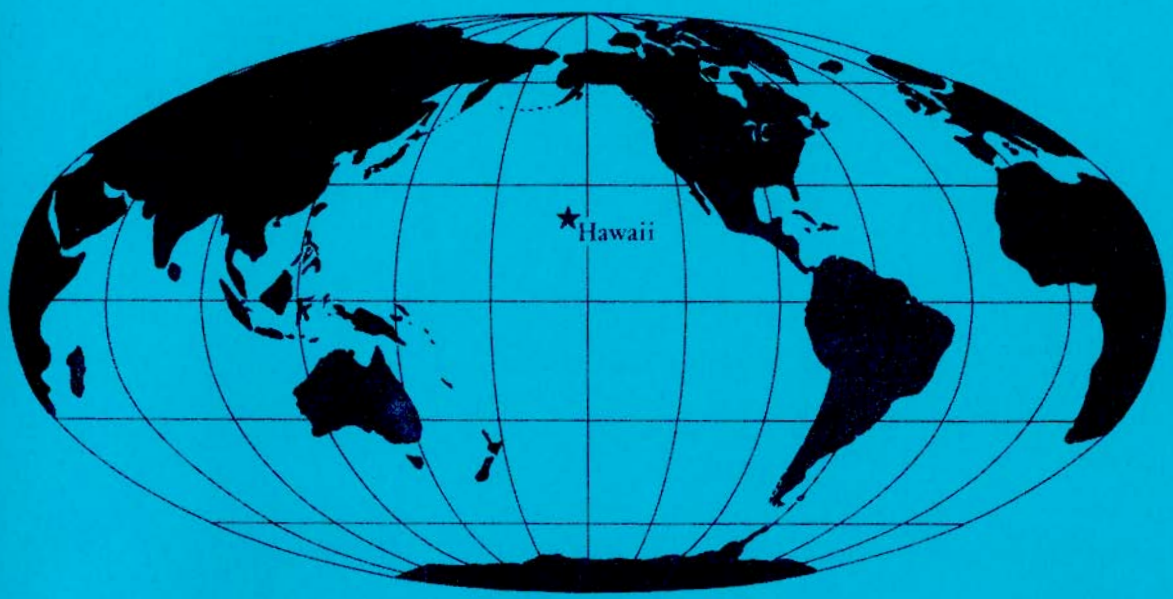
COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT
Hawaii

