ft (1890 m).

Aspect: East-facing cliff--becomes shaded early in the afternoon.

Total vascular plant cover: 40%

General description: The study site is a vertical cliff inaccessible by goats and therefore is rich in species. 'Ōhi'a is seen hanging from the walls of the cliff along with many other species that are presently not seen in the Crater. The species composition of this site is apparently sufficient to support a population of 'Apapane (*Himatione sanguinea sanguinea*) not seen elsewhere in this part of the Crater.

Substrate: Rock.

Surrounding area: The talus slopes below the study site consist of large pieces of breccia. *Pteridium aquilinum* (kīlau) provided 40% cover on these slopes, and *Festuca megalura* (foxtail fescue) 10% for a total cover of 50%. Upslope of the lower cliff face the area appeared to have the same species composition as the study site, but it would be extremely interesting to examine these cliffs more carefully. East of the study site is mixed scrub (Study Area #33) which is heavily damaged by goats. A few 'ōhi'a trees are found on the banks of the large intermittent stream at the foot of the talus slopes.

Climate: Annual rainfall approximately 40 inches (100 cm). A harsh, hot environment, infrequently shaded by cloud.

Rationale for studying area: This area is unlike similar adjoining areas in both species composition and in its substrate. It is one of the few locations in the Park that is protected from the ravages of the feral goats, and we were only able to sample the lower parts of the cliff which are likely also accessible by goats. The area can be compared with goat-infested areas, and therefore the damage by goats in other areas could be assessed.

Number of specimens collected:

Flowering plants	9
Ferns	2
Bryophytes	0
Lichens	16

VEGETATION OF STUDY AREA #32

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m	*Metrosideros* sp.[1]	'Ōhi'a-lehua, lehua	30	1.0 m	E
<1 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	5	0.5 m	I
	Artemisia mauiensis (Gray) Skottsb.	Maui wormwood	+	0.5 m	E
	Bidens sp.[2]	Ko'oko'olau	+	0.3 m	E
	Cerastium vulgatum L.	Larger mouseear chickweed, nehine-hāuli	+	0.1 m	X
	Eupatorium adenophorum Spreng.	Maui pā-makani, white thoroughwort	+	0.5 m	X
	Euphorbia celastroides Boiss. in A. DC. var. *amplectens* Sherff	. . . . .	+	0.5 m	E
	Gnaphalium purpureum L.	Purple cudweed	+	0.1 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Lobelia grayana E.Wimm.	. . . . .	+	0.75 m	E
	Lysimachia sp.[2]	. . . . .	+	0.3 m	E
	Oenothera stricta Ledeb. in Link	Evening primrose	+	0.2 m	X
	Osteomeles anthyllidifolia (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	0.3 m	E
	Pilea peploides (Gaud.) H. & A.	. . . . .	+	0.1 m	I
	Plantago princeps C. & S. var. *laxifolia* Gray	Ale	r	0.4 m	E
	Schiedea haleakalensis Deg. & Sherff in Sherff	Haleakalā schiedea	+	0.3 m	E
	Silene gallica L.	Small-flowered catchfly	+	0.1 m	X

NOTE: % Cover: + = presence, r = rare
Status: E = Endemic, I = Indigenous, X = Exotic

[1]The pendant plants are about 1 m tall, but hang down cliff about 2 m from roots. Unfortunately, no specimen was taken to determine variety.
[2]Sterile.

VEGETATION OF STUDY AREA #32--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Silene hawaiiensis* Sherff	. . . . .	+	0.3 m	E
	Viola tracheliifolia Gingins	Pā-makani	+	0.3 m	E
	Eragrostis grandis Hbd.	Large Hawaiian lovegrass	+	0.75 m	E
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Luzula hawaiiensis Buch.	. . . . .	+	0.1 m	E
	Rhynchelytrum repens (Willd.) C.E.Hubb.	Natal redtop	+	0.2 m	X
	Christella parasitica (L.) Léveillé	. . . . .	+	0.3 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Pityrogramma calomelanos (L.) Link	Gold fern, silver fern	+	0.2 m	X
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	+	0.3 m	E

STUDY AREA #33

Map reference: 156° 9' 56" W
20° 42' 23" N

Date studied: 20 June 1976

Location: About 1/4 mile (2/5 km) east of cliff in upper west Kaupō Gap (Study Area #32).

Elevation: 6000 ft (1830 m).

Aspect: South-facing 35° slope.

Total vascular plant cover: 45%.

General description: The study area is a goat-infested *Styphelia* (pūkiawe) scrubland in the upper west portion of Kaupō Gap. There are many dead pūkiawe plants present which presumably have been killed off by goat activity. It is rarely traversed by people, and this may attribute to the heavy damage of goats here. Many of the 'ōhi'a trees in the area are the yellow-flowered variety.

Substrate: Old pāhoehoe lava flow with accumulated ash in crevices.

Surrounding area: To the west is a gully with an intermittent stream, sheltered from the extreme exposure of this study site. To the north is the Crater proper with scrub vegetation. Similar scrub vegetation is presumably found to the east and south of this site but those areas have not yet been assessed.

Climate: Annual rainfall about 40 inches (100 cm).

Rationale for studying area: This area was studied as it is fairly typical of the upper west Kaupō Gap vegetation, and can be compared with scrub vegetation elsewhere in the Crater which is not nearly so damaged by goat activity. The site forms part of a minor transect running up the west side of the Kaupō Gap.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	16
Lichens	16

VEGETATION OF STUDY AREA #33

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	35	1.0 m	I
<1 m	*Pteridium aquilinum* (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	10	0.2 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #34

Map reference: 156° 10' 57" W
20° 42' 54" N

Date studied: 21 June 1976

Location: Pu'u Maile northeast of Kapalaoa Cabin.

Elevation: 7400 ft (2260 m).

Aspect: North- and west-facing slopes of the crater in the cinder cone.

Total vascular plant cover: 65%.

General description: Pu'u Maile is shaped like most of the other cinder cones in Haleakalā, and like them has a central crater in it. This central crater is sheltered more than the slopes of the cone, and is more heavily vegetated. The outer slopes of the Pu'u are rather barren but the crater supports a mixed scrub forest with such taxa as *Pittosporum* and *Stenogyne* which are not common in Haleakalā Crater.

Substrate: Cinder.

Surrounding area: Lava fields surround Pu'u Maile on all sides.

Climate: Annual rainfall approximately 40 inches (100 cm).

Rationale for studying area: Pu'u Maile was studied as it is a cinder cone in the central Haleakalā Crater region, and its vegetation can be compared with that of surrounding areas. Certain species are found here that are absent in the scrub generally found throughout the Crater floor. The site is peripheral to a transect running from Haleakalā down to Pu'u Māmane and then skirting the east side of the Ko'olau Gap to Waikau Cabin. It is also part of a transect from Palikū to Red Hill.

Number of specimens collected:

Flowering plants	8
Ferns	0
Bryophytes	12
Lichens	26

VEGETATION OF STUDY AREA #34

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	20	1.0-2.0 m	I
	Coprosma montana Hbd.	Pilo	10	2.0 m	E
	Pittosporum confertiflorum Gray	Hō'awa	+	2.5 m	E
	Santalum haleakalae Hbd.	'Ili-ahi, Haleakalā sandalwood	+	2.0 m	E
≤1 m	*Vaccinium reticulatum* Sm.	'Ōhelo	15	1.0 m	E
	Dodonaea eriocarpa Sm.	'A'ali'i ku-ma-kua	5	1.0 m	E
	Railliardia menziesii Gray	Na'ena'e	5	1.0 m	E
	Holcus lanatus L.	Yorkshire fog, velvetgrass	10	0.5 m	X
	Cerastium vulgatum L.	Larger mouseear chickweed, nehine-hāuli	+	0.1 m	X
	Epilobium cinereum A. Rich.	Willow herb, pūkāmole	+	0.1 m	X
	Erigeron bonariensis L.	Ilioha, hairy horseweed	+	0.2 m	X
	Eupatorium adenophorum Spreng.	Maui pā-makani, white thoroughwort	+	0.5 m	X
	Gnaphalium purpureum L.	Purple cudweed	+	0.1 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Lepidium virginicum L.	Wild peppergrass	+	0.2 m	X
	Osteomeles anthyllidifolia (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	1.0 m	E

NOTE: % Cover: + = presence

Status: E = Endemic, I = Indigenous, X = Exotic

VEGETATION OF STUDY AREA #34--Continued

Stratum	Species	Common Name	% Cover	Height	Status
≤1 m	*Rumex acetosella* L.	Sheep sorrel	+	0.1 m	X
	Stenogyne crenata Gray	Crenate-leaved stenogyne	+	2.0 m[1]	E
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.5 m	E
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Poa pratensis L.	Kentucky bluegrass	+	0.1 m	X
	Trisetum glomeratum (Kunth) Trin. in Steud.	pili-uka, mountain pili, he'u-pueo	+	0.2 m	E
	Polypodium pellucidum Kaulf.	'Ae, 'ae-lau-nui	+	0.2 m	E
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	+	0.2 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic
[1]Vine growing to 2 m maximum.

STUDY AREA #35

Map reference: 156° 10' 39" W, 20° 42' 55" N Date studied: 21 June 1976

Location: 'A'ā flow just east of Pu'u Maile.

Elevation: 7100 ft (2160 m).

Aspect: Slight southeast-facing slope, full exposure.

Total vascular plant cover: 30%.