TECHNICAL REPORT No. 7

02-Year FIRST PROGRESS REPORT



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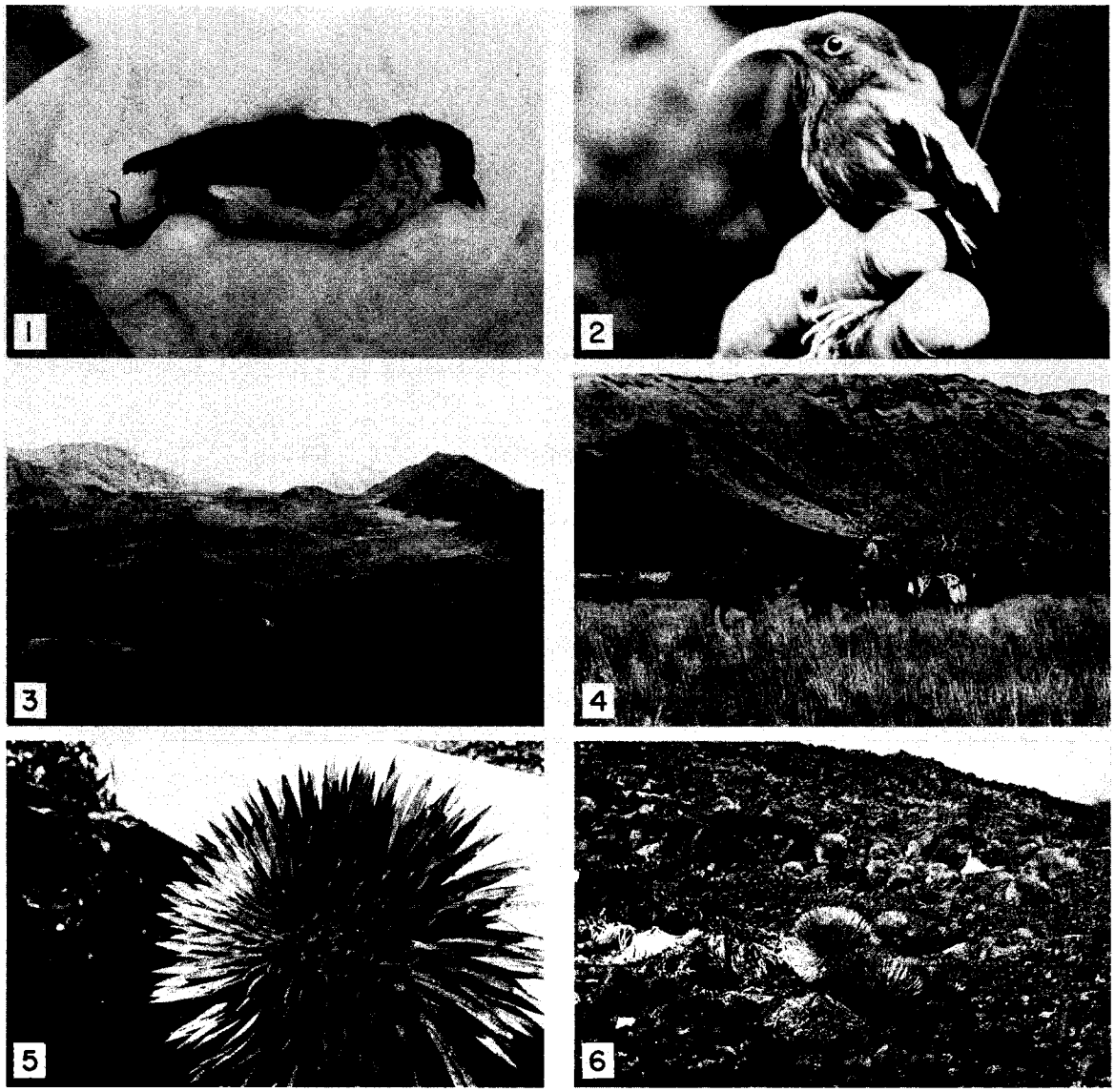
This report is issued for the use of the Western Region of the National Park Service and for the use of the Cooperative National Park Resources Studies Unit in partial fulfillment of the requirements of the related contract number CX800050003 between the University of Hawaii and the Western Regional Office of the National Park Service. The transmission of the information in this report is the responsibility of Maxwell S. Doty, Botany Department, University of Hawaii, Honolulu, Hawaii, who is Director of the Unit.

University of Hawaii

Cooperative National Park Resources Studies Unit

Completed 30 March, 1975



FRONTISPIECE. Haleakala National Park natural history problems. 1- Melamprosops phaeosoma, second of the two known specimens of this bird species unknown before its recent discovery on Haleakala. 2- The startlingly red native bird, IIWI, Vestiaria coccinea. 3- Looking eastward through Haleakala Crater. At the far end under the clouds, where people seldom go, there is the grassland of figure 4 and, on beyond, the biologically relatively unknown rain forests and Kipahulu Valley which can be reached only by hiking, horseback or helicopter. 5- The greensword of eastern Haleakala formerly thought to be very rare and, 6, the closely related silversword of Haleakala's western accessible upper elevations. These unique plants and birds have been endangered by feral animals. (Original photo for Figure 1 used by courtesy of James Jacobi [See Casey & Jacobi in Occas. Paper 24:12 of the B. P. Bishop Museum]; the remainder by courtesy of H. Eddie Smith.)

Preface and Introduction

This report details the progress made during the 02-year through January, 1975. It was decided early in the 02-year to remove some personnel from the UH/CPS-unit and transfer them to other projects in order to conserve NPS contract funds for concentrating the Unit's work during the winter and summer University vacation periods when faculty and staff have more time to engage in research. This procedure has been a rewarding move in developing the Unit's design so as to ensure the most efficient use of money and time. When one considers the manpower limitations imposed by the Unit's staff being on annual appointments and the manpower available, progress has been quite satisfactory.

Various of the projects listed in the "02-year Work Plan" have been concluded, taken on by others or have been shelved due to changes in priorities. Thus in future reports only those projects continued further will be reported, not the entire list reported here in the four areas. While a list of the projects to be continued as well as a programmed tabulation of their anticipated budgets for the ensuing 5-year period have been prepared as a 36-page working paper this paper is not included here.

As the Frontispiece would seem to indicate, the Unit is currently turning attention to Haleakala National Park. While Hawaii's other Parks have their volcanism and historical interests, Haleakala is to most visitors a geological splendor. To scientists, Haleakala is a challenge in its biologically unexplored tracts and in the opportunities to study the apparent interrelationships between such as the native and exotic birds via their pig-abbetted-mosquito and other disease vectors. The human visitors, feral animals and exotic plants one way or another put pressures on the native fauna and flora, e.g., as Ken Baker, Research Biologist at Volcanoes National Park, has shown for pigs which in their destruction of tree ferns, create conditions favorable to mosquitoes.

While continuing the work plan for the 02-year through June, 1975, considerable energy is being expended in preparing for an effort to extend the Resources Basic Inventories for all the Parks and prepare for the expansion proposed both by the Unit's Resources Group and Park personnel of the Unit's program for the 03-year. It is anticipated that some of the $50,000 budget for Unit operations during the 02-year will serve to set many of these projects "moving". These initial projects will be described in the final report for the 02-year. In several cases a proposal in greater budgetary and structural detail has already been prepared for submission by the Unit.

The Unit staff is spending a significant amount of effort attempting to attract suitable principal investigators to pursue Unit projects. However, many of these people are already engaged in their own research and are being asked to perform work for the Unit at no salary and often for no permanent rewards. Likewise the Unit is at present not a highly funded operation. It is largely to offset these two situations that we chose to provide base facilities and

provide transportation to expedite and facilitate field research on the part of principal investigators and thus get their desired professional participation.

It is important to note, and it must be stressed as of first order importance, that the basic inventory work must be done before operationally more advanced or detailed projects can be carried out. Secondly, the base and field accommodation facilities for principal investigators and their staff assistants should be further upgraded (in the case of Hawaii Volcanoes National Park) or created (in the cases of Haleakala National Park and the City of Refuge) before many of the more advanced research projects can be undertaken. Providing such will be more efficient and less costly to the program as a whole than providing each principal investigator an increased budget to provide for, e.g., housing, transportation and equipment separately.

The work reported here was done by the individuals credited or by the Unit's staff members. This staff, usually acting in concert, was part or all the time of Ms. Carole Packard, Mssrs. Fred Ball, H. Eddie Smith and Ismael Trono augmented by Mr. Barry Hill (on loan from another project for some months in the absence of the Unit's Director).

Throughout this report the Cooperative Park Studies Unit is referred to as the Unit and the National Park Service is referred to as the Service or as the Park Service. By Parks alone, we refer to all Park Service operations in Hawaii, particular parks are often referred to as "the Park." Hawaiian names for living organisms are provided in capital letters.

Maxwell S. Doty, Director

UH/CPS-Unit

AREA A. Training

1. The certification program

Dr. Charles Lamoureux has submitted proposals for two new courses, "Resource Management in the Wildlands" and "Seminar in Resource Management in the Wildlands," to the University Curriculum Committee for consideration and approval. (See Course Outlines, pages 5-8 .) The Committee's initial reaction to both the courses and the proposed Resource Management Certificate Program was positive, but concern was expressed about sources of program funding and instructional costs as the University is currently in a financial crisis. The Committee is very receptive to the courses and Program and approval appears to be forthcoming if extramural funding is obtained to bridge to less tight University budget times, signs of which are now visible.

2. Course development

Since both courses will be taught principally by guest speakers from the University and National Park Service, instructors need not be hired. It is proposed a coordinator be obtained for the program. This individual would assist the director to develop and implement the new courses, select and advise student participants, seek out and develop field internship programs and obtain the assistance of professionals in the field or lecturers and advice from the Resources Group. Of the three courses involved, "Natural History of the Hawaiian Islands" is already funded and has been a very successful course at the University for some years. Its outline and that of the other two courses follow.