General description: The study area is on a rough 'a'ā flow with sparse vegetation. The vegetation of the flow consists of scattered shrubs, widely spaced and of low stature. The rough 'a'ā apparently traps sufficient organic material in cracks to store enough water for such species to survive. The species present were for the most part expected, but *Dianella sandwicensis* was present and it is not usually found in such xeric conditions.

Substrate: 'A'ā lava

Surrounding area: The study area is surrounded by 'a'ā flows similar to the study site on the northeast and south, and is adjacent to Pu'u Maile on the west.

Climate: Approximately 40 inches (100 cm) rainfall per year. Little or no fog interception.

Rationale for studying area: Sampling was needed of a sparsely vegetated area in the central Crater region to compare with other vegetation types in surrounding areas. The area forms part of a transect traversing the southern side of the Crater from Palikū to Red Hill.

Number of specimens collected:

Flowering plants	5
Ferns	0
Bryophytes	0
Lichens	4

VEGETATION OF STUDY AREA #35

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	10	1.5 m	I
	Coprosma montana Hbd.	Pilo	5	1.5 m	E
	Dodonaea eriocarpa Sm.	'A'ali'i ku-ma-kua	5	1.5 m	E
	Sophora chrysophylla (Salisb.) Seem.	Māmane, māmani	+	1.5-2.0 m	E
<1 m	*Osteomeles anthyllidifolia*[1] (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	5	0.25-1.0 m	E
	Vaccinium reticulatum Sm.	'Ōhelo	5	0.5-1.0 m	E
	Anagallis arvensis L.	Scarlet pimpernel	+	0.1 m	X
	Cerastium vulgatum L.	Larger mouseear chickweed, nehine-hāuli	+	0.1 m	X
	Coprosma ernodeoides Gray	Kūkae-nēnē	+	0.3-0.5 m	E
	Gnaphalium sandwicensium Gaud. f. *canum* Sherff	'Ena'ena, Hawaiian cudweed	+	0.1 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Lapsana communis L.	Nipplewort	+	0.2 m	X
	Oenothera stricta Ledeb. in Link	Evening primrose	+	0.2 m	X
	Railliardia menziesii Gray	Na'ena'e	+	0.5-1.0 m	E
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Tetramolopium humile (Gray) Hbd.	Alpine tetramolopium	+	0.1 m	E
	Aira caryophyllea L.	Silver hairgrass	+	0.1 m	X
	Carex wahuensis C.A. Mey.	. . . . .	+	0.1 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1]Small stature due to animal browsing.

VEGETATION OF STUDY AREA #35--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.5 m	E
	Dianella sandwicensis H. & A.	'Uki'uki, Hawaiian dianella	+	0.5 m	E
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.2 m	X
	Trisetum glomeratum (Kunth) Trin. in Steud.	Pili-uka, mountain pili, he'u-pueo	+	0.2 m	E
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I

STUDY AREA #36

Map reference: 156° 08' 06" W
20° 42' 44" N

Date studied: 22 June 1976

Location: *Metrosideros* ('ōhi'a) forest south of Kuiki above the east side of Kaupo Gap.

Elevation: 6910 ft (2110 m).

Aspect: South-facing slope.

Total vascular plant cover: 100%.

General description: The study area consists of a closed 'ōhi'a forest with the upper canopy at 30 ft (9 m). 'Ōhi'a is clearly the dominant species, but several other species are present in the understory. The area is similar to 'ōhi'a forests north of the Crater region in the Wai'ānapanapa area but species diversity appears lower. Pig damage is evident in the forest, and both pig and goat damage is severe in the grasslands north of this study site.

Substrate: Hydrandepts--well drained thixotropic isometric typic Hydrandepts.

Surrounding area: There is a *Deschampsia* grassland north of this study area, and a continuation of the 'ōhi'a forest to the south which ultimately merges into a koa zone. To the east is similar 'ōhi'a forest, and to the west is the eastern wall of Kaupō Gap.

Climate: Area frequently immersed in the orographic cloud blown up Kīpahulu by the prevailing tradewinds. The rainfall is typically over 250 cm each year.

Rationale for studying area: This area is part of the Kīpahulu District of Haleakala National Park. It was studied by the Manawainui Research Project (NSF-sponsored Student Originated Studies program) in 1976. A brief assessment was made by the RBI team so that they could make a comparison of this area with other vegetation types in the Crater District, and with the 'ōhi'a forests north of the Crater region.

Number of specimens collected:

Flowering plants	14
Ferns	0
Bryophytes	16
Lichens	30

VEGETATION OF STUDY AREA #36

Stratum	Species	Common Name	% Cover	Height	Status
>5 m	*Metrosideros collina* (J. R.& G. Forst.) Gray	'Ōhi'a-lehua lehua	90	10 m	E
	Cheirodendron trigynum (Gaud.) Heller var. *mauiens* Lévl.	'Ōlapa, māhu, ehu	5	5 m	E
1-5 m	*Styphelia tameiameiae*[1] (Cham.) F. Muell.	Pūkiawe	20	2 m	I
	Coprosma ochracea Oliver	Pilo	10	3 m	E
	Myrsine lessertiana A. DC.	Kōlea-lau-nui	5	3 m	E
	Sadleria cyatheoides Kaulf.	'Ama'u, ma'uma'u	5	1 m	E
	Rubus hawaiiensis Gray	'Ākala, 'ākalakala	+	1.5 m	E
	Vaccinium calycinum Sm.	'Ōhelo-kau-lā'au	+	2 m	E
≤1 m	*Dryopteris parallelogramma* (Ktze.) Alston	Fern	20	0.7 m	I
	Dryopteris sp.	Fern	10	0.4 m	.
	Coprosma ernodeoides Gray	Kūkae-nēnē	10	0.5 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Plantago pachyphylla Gray	Manene	+	0.2 m	E
	Stenogyne sp.[2]	. . . . .	+	2 m[3]	E
	Vaccinium reticulatum Sm.	'Ōhelo	+	0.5 m	E
	Astelia forbesii[4] Skottsb.	Pa'iniu	r	0.3 m	E
	Carex alligata[5] F. Boott	Hawaiian sedge	+	1.0 m	E
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.2 m	X

NOTE: % Cover: + = presence, r = rare
Status: E = Endemic, I = Indigenous, X = Exotic

[1] On edge of forest only.
[2] Sterile.
[3] Vine growing to 2 m maximum.
[4] Only one seen in forest.
[5] In stream.

VEGETATION OF STUDY AREA #36--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Luzula hawaiiensis* Buch.	. . . . .	+	0.1 m	E
	Oreobolus furcatus Mann	. . . . .	+	0.05 m	E
	Uncinia uncinata (L. f.) Kuek.	. . . . .	+	0.2 m	I

STUDY AREA #37

Map reference: 156° 08' 13" W
20° 42' 48" N

Date studied: 22 June 1976

Location: Grasslands south of Kuiki above east Kaupō Gap. This grassland is located between Kuiki summit and the rain forest to the south, and forms a small triangle on the Manawainui planeze.

Elevation: 7450 ft (2270 m).

Aspect: South-facing slope.

Total vascular plant cover: 85%.

General description: The study area consists of a *Deschampsia* grassland which is very disturbed by pigs and goats. *Hypochaeris* is almost a co-dominant with *Deschampsia*--an effect of the abuse by feral mammals. Bare areas are exposed to erosion, and it appears that the grasslands may be retreating downslope from the summit of Kuiki due in part to the effects of pig rooting and goat trampling.

Substrate: Tropaquod (Ellingson 1976).

Surrounding area: South of this study site is a *Metrosideros* forest (Study Area #36), northeast is Kīpahulu Valley, west is the upper part of Kaupō Gap, and north is Kuiki summit, which is barren and rocky (Study Area #38).

Climate: Area frequently immersed in the orographic cloud blown up Kīpahulu by the prevailing tradewinds. The rainfall is typically over 250 cm each year.

Rationale for studying area: This area was studied so that it could be compared with *Deschampsia* meadows elsewhere in the Crater District. The damage by feral animals was of considerable concern to the members of the survey. The Manawainui Research Project also studied this area in 1976.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	4
Lichens	10

VEGETATION OF STUDY AREA #37

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	60	0.5 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	20	0.1 m	X
	Vaccinium reticulatum Sm.	'Ōhelo	5	0.2 m	E
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	5	0.2 m	E
	Holcus lanatus L.	Yorkshire fog, velvetgrass	1	0.1 m	X
	Coprosma ernodeoides Gray	Kūkae-nēnē	+	<0.1 m	E
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Luzula hawaiiensis Buch.	. . . . .	+	0.1 m	E
	Racomitrium lanuginosum var. *pruinosum* Wils.	Moss	5	<0.1 m	I
	Stereocaulon ramulosum (Sw.) Raeusch.	Lichen	2	<0.1 m	I
	Campylopus introflexus (Hedw.) Brid.	Moss	+	<0.1 m	I

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #38

Map reference: 156° 08' 19" W
20° 42' 48" N

Date studied: 22 June 1976

Location: Summit of Kuiki above Palikū.

Elevation: 7553 ft (2302 m).

Aspect: Full exposure.

Total vascular plant cover: 30%.

General description: This study site is the barren summit of Manawainui planeze. Few plants are present on the exposed rocks. This area is confined to the summit and a small area south of the summit. Activities of feral mammals, particularly goats, at the edge of the grassland appear to be enlarging this rocky exposed area at the expense of the grassland.

Substrate: Exposed rock.

Surrounding area: North of the study site is the back wall of Kīpahulu Valley which separates that Valley from Haleakalā Crater. The vegetation to the north is a *Metrosideros* scrub forest. The *Deschampsia* grassland to the south and southeast of the study area has been described (Study Area #37). West of the summit are the vertical slopes of Kuiki and east of the summit is Kīpahulu Valley--both of which are vegetated by *Metrosideros*.

Climate: Area frequently immersed in the orographic cloud blown up Kīpahulu by the prevailing tradewinds. The rainfall is typically over 250 cm each year.

Rationale for studying area: This area is the only site where barren, exposed, weathered rock is present over any considerable area in a high rainfall area. Its possible origin--from natural or unnatural erosion, or from natural erosion aggravated by feral mammal activity--makes it a necessary site for study. Our visit was only a cursory inspection to check on the conditions in the area.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	5
Lichens	4

VEGETATION OF STUDY AREA #38

Stratum	Species	Common Name	% Cover	Height	Status
<1 m[1]	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	5	0.5 m	E
	Vaccinium reticulatum Sm.	'Ōhelo	25	0.3-0.5 m	E
	Coprosma ernodeoides Gray	Kūkae-nēnē	+	0.5 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.2 m	X
	Luzula hawaiiensis Buch.	. . . . .	+	0.1 m	E
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	+	0.2 m	E
	Sadleria cyatheoides Kaulf.	'Ama'u, ma'uma'u	+	0.5 m	E
	Racomitrium lanuginosum var. *pruinosum* Wils.	. . . . .	+	<0.1 m	I

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1] *Grimmia haleakalae* absent.

STUDY AREA #39

Map reference: 156° 08' 13" W
20° 41' 05" N

Date studied: 24 June 1976

Location: Lower east Kaupō Gap about 0.25 mile (0.4 km) north of the Park boundary on the Kaupō Trail.

Elevation: 4100 ft (1250 m).

Aspect: South-facing slope.

Total vascular plant cover: 95%.

General description: This study site is an area that was until recently used as cattle pasture; it still has the appearance of a pasture. Remnants of the native scrub persist among the Kikuyu grass (*Pennisetum clandestinum*). The native species persist in areas of rough terrain such as around rocks or ridges, while the Kikuyu grass is the dominant species on level substrate within the study area. However, it appears that the Kikuyu grass is strangling the remaining native vegetation.

Substrate: Rocky.

Surrounding area: East of the study site is a gully with some native species not found in the study site itself, such as *Pipturus*. West of this area is the broad expanse of Kaupō Gap which is vegetated for the most part by native scrub. A koa forest with pockets of *Myrsine* is found north of this site, and southward there is more koa, which eventually disappears from the exotic-dominated scrub of lower Kaupō Gap.

Climate: This area is occasionally clouded in and therefore some moisture is available from fog drip as well as from rainfall (estimated at 40 inches [100 cm] per year).

Rationale for studying area: This vigorous Kikuyu grass community is a vegetation type whose potential spread in the Park is enormous. As such it was necessary to sample it and compare this site of decadent scrub land with other scrub areas in the Park. The area forms the bottom of a transect that runs up the Kaupō Gap along the eastern side and up over the Kalapawili Ridge.

Number of specimens collected:

Flowering plants	9
Ferns	0
Bryophytes	5
Lichens	22

VEGETATION OF STUDY AREA #39

Stratum	Species	Common Name	% Cover	Height	Status
1-5 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	5	1.0-1.5 m	I
	Dodonaea eriocarpa Sm.	'A'ali'i ku-ma-kua	+	1.0 m	E
	Vaccinium reticulatum Sm.	'Ōhelo	+	1.0 m	E
<1 m	*Pennisetum clandestinum* Hochst. ex Chiov.	Kikuyugrass	90	0.5 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	30	0.3 m	X
	Cladonia leiodea Magn.	Lichen	1	<0.1 m	E
	Desmodium uncinatum (Jacq.) DC.	Hawaiian tick trefoil, spanish clover	+	0.2 m	X
	Eupatorium adenophorum Spreng.	Maui pā-makani, white thoroughwort	+	0.5 m	X
	Gnaphalium purpureum L.	Purple cudweed	+	0.1 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Lythrum maritimum HBK.	Pūkāmole	+	0.1 m	X
	Osteomeles anthyllidifolia (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	0.5 m	E
	Plantago major L.	Broad-leaved plantain, lau-kāhi	+	0.1 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Cyperus brevifolius (Rottb.) Hassk.	Kili'o'opu, killinga	+	0.1 m	X
	Digitaria violascens Link	Kūkae-pua'a-uka	+	0.1 m	X
	Eragrostis brownei (Kunth) Nees in H.& A.	Brown's lovegrass	+	0.1 m	X

NOTE: % Cover: + = presence

Status: E = Endemic, I = Indigenous, X = Exotic

VEGETATION OF STUDY AREA #39--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Festuca dertonensis* (All.) Aschers. & Graebn.	. . . . .	+	0.1 m	X
	Paspalum orbiculare Forst. f.	Mau'u-laiki, ricegrass	+	0.1 m	X
	Sacciolepis indica (L.) Chase	Glenwoodgrass	+	0.1 m	X
	Sporobolus africanus (Poir.) Robyns & Tournay	African dropseed, rattail grass	+	0.2 m	X
	Asplenium trichomanes L.	'Owāli'i, spleenwort	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	+	0.2 m	E
	Sadleria cyatheoides Kaulf.	'Ama'u, ma'uma'u	+	0.5 m	E

STUDY AREA #40

Map reference: 156° 08' 30" W 20° 42' 23" N Date studied: 24 June 1976

Location: Just east of the Kaupō Trail in dense mixed forest.

Elevation: 5480 ft (1670 m).

Aspect: Slight south-facing slope.

Total vascular plant cover: 100%.

General description: The study area is a mixed dry forest with 100% cover in both the canopy and ground layers. *Myrsine* is the dominant canopy species in this particular study site. Dense pockets of *Myrsine* such as this are found in the koa forests along eastern parts of Kaupō Gap but not elsewhere in the Park.

Substrate: Rocky substrate with organic deposits.

Surrounding area: The surrounding areas lie in the northern portion of Kaupō Gap, some of which is similar to the study site, although eventually the dry forest grades into a more mesic forest with koa and 'ōhi'a as dominant species. To the west is the scrub of the central Kaupō Gap, and to the south there is a gradation from the koa forest with pockets of *Myrsine* to exotic scrub. To the east is the eastern wall of Kaupō Gap which is vegetated by koa forest where the angle of the cliff is not too great.

Climate: Approximately 40 inches (100 cm) rain per year with some precipitation from fog drip.

Rationale for studying area: Dense dry forests are representative of certain areas on the eastern side of Kaupō Gap; therefore one was picked to sample. This site can be compared with other areas within the Park. It is one of the few areas within the Park where dense stands (clones?) of *Myrsine* can be found. The area is part of the transect up the eastern side of the Kaupō Gap to the north side of Kalapawili Ridge.

Number of specimens collected:

Flowering plants	4
Ferns	0
Bryophytes	15
Lichens	48

VEGETATION OF STUDY AREA #40

Stratum	Species	Common Name	% Cover	Height	Status
>5 m	*Myrsine* sp.	Kōlea	30	5 m	E
	Acacia koa Gray	Koa	15	8 m	E
	Metrosideros collina (J. R.&G. Forst.) Gray	'Ōhi'a-lehua, lehua	10	8 m	E
1-5 m	*Sophora chrysophylla* (Salisb.) Seem.	Māmane, māmani	10	3 m	E
	Dodonaea sandwicensis Sherff	'A'ali'i	40	3 m	E
	Styphelia tameiameiae (Cham.) F. Muell.	Pūkiawe	15	1-2 m	I
	Coprosma sp.[1]	Pilo	10	3 m	E
≤1 m	*Eupatorium adenophorum*[2] Spreng.	Maui pā-makani, white thoroughwort	40	0.5-1.0 m	X
	Lapsana communis[3] L.	Nipplewort	40	0.3 m	X
	Holcus lanatus[2] L.	Yorkshire fog, velvetgrass	30	0.3 m	X
	Pteridium aquilinum (L.) Kuhn var. *decompositum*[2] (Gaud.) Tryon	Kīlau, bracken fern	10	0.2 m	E
	Alyxia olivaeformis Gaud.	Maile	+	0.5 m	E
	Coprosma ernodeoides Gray	Kūkae-nēnē	+	0.2-0.5 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Lysimachia sp.	. . . . .	+	0.3 m	E
	Lythrum maritimum HBK.	Pūkāmole	+	0.1 m	X
	Osteomeles anthyllidifolia (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	0.2-1.0 m	E
	Peperomia leptostachya H. & A.	'Ala'ala-wai-nui	+	0.2 m	I
	Peperomia sp.	'Ala'ala-wai-nui	+	0.1 m	.

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1]Bilobed fruit.
[2]Occurs in sun--not under canopy.
[3]Occurs under canopy.