Natural History of the Hawaiian Islands

Course Syllabus (as used Spring 1975)

1. Definition of natural history, introduction to course--Lamoureux
2. History of scientific knowledge in Hawaii--Kay
3. Geological history--Macdonald
4. Climatology--Price
5. The biotic environment and biota of the Hawaiian Islands, Terrestrial--Lamoureux
6. The oceanographic climate--Stroup
7. The biotic environment and biota of the Hawaiian Islands, Aquatic--Kay
8. The high Hawaiian Islands: inshore aquatic areas--Kay
9. The high Hawaiian Islands: processes in inshore aquatic areas--Kay
10. The air-water interface--Kay
11. The atoll as a maximum expression of the air-water interface--Kay
12. The low Hawaiian Islands as atolls--Lamoureux
13. The high Hawaiian Islands: terrestrial areas--Lamoureux
14. Insular evoluation--Lamoureux
15. Freshwater ecosystems--Maciolek
16. Endemism and evolution in the Hawaiian biota:
    a. Plants--St. John, Lamoureux
    b. Mollusks--Kay
    c. Insects--Carson
    d. Cave fauna--Haworth
    e. Birds--Berger
    f. Terrestrial vertebrates--Ziegler
17. Effects of man on the terrestrial biota of the Hawaiian Islands--Lamoureux
18. Effects of man on the marine biota of the Hawaiian Islands, Summary--Kay

Resource Management in the Wildlands

Course Syllabus

1. Objectives of resource management in wildland areas: Conant
2. A survey of natural resources:
   a. Geology--Macdonald
   b. Soils--Green
   c. Water--Lau
   d. Vegetation--Mueller-Dombois, Lamoureux
   e. Fauna--Conant, Gagne
3. The resource management concept: a series
   Conant, Reeser, Mueller-Dombois, Lamoureux, Berger, Kridler, Banko
4. The role of scientific research in resource management: a series
   Berger, Gagne, Mueller-Dombois or Lamoureux, Lau, Swindale or Ekern
5. Methods in resource management; a series
6. Human impact and involvement in resource management: a series
   Gagne, Harry, Huntzinger or Barrel, Shallenberger

Seminar in Resource Management in the Wildlands

Course Syllabus

1. Assessment of human impact on native ecosystems: Conant or Mueller-Dombois
2. Types of wildlands and the purpose of each: a series
   a. National Parks--Barrel
   b. Natural Area Reserves--Lamoureux
   c. Wilderness Preserves--Kay, Conant, Harry
   d. Wildlife Preserves--Kridler
3. The impact of exotic biota on native ecosystems: a series
   a. Plants--Lamoureux or Mueller-Dombois
   b. Invertebrates--Gagne
   c. Vertebrates--Conant, Tomich, Berger
4. The assessment of feral biota impact: J.K. Baker
5. Preservation of rare and endangered species:
   a. Plants--Herbst
   b. Animals--Berger
6. Restoration of native ecosystems: Reeser, Tomich, Van Riper

   (There are at least two actual case histories in management that could be considered, and/or they could be broken into several parts: goats, planting, etc.)
7. Agency policy formation: Head, Department of Lands and Natural Resources and/or Barrel and/or Huntzinger
8. Student presentations: more case histories
9. Outside activities:
   a. Attendance at legislative hearings, perhaps involving presentation of testimony in appropriate cases

b. Attendance at Animal Species Advisory Commission meetings

c. Field trips to observe management practices

3. Internship program

Preliminary discussions about internships have been held at various levels. There being no candidates for internships as yet it would seem inappropriate to do more than pursue the agreements in principle being sought and obtained thus far. Currently we are cooperating with the University of California related program and expect the first intern this spring.

Provision of funds for internships at the right time will greatly facilitate and expedite the work of the Unit and provide future skilled management personnel for local and state as well as the federal park systems. It is envisaged that with the advice of the Unit's funded principal investigators and under the supervision of Park management personnel the interns will carry out data collection and field research or other work in the Parks during vacation and summer periods, or for semesters of their school year. Park administrators will be able to observe the work of the interns first-hand and may, as positions become available, offer employment to those who have accomplished exemplary work and show promise for prospective Park scientific, interpretive or management work.

AREA B. Resources Basic Inventory

1. Projects generally applicable to entire State program.

a. A bibliography is being compiled which comprises information pertinent to natural history studies performed at Hawaii Volcanoes National Park -

b. Design a UTM-compatible grid system and seek its establishment in each Park as a practical way of locating the Park's resources and areas of interest.