VEGETATION OF STUDY AREA #40--Continued

Stratum	Species	Common Name	% Cover	Height	Status
≤1 m	*Prunella vulgaris* L.	Self-heal	+	0.1 m	X
	Rubus penetrans Bailey	Prickly Florida blackberry	+	0.3 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Cyperaceae sp. 1	Sedge	+	0.1 m	.
	Cyperaceae sp. 2	Sedge	+	0.1 m	.
	Deschampsia australis Nees ex Steud. *f. haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.5 m	E
	Luzula hawaiiensis Buch.	. . . . .	+	0.1 m	E
	Sporobolus africanus (Poir.) Robyns & Tournay	African dropseed, rattail grass	+	0.2 m	X
	Dryopteris parallelogramma (Ktze.) Alston	Lau-kāhi	+	0.75-1.0 m	I
	Dryopteris sp.	Fern	+	?	.
	Microlepia sp.	Palai	+	0.5 m	I
	Pleopeltis thunbergiana Kaulf.	Pākahakaha	+	0.1 m	I
	Polystichum sp.	Ka'upu, papa'oi	+	?	E
	Pteris excelsa Gaud.	Waimaka-nui	+	0.2 m	I
	Sadleria cyatheoides Kaulf.	'Ama'u, ma'uma'u	+	1.0 m	E

STUDY AREA #41

Map reference: 156° 12' 35" W
20° 44' 30" N

Date studied: 3 June 1977

Location: One-half way across Ko'olau Gap from Holua Cabin midway to Hanakauhi. Reddish 'a'ā flow with ash cover.

Elevation: 7000 ft (2130 m).

Aspect: North-facing.

Total vascular plant cover: 20%.

General description: Open *Styphelia-Coprosma* (pūkiawe-'a'ali'i) scrub to 1.5 m (5 ft) in height. Widely spaced clumps of shrubs in lava field. There appears to be moderate feral goat damage though occasional signs of pig rooting activity were seen in the general area.

Substrate: 'A'ā with ash.

Surrounding areas: A few pockets of deep ash substrate are seen in surrounding areas with dying *Sophora* (3-4 m [10-13 ft] tall), *Santalum*, and trees of *Dodonaea*. Below those trees are exotic grasses (*Poa pratensis*, *Festuca megalura*, and *Bromus rigidus*).

Climate: Very dry area with approximately 40 inches (100 cm) rain per year. However, the area is frequently inundated by cloud rolling up the Ko'olau Gap around noon which cools the area and supplies a small amount of fog drip.

Rationale for studying area: No fairly recent lava fields in this part of the Park have been sampled in previous inventories. The vegetation at this site is fairly typical of the vegetation found on the Hāna lava flows that poured out through Ko'olau Gap during the rejuvenated period of activity in Haleakalā.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	3
Lichens	12

VEGETATION OF STUDY AREA #41

Stratum	Species	Common Name	% Cover	Height	Status
>1 m[1]	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	10	1.0 m	I
	Coprosma montana Hbd.	Pilo	5	1.5 m	E
	Railliardia menziesii Gray	Na'ena'e	<5	1.5 m	E
	Vaccinium reticulatum Sm.	'Ōhelo	<5	1.0 m	E
	Dodonaea eriocarpa Sm.	'A'ali'i ku-ma-kua	<5	1.0 m	E
<1 m	*Hypochaeris radicata* L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Tetramolopium humile (Gray) Hbd.	Alpine tetramolopium	+	0.1 m	E
	Agrostis sandwicensis Hbd.	Hawaiian bent	+	0.3 m	E
	Aira caryophyllea L.	Silver hairgrass	+	0.1 m	X
	Carex wahuensis C. A. Mey.	. . . . .	+	0.2 m	E
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.3 m	E
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Luzula hawaiiensis Buch.	. . . . .	+	0.2 m	E
	Trisetum glomeratum (Kunth) Trin. in Steud.	Pili-uka, mountain pili, he'u-pueo	+	0.2 m	E
	Asplenium adiantum-nigrum L.	'Iwa'iwa	+	0.2 m	I
	Asplenium trichomanes L.	'Owāli'i, spleenwort	+	0.1 m	I

NOTE: % Cover: + = presence

Status: E = Endemic, I = Indigenous, X = Exotic

[1] *Holcus* absent.

VEGETATION OF STUDY AREA #41--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Pellaea ternifolia* (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Polypodium pellucidum Kaulf.	'Ae, 'ae-lau-nui	+	0.2 m	I

STUDY AREA #42

Map reference: 156° 13' 33" W
20° 42' 30" N

Date studied: 4 June 1977

Location: Undulating barren lava ('a'ā) field with ash pockets about 0.1 mile (0.2 km) east of Leleiwi Pali and about 1 mile (1.6 km) south of Hōlua.

Elevation: 7260 ft (2210 m).

Aspect: Very slight north-facing slope.

Total vascular plant cover: <1%.

General description: This site is barren 'a'ā lava with little vegetation present. *Racomitrium* (a moss) is present with 5% total cover (only on north-facing rocks) and the lichen *Stereocaulon vulcani* (immature) with about 1% cover. Goat spoor is present despite the lack of much vegetation.

Substrate: 'A'ā with ash pockets.

Surrounding area: West of the study site are Leleiwi Pali, talus slopes, and alluvial deposits. North, east, and west of the site is the same 'a'ā flow.

Climate: Very dry area with approximately 40 inches (100 cm) rain per year. However, the area is occasionally inundated in cloud rolling up the Ko'olau Gap around noon which cools the area and supplies a small amount of fog drip.

Rationale for studying area: This area is representative of barren recent 'a'ā flows in this part of the crater. This area forms the upper limit of a short transect up the Ko'olau Gap along the base of Leleiwi Pali.

Number of specimens collected:

Flowering plants	1
Ferns	0
Bryophytes	10
Lichens	6

VEGETATION OF STUDY AREA #42

Stratum	Species	Common Name	% Cover	Height	Status
≥.5 m	*Eupatorium adenophorum* Spreng.	Maui pā-makani, white thoroughwort	+	0.5 m	X
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.5 m	E
	Railliardia menziesii Gray	Na'ena'e	+	0.5 m	E
	Heterotheca grandiflora Nutt.	Telegraph plant	+	0.2 m	X
<.5 m	*Hypochaeris radicata* L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Gnaphalium purpureum L.	Purple cudweed	+	0.1 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Tetramolopium humile (Gray) Hbd.	Alpine tetramolopium	+	0.1 m	E
	Agrostis sandwicensis Hbd.	Hawaiian bent	+	0.2 m	E
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.3 m	E
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.2 m	X
	Trisetum glomeratum (Kunth) Trin. in Steud.	pili-uka, mountain pili, he'u-pueo	+	0.2 m	E
	Asplenium trichomanes L.	'Owāli'i, spleenwort	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Polypodium pellucidum Kaulf.	'Ae, 'ae-lau-nui	+	0.2 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #43A

Map reference: 156° 13' 43" W
20° 44' 04" N

Date studied: 4 June 1977

Location: Alluvial wash at base of Leleiwi Pali about 1 mile (1.6 km) south of Hōlua.

Elevation: 7400 ft (2260 m).

Aspect: 20° north-facing slope.

Total vascular plant cover: 10%.

General description: The site is sparsely vegetated terrain with evidence of goat damage. Only a few plants are found between the alluvial rocks. From the lack of vegetation in this site, it appears to be a very unstable area, with deposition of large quantities of alluvial material likely occurring during heavy winter storms. No water or worn streambeds can be seen in the area, indicating that the alluvium is not continuously being deposited but occurs often enough so that, with the dry conditions and goat activity, a dense vegetation cover does not get established.

Substrate: Alluvium consisting of somewhat smoothed rocks averaging 6 to 8 inches (15-20 cm) in diameter with some to 4 ft (1.2 m).

Surrounding area: Talus slopes with *Pteridium* at base of Leleiwi Pali to the west of the site, 'a'ā flow to the east, and similar alluvium to the north and south.

Climate: Very dry area with approximately 40 inches (100 cm) rain per year. However, the area is occasionally inundated in cloud rolling up the Ko'olau Gap around noon which cools the area and supplies a small amount of fog drip.

Rationale for studying area: This area was chosen for study as it is representative of the alluvial washes in this part of the Crater. It forms the upper limit of a short transect up the Ko'olau Gap along the base of Leleiwi Pali.

Number of specimens collected:

Flowering plants	1
Ferns	0
Bryophytes	7
Lichens	9

VEGETATION OF STUDY AREA 43A

Stratum	Species	Common Name	% Cover	Height	Status
≥.5 m	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	7	0.5 m	E
<.5 m	*Hypochaeris radicata* L.	Hairy cat's ear, gosmore	3	0.2 m	X
	Anagallis arvensis L.	Scarlet pimpernel	+	0.1 m	X
	Heterotheca grandiflora Nutt.	Telegraph plant	+	0.2 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Agrostis avenacea Gmel.	He'u-pueo	+	0.1 m	X
	Agrostis sandwicensis Hbd.	Hawaiian bent	+	0.3 m	E
	Bromus rigidus Roth	Ripgutgrass	+	0.2 m	X
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.3 m	X
	Sporobolus africanus (Poir.) Robyns & Tournay	African dropseed, rattail grass	+	0.2 m	X
	Asplenium trichomanes L.	'Owãli'i, spleenwort	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #43B

Map reference: 156° 13' 43" W
20° 44' 11" N

Date studied: 4 June 1977

Location: Talus slope at base of Leleiwi Pali about 1 mile (1.6 km) south of Hōlua, adjacent to the alluvial deposits at Study Area #43A.

Elevation: 7450 ft (2270 m).

Aspect: 45° east-facing slope.

Total vascular plant cover: 50%.

General description: The site is a *Pteridium-Deschampsia*-covered talus slope with various other plants. There appears to be a stratification of the two dominant species with *Pteridium* on the lower (damper?) part of the talus and *Deschampsia* on the upper (drier?) slope.

Substrate: Talus breccia.

Surrounding area: An alluvial wash is found to the north, east, and south, and Leleiwi Pali to the immediate west. A collection of *Schiedea haleakalensis* was made on the base of Leleiwi Pali out of reach of goats.

Climate: Very dry area with approximately 40 inches (100 cm) rain per year. However, the area is occasionally inundated in cloud rolling up the Ko'olau Gap around noon which cools the area and supplies a small amount of fog drip.

Rationale for studying area: This talus slope was studied because it is representative of such slopes in the area. The talus slopes at this site are adjacent to alluvial deposits, and the difference in the vegetation of the two is quite apparent, with the talus slopes being more heavily vegetated. This is probably because the gradual deposition of talus is likely less damaging than the deposition of alluvium. This area forms the upper limit of a short transect up the Ko'olau Gap along the base of Leleiwi Pali.

Number of specimens collected:

Flowering plants	1
Ferns	0
Bryophytes	6
Lichens	9

VEGETATION OF STUDY AREA #43B

Stratum	Species	Common Name	% Cover	Height	Status
≥.5 m	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	20	0.5 m	E
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	20	0.5 m	E
<.5 m	*Anagallis arvensis* L.	Scarlet pimpernel	+	0.1 m	X
	Cirsium vulgare (Savi) Tenore	Pua-kala, bull thistle, spear thistle	+	0.3 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Polycarpon tetraphyllum (L.) L.	Allseed	+	0.1 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Bromus rigidus Roth	Ripgutgrass	+	0.1 m	X
	Carex wahuensis C. A. Mey.	. . . . .	+	0.1 m	E
	Festuca megalura Nutt.	Foxtail fescue	+	0.2 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.3 m	X
	Pityrogramma calomelanos (L.) Link	Gold fern, silver fern	+	0.2 m	X

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #44

Map reference: 156° 13' 20" W
20° 44' 45" N

Date studied: 4 June 1977

Location: North-facing slope, 50 ft (15 m) east of Hōlua Spring.

Elevation: 7000 ft (2130 m).

Aspect: 45-60° north-facing slope.

Total vascular plant cover: 60%.

General description: The vegetation of this site is rather typical subalpine scrub on steep slope. There is moderate damage by goats and pigs. The absence of certain species, such as *Sophora* (māmane) and *Coprosma* (pilo) except in inaccessible spots, might be blamed on feral mammals.

Substrate: Soil with rock outcroppings.

Surrounding area: *Coprosma montana* and *Vaccinium reticulatum* found in surrounding areas. To the east is Hōlua Spring with *Polystichum haleakalense*, *Dryopteris parallelogramma*, and *Sadleria cyatheoides*.

Climate: Very dry area with approximately 40 inches (100 cm) rain per year. However, the area is frequently inundated in cloud rolling up the Ko'olau Gap around noon which cools the area and supplies a small amount of fog drip.

Rationale for studying area: This site was chosen as an example of the scrub vegetation found on the west wall of Haleakalā Crater. The area forms part of a short transect at the base of the west wall of the Ko'olau Gap.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	9
Lichens	1

VEGETATION OF STUDY AREA #44

Stratum	Species	Common Name	% Cover	Height	Status
≥1 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	25	1.0-1.5 m	I
<1 m	*Pteridium aquilinum* (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	10	0.4 m	E
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	15	0.4 m	E
	Holcus lanatus L.	Yorkshire fog, velvetgrass	15	0.3 m	X
	Trisetum glomeratum (Kunth) Trin. in Steud.	Pili-uka, mountain pili, he'u-pueo	15	0.3 m	E
	Artemisia mauiensis[1] (Gray) Skottsb.	Maui wormwood	+	0.7 m	E
	Coprosma ernodeoides Gray var. *mauiensis* St. John	Kūkae-nēnē	+	0.5 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	5	0.2 m	X
	Railliardia menziesii[1] Gray	Na'ena'e	+	0.7 m	E
	Anthoxanthum odoratum L.	Sweet vernal grass	+	0.3 m	X
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Luzula hawaiiensis Buch.	. . . . .	+	0.2 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1]On rocky outcroppings.

STUDY AREA #45

Map reference: 156° 12' 02" W
20° 43' 27" N

Date studied: 5 June 1977

Location: One-tenth mile (0.2 km) west of Bottomless Pit on north-facing slope of Hālāli'i along Palikū-Hōlua Trail.

Elevation: 7400 ft (2260 m).

Aspect: 45° north-facing slope.

Total vascular plant cover: 1-5%.

General description: The site is a rather barren cinder cone with little vegetation.

Substrate: Clinker, bombs, and some ash.

Surrounding area: Surrounding areas are similar in substrate and vegetation.

Climate: Among the driest areas of the Crater District. The average annual rainfall is 40 inches (100 cm) per year. The area is rarely immersed in cloud.

Rationale for studying area: This area was sampled because it seems rather typical of cinder cones in this part of the Crater. Further, since the trail passes along its base, it was possible to avoid disturbing the fragile cinder cone slopes. Other cinder cones nearby have silverswords on them, but there were none in the immediate study site. The area forms part of a transect from Palikū to Kilohana.

Number of specimens collected:

Flowering plants	0
Ferns	0
Lichens	3
Bryophytes	0

VEGETATION OF STUDY AREA #45

Stratum	Species	Common Name	% Cover	Height	Status
≥1 m	*Railliardia menziesii* Gray	Na'ena'e	+	1.0 m	E
<1 m	*Hypochaeris radicata* L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Tetramolopium humile (Gray) Hbd.	Alpine tetramolopium	+	0.1 m	E
	Agrostis sandwicensis Hbd.	Hawaiian bent	+	0.3 m	E
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.3 m	E
	Asplenium trichomanes L.	'Owāli'i, spleenwort	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Polypodium pellucidum Kaulf.	'Ae, 'ae-lau-nui	+	0.1 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #46

Map reference: 156° 12' 10" W
20° 43' 28" N

Date studied: 6 June 1977

Location: One-tenth mile (0.2 km) north of 'Ō'ilipu'u.

Elevation: 6700 ft (2040 m).

Aspect: Flat.

Total vascular plant cover: 30%.

General description: Open pioneer scrub vegetation on pāhoehoe flow. Low scrub species are present. Approximately 30% of the pāhoehoe is covered with the lichen *Stereocaulon*.

Substrate: Undulating pāhoehoe flow with a little humus in cracks.

Surrounding area: 'Ō'ilipu'u to the south is vegetated with a denser scrub vegetation of the same general composition. The same pāhoehoe flow is found to the north and east, and an 'a'ā flow is found to the west with a more open scrub.

Climate: The area is dry, with average rainfall of 30 inches (75 cm) per year, most of which comes from a few storms. The area is occasionally covered by cloud.

Rationale for studying area: This area was chosen for study as a constrast to 'Ō'ilipu'u, and to compare with the vegetation in the kīpuka north of 'Ō'ilipu'u and northwest of the study site. The area is associated with a transect running from Palikū to Kilohana.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	6
Lichens	13

VEGETATION OF STUDY AREA #46

Stratum	Species	Common Name	% Cover	Height	Status
≥.75 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	15	0.75-1.0 m	I
	Vaccinium reticulatum Sm.	'Ōhelo	10	0.75 m	E
	Dodonaea eriocarpa Sm.	'A'ali'i ku-ma-kua	5	0.75 m	E
<.75 m	*Coprosma ernodeoides* Gray var. *mauiensis* St. John	Kūkae-nēnē	5	0.4 m	E
	Machaerina gahniaeformis (Gaud.) Kern	. . . . .	5	0.2 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Osteomeles anthyllidifolia (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	0.5 m	E
	Plantago lanceolata L.	Narrow-leaved plantain	+	0.2 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.2 m	X
	Silene gallica L.	Small-flowered catchfly	+	0.2 m	X
	Tetramolopium humile (Gray) Hbd.	Alpine tetramolopium	+	0.1 m	E
	Aira caryophyllea L.	Silver hairgrass	+	0.1 m	X
	Dianella sandwicensis H. & A.	'Uki'uki, Hawaiian dianella	+	0.5 m	E
	Eragrostis brownei (Kunth) Nees in H. & A.	Brown's lovegrass	+	0.2 m	X
	Festuca dertonensis (All.) Aschers. & Graebn.	. . . . .	+	0.2 m	X
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.2 m	X
	Trisetum glomeratum (Kunth) Trin. in Steud.	Pili-uka, mountain pili, he'u-pueo	+	0.2 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

VEGETATION OF STUDY AREA #46--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<.75 m	*Asplenium adiantum-nigrum* L.	'Iwa'iwa	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Polypodium pellucidum Kaulf.	'Ae, 'ae-lau-nui	+	0.2 m	E

STUDY AREA #47

Map reference: 156° 12' 14" W, 20° 43' 32" N Date studied: 6 June 1977

Location: Kīpuka north of 'Ō'ilipu'u.

Elevation: 6830 ft (2080 m).

Aspect: South-facing slope.

Total vascular plant cover: 100%

General description: The vegetation in this kīpuka is a relictual *Sophora* (māmane) forest which presumably once occurred throughout this portion of the park. The understory is dense with *Eupatorium* (Maui pamakani) and *Pteridium* (kīlau). There is little (present) evidence of feral mammal impact, which may have been present in the past. The upper story here is relatively intact (60%), while at a nearby site (Study Area #48) where goat disturbance is great the upper story cover is less than 5%.