Contact has been made with the United States Geological Survey regarding the location of ground control points in the Parks which are essential for reference when examining aerial photographs. At present, sufficient control points are lacking and will have to be supplemented before a UTM-grid system can be established. To install additional control points through a commercial engineering survey firm at this time would be cost prohibitive; hence, other means for establishing a system are being investigated. Possible assistance from the Department of Geology and Geophysics at the University of Hawaii may be available.

The need for more precise mapping is keenly felt by some members of the Unit. Some of the needs for more precise location of activities and sites are clarified by considering some recent problems. Had the Park Research Biologist's and the Wildlife Management's work plans been located and communicated clearly on such a mapping as proposed here, the Hiiaka Fire Burn recovery study perhaps would not have been inadvertently terminated. Possibly the construction of pathways across study plots on the 1961 ash fall could have been avoided if the study areas had been plotted on base maps such as proposed here.

Such precise and readily useful mapping would also be of real value in deciding where to fight a fire regardless of its cause or to send effort to cope with an emergency.

c. Describe and map the ecosystems of the Hawaiian National Parks and their immediate environs, including historic changes.

Partial mapping of the ecosystems (botanical aspects) has

been accomplished. Technical Report #4, entitled "Vegetation Maps of Volcanoes," reports results of this work. Further gathering of empirical data in the areas of botany, ornithology and entomology has been planned to commence during the summer of 1975 if funding is available. Traplines set along each transect could permit evaluation of mongoose and rat populations.

The results of this initial basic inventory will afford an immediate index to the existing biota within the Parks and the initial basic information for the compilation of atlases including vegetation maps. This inventory will bring to date the prevalence and densities of the rare and endangered species in the flora and fauna and, thus, provide a base for research designed to reveal the causes for some species being rare or endangered. This work should uncover peculiarities of the environment and historic events which have led to the alteration of native habitats and the present biotic communities. It is confidently felt this is the provision of new interpretive information and a logical basis for management decisions.

2. Projects especially applicable to City of Refuge National Historical Park.

a. Compile a bioecological atlas for the City of Refuge.

At present, an inventory of the marine life associated with Honaunau is in its initial stages (see "2b" following). Other completed and proposed work as described below contributes to the information base required for such an atlas.

Although Honaunau is an historical park, it is located adjacent to one of the most beautiful and pristine bays on the Kona Coast and there is a need to know its natural history, Interpreting the many

different ways the ancient Hawaiians used products of the sea as food and their beliefs concerning them requires such natural history information. A proposal has been submitted to the Unit to seek out and synthesize all previous data on the marine biota in and around Honaunau Bay and gather additional data if needed. These data could be combined with the historical information gleaned from Bishop Museum Hawaii Archives collections, and other sources to serve as a base for the construction of static shore displays by the NPS and informational talks for the public concerning the ways Hawaiians gathered and prepared fish, molluscs, seaweed and other organisms for consumption.

Since there is a paucity of natural history information regarding the more inland non-marine areas of the Park, future studies of these areas are anticipated. Some as follows, have been begun. However, this not being a natural history park and that being the principal task of the Unit means the Unit has far fewer projects for this Park than for Haleakala or Volcanoes National Park.

Dr. D. Mueller-Dombois made a recent trip to the Park to make observations on the current status of the vegetation and discuss restoration problems with, especially, Ranger Gilbert Tanaka. It is envisioned that the Unit may receive proposals to aid in the solution of such problems. Also, once adequate data are at hand, work can then begin on the compilation of a bioecological atlas for the City of Refuge.

Dr. Mueller-Dombois' report is included here to indicate the nature of some current problems.

"The restoration objective (of the Park) is to make the inland area of the coastal park look like it did before the arrival of

the Europeans. The current idea is that the area inland (behind the planted coconut palms and Morinda citrifolia trees) as a barren lava rock surface covered only with scattered native dry-zone trees. Currently, the vegetation consists of two structurally contrasting communities: (1) a dense tall-scrub community and (2) a grass community with scattered shrubs.