Substrate: Old 'a'ā with developed soil.

Surrounding area: Surrounding this kīpuka is a rather recent 'a'ā flow, and adjacent to that, a pāhoehoe flow. Both of these are vegetated with typical low open scrub vegetation (see Study Area #46).

Climate: The area is dry, with average rainfall of 30 inches (75 cm) per year, most of which comes from a few storms. The area is occasionally covered by cloud.

Rationale for studying area: This kīpuka is the only one in the park where younger flows have enclosed a much older flow with a developed forest. The vegetation within the kīpuka contrasts with the open scrub in the adjacent flows, as is obvious when one looks north from 'Ō'ilipu'u. This site was chosen for study because its vegetation was so obviously different from the surrounding vegetation, and because such a vegetation type had not heretofore been included in our studies. The flows surrounding this kīpuka may protect it to some extent from feral mammal impact. The area also falls along a major transect from Palikū to Kilohana.

Number of specimens collected:

Flowering plants	6
Ferns	1
Bryophytes	11
Lichens	16

VEGETATION OF STUDY AREA #47

Stratum	Species	Common Name	% Cover	Height	Status
≥1.5 m	*Sophora chrysophylla* (Salisb.) Seem.	Māmane, māmani	30	3-5 m	E
	Dodonaea eriocarpa Sm.	'A'ali'i ku-ma-kua	20	1.5-4.0 m	E
	Coprosma montana Hbd.	Pilo	10	1.5-3.0 m	E
0.5-1.5 m	*Eupatorium adenophorum* Spreng.	Maui pā-makani, white thoroughwort	70	0.5-1.5 m	X
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	30	0.5-1.5 m	E
	Chenopodium oahuense (Meyen) Aellen var. *discospermum*[1] Fosb.	'Āheahea, 'āweoweo, 'ahea, alaweo	+	1.0-1.5 m	E
	Osteomeles anthyllidifolia (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	1.0 m	E
	Vaccinium reticulatum[1] Sm.	'Ōhelo	+	0.5-1.0 m	E
≤0.5 m	*Lapsana communis* L.	Nipplewort	+	0.2 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Stenogyne crenata Gray	Crenate-leaved stenogyne	+	. . .[2]	E
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.5 m	E
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.4 m	X
	Asplenium adiantum-nigrum L.	'Iwa'iwa	+	0.2 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Polypodium pellucidum Kaulf.	'Ae, 'ae-lau-nui	+	0.2 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1]On kīpuka edge.

[2]Vine in trees.

STUDY AREA #48

Map reference: 156° 09' 15" W
20° 43' 35" N

Date studied: 6 June 1977

Location: Along the unmarked trail between Lā'ie Cave and Palikū at the base of Kalapawili Ridge.

Elevation: 6700 ft (2040 m).

Aspect: Slight east-facing slope.

Total vascular plant cover: 95%.

General description: The vegetation of the site is a decadent māmane forest with large, dying trees, and few intermediate-sized plants. Dead stumps are present. There is much evidence of goat damage in the area. This area might be compared with Study Area #47 where the māmane forest is still intact, and feral mammal disturbance has not been as great. Note that the upper story cover here is less than 5%, while in Study Area #47 it is 60%.

Substrate: Alluvial wash with some ash interspersed with a few exposed rocks of an underlying flow.

Surrounding area: To the north of the site is the north wall of the Crater, vegetated by a disturbed scrub community which grades into the decadent māmane forest. To the south are fairly recent lava flows with typical open low pioneer scrub (such as that at Study Area #47). The vegetation along the trail to the east and west of this study area is similar to that of the study site.

Climate: The area is dry, with average rainfall of 30 inches (75 cm) per year, most of which comes from a few storms. The area is occasionally covered by cloud.

Rationale for studying area: This area was once presumably a much denser māmane forest comparable to that at the kīpuka north of 'Ō'ilipu'u (Study Area #47). This site was chosen as it represents an area where the impact of browsing feral goats has been severe on a māmane forest.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	0
Lichens	0

VEGETATION OF STUDY AREA #48

Stratum	Species	Common Name	% Cover	Height	Status
>1.5 m	*Sophora chrysophylla* (Salisb.) Seem.	Māmane, māmani	<5	2.0-3.5 m	E
0.75-1.5 m	*Styphelia tameiameiae* (Cham.) F.Muell	Pūkiawe	5	0.75-1.5 m	I
≤0.75 m	*Pteridium aquilinum* (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	60	0.5 m	E
	Holcus lanatus L.	Yorkshire fog, velvetgrass	50	0.4 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	5	0.2 m	X
	Vaccinium reticulatum Sm.	'Ōhelo	<5	0.5-0.75 m	E
	Eupatorium adenophorum Spreng.	Maui pā-makani, white thoroughwort	+	0.5-0.75 m	X
	Plantago lanceolata L.	Narrow-leaved plantain	+	0.2 m	X
	Polycarpon tetraphyllum (L.) L.	Allseed	+	0.1 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Carex macloviana D'Urv. var. *subfusca* (W. Boott) Kuek.	St. Malo's sedge	+	0.1 m	I
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.5-0.75 m	E
	Luzula hawaiiensis Buch.	. . . . .	+	0.2 m	E
	Poa pratensis L.	Kentucky bluegrass	+	0.2 m	X

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #49

Map reference: 156° 09' 11" W
20° 43' 27" N

Date studied: 6 June 1977

Location: *Holcus* grassland along unmarked trail between Lā'ie Cave and Palikū at the base of Kalapawili Ridge.

Elevation: ca 6600 ft (2010 m).

Aspect: Flat land with full exposure.

Total vascular plant cover: >95%

General description: *Holcus* grassland of several acres.

Substrate: Alluvial wash from north face.

Surrounding area: Mixed native scrub, typical of this part of the Crater, surrounds this *Holcus* grassland.

Climate: The area is dry, with average rainfall of 30 inches (75 cm) per year, most of which comes from a few storms. The area is occasionally covered by cloud.

Rationale for studying area: The *Holcus* grassland was studied because it represents a vegetation type which consists mostly of exotic species. Previous cattle-grazing within the Crater may have been the disturbance which caused this grassland to consist mainly of *Holcus*.

Number of specimens collected:

Flowering plants	0
Ferns	0
Bryophytes	0
Lichens	2

VEGETATION OF STUDY AREA #49

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Holcus lanatus* L.	Yorkshire fog, velvetgrass	90	0.5 m	X
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	<5	0.5 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Epilobium cinereum A. Rich.	Pūkāmole, willow herb	+	0.2 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Carex macloviana D'Urv. var. *subfusca* (W. Boott) Kuek.	St. Malo's sedge	+	0.2 m	I
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.5 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #50A

Map reference: 156° 09' 12" W
20° 42' 40" N

Date studied: 7 June 1977

Location: One-third way across upper Kaupō Gap from east wall.

Elevation: 6100 ft (1860 m).

Aspect: South-facing.

Total vascular plant cover: 75%.

General description: Mixed rather dense scrub vegetation to 1.5 m (4.9 ft) on 'a'ā flow. The species present are the common species found throughout the Park.

Substrate: 'A'ā.

Surrounding area: Similar open scrub in all directions. There are a few ash pockets in the Gap where *Metrosideros* may be found. One of these south of the study site appears (using field glasses) to have a *Pteridium* and *Holcus* understory.

Climate: Annual rainfall approximately 40 inches (100 cm). A harsh, hot environment infrequently shaded by cloud.

Rationale for studying area: The vegetation at this site can be compared with that of the east and west sides of Kaupō Gap (Study Areas #16, #32, #33, #50B, and #52). There appears to be increasingly greater goat damage in the Gap as one moves from the east to the west side. The annual rainfall decreases in the same direction.

Number of specimens collected:

Flowering plants	0	
Ferns	0	
Bryophytes	9	(includes Area #50B)
Lichens	3	

VEGETATION OF STUDY AREA #50A

Stratum	Species	Common Name	% Cover	Height	Status
1.0-1.5 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	25	1.0 m	I
	Dodonaea eriocarpa Sm.	'A'ali'i ku-ma-kua	20	1.5 m	E
<1 m	*Vaccinium reticulatum* Sm.	'Ōhelo	20	0.4 m	E
	Coprosma ernodeoides Gray var. *mauiensis* St. John	Kūkae-nēnē	+	0.3 m	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.2 m	X
	Machaerina gahniaeformis (Gaud.) Kern	. . . . .	+	0.2 m	E
	Polypodium pellucidum Kaulf.	'Ae, 'ae-lau-nui	+	0.2 m	E
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	+	0.3 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

STUDY AREA #50B

Map reference: 156° 09' 22" W
20° 42' 36" N

Date studied: 3 June 1977

Location: Upper mid Kaupō Gap, in scrub vegetation on 'a'ā flow.

Elevation: 5950 ft (1810 m).

Aspect: 20° south-facing slope.

Total vascular plant cover: 60%.

General description: The vegetation is a rather dense scrub vegetation to 1.5 m (4.9 ft) consisting of the common scrub species.

Substrate: 'A'ā.

Surrounding area: Similar scrub vegetation is found in all directions with a few scattered pockets of *Metrosideros* in ash deposits.

Climate: Annual rainfall approximately 40 inches (100 cm). A harsh, hot environment infrequently shaded by cloud.