"(1) Tall-scrub community. -This is a variation of the typical Leucaena latisiliqua scrub vegetation that is so common in the hot dry lowlands of the Hawaiian Islands. The variation is caused by the prevalence of a tree legume, Pithecellobium dulce that appears to be locally dominant throughout the wild woody vegetation along the Kona Coast. Other associated trees and shrubs are (among others) Prosopis pallida (scattered), Acacia farnesiana (common in more open places) an occasionally planted Samanea saman. A conspicuous undergrowing shrubby weed is the red **berried** Ravina humilis (Phytolaccaceae, 'coral berry'). No native tree of shrub species was seen. A botanical survey has been done by Amy Greenwell, according to Gilbert Tanaka, and should list any native species remaining in the area.

"This tall-scrub community apparently represents the currently persistent wild vegetation as shown by its wide-spread occurrence in the Kona lowland. It grows on rock outcrop substrates, mostly on PAHOEHOE or finer rock rubble that seems to have very little fine soil. The annual mean rainfall is probably between 500-750 mm (20-30"). However, unique is the month-to-month rainfall distribution. Here, in contrast to other dry-zone areas in the Hawaiian Islands, the humid period coincides with the summer-

months, while the drought period occurs in the winter (see in the "Atlas for Bioecology Studies: page 87," climate diagram of Holualoa Beach, a few miles north of this area).

"(2) Grass community with scattered shrubs. - This is a man-modified vegetation that has developed following cutting of the tall-scrub community. The dominant grass is Rhynchelytrum repens (Natal redtop). Another important grass in local depressions and near shrubs is Panicum maximum (Guinea grass). Abundant associated plants are the herbaceous vines, Passiflora foetida and Momordica charantia and scattered shrubs of Leucaena latisiliqua, Acacia farnesiana Waltheria americana and others.

"Significant is the absence of the pili grass (Heteropogon contortus) in this Rhynchelytrum grass community. Elsewhere in the Hawaiian Islands, in areas with the same mean annual rainfall, one finds Heteropogon contortus as the distinctly dominant grass.

"Evaluation with respect to the specified restoration objective. The Park Service cleared the tall-scrub vegetation in 60-80% of the 180 acre Park terrain with the objective of restoring a barren lava surface. This clearing operation was started in 1961 and continued through 1963 according to Gilbert Tanaka. The almost immediate response was the establishment of the Rhynchelytrum grass community. A continuing process is the reestablishment of the woody plants as evidenced by the current presence of the scattered shrubs. Thus, the cleared area has a tendency to return to the tall-scrub community stage, and the recovery process may take only two decades.

"(1) Controlled burning as a treatment. - If the sole objective was the elimination of the woody plants, periodic burning of the cleared area would be a promising method. However, another objective is apparently to reintroduce some native woody plant species. In that case burning cannot be used as a ground-clearing treatment freely because the planted trees would be destroyed also.

"Periodic burning as a management tool in this vegetation would definitely promote and arrest the vegetation in the grass stage. Most likely it would perpetuate the Rhynchelytrum grass community. Fire will certainly not have the desired effect of keeping the area barren. For this one would have to introduce more drastic measures, such as repeated herbicide control (which is expensive and probably damaging to the hydrology of the area) or goats in enclosures (which would also not accomplish the objective of establishing a pre-European condition).

"Thus, it would seem advisable to accept the fact that maintaining the grass stage (an early successional stage) is a more feasible management alternative to total clearing of the ground cover.

"(2) Introducing a native grass species. - PILI grass (Heteropogon contortus), though not really a native grass, probably would be a more desirable ground cover than Natal redtop (Rhynchelytrum repens), since PILI grass is said to have been introducted by the Hawaiians and used for thatching the roofs of their huts.

"Note that PILI grass is apparently absent in the Rhynchelytrum grass cover of the Park although it is found elsewhere in Hawaii

on rockland in the dry zone with similar mean annual rainfalls. The absence of PILI grass may be caused by several reasons. A few may be as follows:

"(1) The peculiar summer-humid-winter-dry climatic situation of the Park, which may promote the prevalence of Rhynchelytrum. PILI grass has been planted in a 0.1-acre lawn area in front of the Administration Building of the Park. Here it becomes invaded with Natal redtop, which without periodic weeding, will probably replace PILI grass in time.

"(2) Absence of periodic fires. It is possible that PILI grass may gain a competitive advantage over Natal redtop by controlled burning. However, this is an untested hypothesis. Perhaps a controlled burning experiment would be worthwhile on the 0.1-acre lot in front of the Administration Building to test this hypothesis. Of course, it should be remembered that periodic firing to maintain a certain grass species cannot be very well combined with the other objective of maintaining planted trees unless grass is removed from around the tree trunks before each refiring.