Rationale for studying area: The vegetation of Kaupō Gap changes from east to west with increasing goat damage and decreasing rainfall. This site can be compared with other sites in the Gap so that any continuum present in the vegetation may be observed (see Study Areas #16, #32, #33, #50A, and #52).

Number of specimens collected:

Flowering plants	1	
Ferns	0	
Bryophytes	9	(includes Area #50A)
Lichens	14	

VEGETATION OF STUDY AREA #50B

Stratum	Species	Common Name	% Cover	Height	Status
1.0-1.5 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	40	1.0 m	I
	Dodonaea eriocarpa Sm.	'A'ali'i ku-ma-kua	5	≥1.0 m	E
<1 m	*Vaccinium reticulatum* Sm.	'Ōhelo	20	0.4 m	E
	Anagallis arvensis L.	Scarlet pimpernel	+	0.1 m	X
	Coprosma ernodeoides Gray var. *mauiensis* St. John	Kūkae-nēnē	+	0.4 m	E
	Epilobium cinereum A. Rich.	Pūkāmole, willow herb	+	0.2 m	X
	Eupatorium adenophorum Spreng.	Maui pā-makani, white thoroughwort	+	0.3 m	X
	Gnaphalium purpureum L.	Purple cudweed	+	0.2 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Osteomeles anthyllidifolia (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	0.5 m	E
	Polycarpon tetraphyllum (L.) L.	Allseed	+	0.1 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.2 m	X
	Verbena litoralis HBK.	Ōwī, ha'uōwī, oi, weed verbena	+	0.3 m	X
	Deschampsia australis Nees ex Steud. *f. haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.4 m	E
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.2 m	X

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

VEGETATION OF STUDY AREA #50B--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Machaerina gahniaeformis* (Gaud.) Kern	. . . . .	+	0.2 m	E
	Sporobolus africanus (Poir.) Robyns & Tournay	African dropseed, rattail grass	+	0.2 m	X
	Elaphoglossum hirtum (Sw.) Chr. var. *micans* (Mett.) Chr.	'Ēkaha	+	0.1 m	I
	Asplenium trichomanes L.	'Owāli'i, spleenwort	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	+	0.3 m	E

STUDY AREA #51

Map reference: 156° 09' 26" W
20° 42' 29" N

Date studied: 7 June 1977

Location: West of Study Area #50B, upper mid Kaupō Gap.

Elevation: 5820 ft (1770 m).

Aspect: Slight south-facing slope.

Total vascular plant cover: 25%.

General description: The vegetation of the study area consists of widely spaced 'ōhi'a trees, and below them, a ground cover of exotic species. Some of the species occurring in the adjacent scrub are also present.

Substrate: Ash deposit with rock outcroppings of 'a'a flow.

Surrounding area: Surrounding areas are vegetated by rather open low scrub as at Study Area #50B.

Climate: Annual rainfall approximately 40 inches (100 cm). A harsh, hot environment infrequently shaded by cloud.

Rationale for studying area: This site was chosen for study so that the vegetation in the pockets of 'ōhi'a could be contrasted with the scrub vegetation in other areas of the Kaupō Gap.

Number of specimens collected:

Flowering plants	4
Ferns	1
Bryophytes	6
Lichens	15

VEGETATION OF STUDY AREA #51

Stratum	Species	Common Name	% Cover	Height	Status
>1.5 m	*Metrosideros collina* (J.R. & G.Forst.) Gray subsp. *polymorpha*[1] (Gaud.) Rock.	'Ōhi'a-lehua, lehua	10	2.0-3.0 m	E
1.0-1.5 m	*Styphelia tameiameiae*[2] (Cham.) F.Muell.	Pūkiawe	15	1.0-1.5 m	I
<1 m	*Anagallis arvensis* L.	Scarlet pimpernel	+	0.1 m	X
	Eupatorium adenophorum Spreng.	Maui pā-makani, white thoroughwort	+	0.3 m	X
	Gnaphalium purpureum L.	Purple cudweed	+	0.1 m	X
	Korthalsella complanata[3] (v.Tiegh.) Engler	Hulu-moa	+	0.1 m	E
	Osteomeles anthyllidifolia (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	0.4 m	E
	Polycarpon tetraphyllum (L.) L.	Allseed	+	0.1 m	X
	Verbena litoralis HBK.	Ōwī, ha'uōwī, oi, weed verbena	+	0.3 m	X
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.4 m	E
	Digitaria sp.	. . . . .	+	<0.1 m	X
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.3 m	X
	Juncus bufonius L.	Common toad rush	+	0.1 m	X

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic
[1]Both red and yellow forms blooming.
[2]Mostly not flowering.
[3]Host unknown.

VEGETATION OF STUDY AREA #51--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Machaerina gahniaeformis* (Gaud.) Kern	. . . . .	+	0.2 m	E
	Elaphoglossum hirtum (Sw.) Chr. var. *micans* (Mett.) Chr.	'Ēkaha	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	+	0.3 m	E

STUDY AREA #52

Map reference: 156° 09' 42" W
20° 41' 57" N

Date studied: 7 June 1977

Location: West side of Kaupō Gap; just east of large stream running down west side of Kaupō Gap.

Elevation: 5300 ft (1620 m).

Aspect: 10° south-facing slope.

Total vascular plant cover: 50%.

General description: The vegetation at this site consists of goat-damaged *Styphelia* (pūkiawe) scrub with few other woody shrubs (one keiki *Dodonaea* in crack, and some *Osteomeles* remnants). Many exotic herbs are present--a result of feral mammal disturbance.

Substrate: Undulating old 'a'ā flow.

Surrounding area: The river to the east has *Metrosideros* ('ōhi'a) in it, but otherwise most of the surrounding vegetation is similar to that of the study area.

Climate: Annual rainfall approximately 40 inches (100 cm). A harsh, hot environment infrequently shaded by cloud.

Rationale for studying area: The vegetation of Kaupō Gap changes from east to west with increasing goat damage and decreasing rainfall. This site is heavily goat damaged, with many exotic species present, and quite dry. Note that at this site *Styphelia* (pūkiawe) is the dominant and only shrub species, while at more easterly sites (Study Areas #16, #50A, and #50B) *Dodonaea* and *Vaccinium* are also present. Further, exotic species are more abundant here than at the other sites of this transect.

Number of specimens collected:

Flowering plants	11
Ferns	0
Bryophytes	8
Lichens	12

VEGETATION OF STUDY AREA #52

Stratum	Species	Common Name	% Cover	Height	Status
0.75-1.5 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	45	0.75-1.5 m	I
<.75 m	*Anagallis arvensis* L.	Scarlet pimpernel	+	0.1 m	X
	Centaurium erythraea Rafn.	Bitter herb, European centaury	+	0.1 m	X
	Cerastium vulgatum L.	Larger mouseear chickweed, nehine-hāuli	+	0.1 m	X
	Cirsium vulgare (Savi) Tenore	Pua-kala, bull thistle, spear thistle	+	0.3 m	X
	Dodonaea eriocarpa[1] Sm.	'A'ali'i ku-ma-kua	+	0.3 m	E
	Epilobium cinereum A. Rich.	Pūkāmole, willow herb	+	0.2 m	X
	Erigeron bonariensis L.	Ilioha, hairy horseweed	+	0.2 m	X
	Eupatorium adenophorum Spreng.	Maui pā-makani, white thoroughwort	+	0.3 m	X
	Gnaphalium purpureum L.	Purple cudweed	+	0.1 m	X
	Heterotheca grandiflora[2] Nutt.	Telegraph plant	+	0.1 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Korthalsella complanata[3] (v.Tiegh.) Engler	Hulu-moa	+	0.1 m	E
	Lythrum maritimum HBK.	Pūkāmole	+	0.1 m	X
	Osteomeles anthyllidifolia (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	0.3 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1] Keiki in crack.
[2] Immature.
[3] Host: *Styphelia*

VEGETATION OF STUDY AREA #52--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<.75m	*Oxalis corniculata* L.	'Ihi-'ai, yellow wood sorrel	+	0.1 m	X
	Polycarpon tetraphyllum (L.) L.	Allseed	+	0.1 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Trifolium dubium Sibth.	European yellow clover, shamrock	+	0.1 m	X
	Unident. 2265 (sterile) (Compositae?)	. . . . .	+	0.1 m	X
	Agrostis avenacea Gmel.	He'u-pueo	+	0.1 m	X
	Aira caryophyllea L.	Silver hairgrass	+	0.1 m	X
	Bromus rigidus Roth	Ripgutgrass	+	0.2 m	X
	Digitaria violascens Link	Kūkae-pua'a-uka	+	0.1 m	X
	Festuca dertonensis (All.) Aschers. & Graebn.	. . . . .	+	0.2 m	X
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Gastridium ventricosum (Gouan) Schinz & Thell.	Nittgrass	+	0.2 m	X
	Sporobolus africanus (Poir.) Robyns & Tournay	African dropseed, rattail grass	+	0.2 m	X
	Asplenium trichomanes L.	'Owāli'i, spleenwort	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	+	0.3 m	E

STUDY AREA #53

Map reference: 156° 09' 18" W
20° 41' 19" N

Date studied: 7 June 1977

Location: Near the *Schinus* tree, 1/4 mile (2/5 km) east of the west wall of Kaupō Gap.

Elevation: 4250 ft (1300 m).

Aspect: Slight south-facing slope.

Total vascular plant cover: 50% (30% consisting of dead and dying *Styphelia* [pūkiawe] debris)

General description: The goat damage at this site is severe. *Styphelia*, the dominant (and only native) shrub species, were occasionally pruned into trees, with their crowns out of reach of the goats, but more often they were shrubs less than one meter tall with only a few green leaves remaining on them. The height of the tallest *Styphelia* "trees," to 2.5 m (8.2 ft), would indicate that this area at one time consisted of a *Styphelia* forest. The damage to the vegetation is probably greatest here because of poor accessibility by hunters.

Substrate: Developed soil with exposed rocks of underlying lava.

Surrounding area: The damage by feral animals decreases east of the west wall of Kaupō Gap, and the vegetation just one-half mile east of this site is a fairly dense, tall (2.5 m [8.2 ft]) *Styphelia* forest. Downslope (south) of this site the damage to the native scrub is great; upslope (north) the vegetation is not so damaged as at this site.

Climate: Very dry, particularly during the summer. Rainfall is approximately 40 inches (100 cm) per year. The area is occasionally immersed in cloud.

Rationale for studying area: This area is one of the most damaged areas in the Park, and therefore it was necessary to sample it to compare it with other sites with less feral mammal impact. The impact of goats is so heavy that there is a persistent odor of goats in the area.

Number of specimens collected:

Flowering plants	14
Ferns	0
Bryophytes	8
Lichens	18

VEGETATION OF STUDY AREA #53

Stratum	Species	Common Name	% Cover	Height	Status
≥1 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	30[1]	1.0-2.5 m	I
	Schinus terebinthifolius Raddi	Wilelaiki, Christmas berry	+	2.0 m	X
<1 m	*Anagallis arvensis* L.	Scarlet pimpernel	+	0.1 m	X
	Bidens pilosa L.	Kī-nehe, kī, Spanish needle	+	0.2 m	X
	Centaurium erythraea Rafn.	Bitter herb, European centaury	+	0.1 m	X
	Cirsium vulgare (Savi) Tenore	Pua-kala, bull thistle, spear thistle	+	0.2 m	X
	Cocculus ferrandianus Gaud.	Huehue, hue'ie	+	. . .[2]	E
	Erigeron bonariensis L.	Ilioha, hairy horseweed	+	0.2 m	X
	Eupatorium adenophorum Spreng.	Maui pā-makani, white thoroughwort	+	0.2 m	X
	Gnaphalium purpureum L.	Purple cudweed	+	0.1 m	X
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.1 m	X
	Lepidium virginicum L.	Wild peppergrass	+	0.1 m	X
	Lythrum maritimum HBK.	Pūkāmole	+	0.1 m	X
	Osteomeles anthyllidifolia (Sm.) Lindl.	'Ūlei, Hawaiian hawthorn	+	0.3 m	E
	Oxalis corniculata L.	'Ihi-'ai, yellow wood sorrel	+	0.1 m	X
	Polycarpon tetraphyllum (L.) L.	Allseed	+	0.1 m	X

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1]Including and consisting mostly of dead and dying plants.
[2]Vine.

VEGETATION OF STUDY AREA #53--Continued

Stratum	Species	Common Name	% Cover	Height	Status
<1 m	*Silene gallica* L.	Small-flowered catchfly	+	0.1 m	X
	Verbena litoralis HBK.	Ōwī, ha'uōwī, oi, weed verbena	+	0.2 m	X
	Agrostis avenacea Gmel.	He'u-pueo	+	0.1 m	X
	Aira caryophyllea L.	Silver hairgrass	+	0.1 m	X
	Bromus rigidus Roth	Ripgutgrass	+	0.1 m	X
	Deschampsia australis Nees ex Steud. *f. haleakalaensis* (Skottsb.) Skottsb.	. . . . .	+	0.3 m	X
	Digitaria violascens Link	Kūkae-pua'a-uka	+	0.1 m	X
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Gastridium ventricosum (Gouan) Schinz & Thell.	Nittgrass	+	0.2 m	X
	Rhynchelytrum repens (Willd.) C.E.Hubb.	Natal redtop	+	0.2 m	X
	Sporobolus africanus (Poir.) Robyns & Tournay	African dropseed, rattail grass	+	0.2 m	X
	Asplenium trichomanes L.	'Owāli'i, spleenwort	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	+	0.3 m	E

STUDY AREA #54

Map reference: 156° 08' 50" W
20° 41' 29" N

Date studied: 7 June 1977

Location: Lower mid Kaupō Gap.

Elevation: 4500 ft (1370 m).

Aspect: 15° south-facing slope.

Total vascular plant cover: 75%.

General description: Dense *Styphelia-Dodonaea* scrub forest to 3 m (10 ft). Goat droppings are present, but damage is not nearly as severe as Study Area #53 further west.

Substrate: Rocky undulating 'a'ā flow.

Surrounding area: Surrounding areas are similar. There is an interesting pocket of *Santalum ellipticum* a few gulches to the west of the site, but other than that the vegetation is fairly homogeneous.

Climate: Very dry, particularly during the summer. Rainfall is approximately 40 inches (100 cm) per year. The area is occasionally immersed in cloud.

Rationale for studying area: This site is part of a transect across Kaupō Gap which includes Study Areas #40 and #53, and is representative of Kaupō Gap, and the *Dodonaea* forest/scrub to the east.

Number of specimens collected:

Flowering plants	5
Ferns	0
Bryophytes	0
Lichens	24

VEGETATION OF STUDY AREA #54

Stratum	Species	Common Name	% Cover	Height	Status
1.5-3.0 m	*Styphelia tameiameiae* (Cham.) F.Muell.	Pūkiawe	40	2.0-3.0 m	I
	Dodonaea eriocarpa Sm.	'A'ali'i ku-ma-kua	30	2.0-3.0 m	E
	Coprosma montana Hbd.	Pilo	+	2.5 m	E
0.75-1.5 m	*Vaccinium reticulatum* Sm.	'Ōhelo	10	0.75-1.5 m	E
<.75 m	*Eupatorium adenophorum* Spreng.	Maui pā-makani, white thoroughwort	10	0.5 m	X
	Deschampsia australis Nees ex Steud. f. *haleakalaensis* (Skottsb.) Skottsb.	. . . . .	10	0.5 m	E
	Cocculus ferrandianus Gaud.	Huehue, hue'ie	+	. . .[1]	E
	Hypochaeris radicata L.	Hairy cat's ear, gosmore	+	0.2 m	X
	Digitaria violascens Link	Kūkae-pua'a-uka	+	0.1 m	X
	Festuca megalura Nutt.	Foxtail fescue	+	0.1 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	+	0.2 m	X
	Asplenium adiantum-nigrum L.	'Iwa'iwa	+	0.1 m	I
	Pellaea ternifolia (Cav.) Link	Kalamoho, cliff brake	+	0.1 m	I
	Pteridium aquilinum (L.) Kuhn var. *decompositum* (Gaud.) Tryon	Kīlau, bracken fern	+	0.3 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic

[1]Vine.

STUDY AREA #55

Map reference: 156° 08' 45" W
20° 44' 08" N

Date studied: 8 June 1977

Location: Just north of trail from Lau'ulu Trail to Wai'ānapanapa.

Elevation: 8020 ft (2440 m).

Aspect: North-facing slope.

Total vascular plant cover: 95%

General description: *Deschampsia* tussock grassland of several acres. There are channels between the tussocks--caused either by pig rooting or by accumulation of tussock grass and ground settling. This grassland is denser than similar grasslands within Haleakalā Crater. Small plants of *Vaccinium berberifolium* are found at the bases of the tussocks. Bryophytes are confined to the bases of the grass tussocks.

Substrate: Well-developed soil.

Surrounding area: Rocky outcrops adjacent to this grassland are vegetated with scrub *Vaccinium*, and slightly east of the grassland is a *Vaccinium-Styphelia* scrub (as at Study Area #20).

Climate: Rainfall over 100 inches (254 cm) per year but probably much higher since orographic clouds are blown up the slope by the prevailing tradewinds.

Rationale for studying area: This site is located in the Kalapawili grasslands. This large expanse of high elevation grassland is the largest expanse of *Deschampsia* grassland in the park and therefore it was appropriate to sample it. This grassland is far denser than small areas of *Deschampsia* in Haleakalā Crater--except at Kaluanui where the grassland is dense, but is being choked in spots by *Poa pratensis*. The area is the upper end of the transect up the eastern side of Kaupō Gap.

Number of specimens collected:

Flowering plants	2
Ferns	0
Bryophytes	13
Lichens	20

VEGETATION OF STUDY AREA #55

Stratum	Species	Common Name	% Cover	Height	Status
≥0.5 m	*Deschampsia australis* Nees ex Steud. f. *haleakalaensis*[1] (Skottsb.) Skottsb.	. . . . .	95	0.5-0.75 m	E
<0.5 m	*Hypochaeris radicata* L.	Hairy cat's ear, gosmore	<5	0.2 m	X
	Holcus lanatus L.	Yorkshire fog, velvetgrass	<5	0.3 m	X
	Rumex acetosella L.	Sheep sorrel	+	0.1 m	X
	Vaccinium berberifolium (Gray) Skottsb.	Barbary-leaved 'ōhelo	+	0.2 m	E
	Carex (*macloviana*?) (sterile)	Sedge	+	0.2 m	.
	Luzula hawaiiensis Buch.	. . . . .	+	0.2 m	E

NOTE: % Cover: + = presence
Status: E = Endemic, I = Indigenous, X = Exotic
[1]Only a few flowering.

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