"Another native (endemic) grass that may be tried as a ground cover in the area is Eragrostis variabilis (variable lovegrass or EMO-LOA). It certainly has the coarse grass qualities desired for roof thatching. However, judging from its present restricted distribution in the dry zone of the Hawaiian Islands, this grass is probably of low fire resistance.

"An experiment may be worthwhile in the Park to find out if Eragrostis variabilis can be established as a native ground cover."

b. Survey the marine biota at Puukohola Heiau National Historic Site.

The Puukohola Heiau National Historic Site boundary includes ocean waters where ancient Hawaiians erected an underwater heiau dedicated to the shark god, MAMO. Since the Park plans to develop interpretive material concerning this heiau, and other marine biota, the Unit proposes to perform a marine survey of the area.

c. Obtain a plant checklist and plant collection at the Puukohola Heiau National Historic Site.

The Unit proposes to develop a checklist and collection of plants at this historical site to serve as the basis for the restoration and management of the vegetation of the area.

d. Describe the Honaunau fish and other marine populations and plan public viewing so as to stress their pre-European roles in Polynesian Hawaii.

Dr. Leighton Taylor of the Hawaii Cooperative Fishery Unit is currently involved in surveying the fish populations of Honaunau. His report of the initial inventory follows below; Dr. Taylor has submitted a proposal to the UH/CPSU for work during the 03-year to continue his studies over a two-year period.

> "Preliminary Summary of Honaunau Transect Data. The following six tables summarize the transect data recorded at Honaunau, Hawaii by E. Hobson, R. Nolan and L. Taylor during November 18-29, 1974. The transects are 50 m in length and 10 m in width (5 m in each side of the installed line). Counts

are listed here only for the ten most commonly encountered species. The "abundance index" (Hobson 1974) is calculated for each species as the number of a given species divided by the total number of individuals of all species x 100. For certain transects, the rank and indices recorded by Hobson for 1969 transects in the same habitat zones are listed for comparison. Analysis of these data would not be appropriate until a year's data are at hand. When completed, interpretations of historic uses from the behavioral and seasonal abundance variations are expected to be significantly facilitated.

"Transects for these fish studies are located in four distinct habitat zones: 1) Boulder Zone, located in 2-4 m depth near the inner shoreline of Alahaka Bay; characterized by large basalt boulders dotted with various algae and corals; 2) Drop-off Zone, located off Puuhonua Pt. about 100 m from shore where the bottom drops abruptly from 15 m to much deeper depths; generally overgrown with Porites compressa and P. lobata interspersed with sand patches, basaltic pavement areas and boulders; 3) Porites compressa Zone, located 100 m off the south shore of Honaunau Bay in 5-10 m depth, characterized by dominant bottom coverage (80-100%) of fingerlike Porites compressa; and a 4) Porites lobata Zone, located 50 m off the south shore of Honaunau Bay in 5-10 m depth inshore of Transects 3, characterized by dominant bottom coverage of massive and encrusting heads of P. lobata.

1a) Transect: Boulder LT
Date: 19 November 74

Rank	Species	Abundance Index
1	Ctenochaetus strigosus	30.0
2	Acanthurus nigrofuscus	17.5
3	Zebrasoma flavescens	14.5
4	Acanthurus achilles	8.0
5	Pomacentrus jenkinsi	5.2
6	Acanthurus leucopareius	4.3
7	Thalassoma duperreyi	4.2
8	Chromis vanderbilti	3.3
9	Chaetodon multicinctus	2.2
10	Acanthurus guttatus	1.8

Total species: 32

Total individuals: 600

1b) Transect: Boulder EH
Date: 19 November 74 (with data from Hobson taken in 1969)

Rank	Species	Abundance Index	1969 Rank	1969 Index
1	Acanthurus nigrofuscus	21.7	1	13.7
2	Ctenochaetus strigosus	17.7	2	10.8
3	Zebrasoma flavescens	8.3	3	9.6
4	Acanthurus achilles	7.6	4	8.0
5	Pomacentrus jenkinsi	6.8	6	5.3
6	Acanthurus guttatus	5.8	unranked	1.6
7	Thalassoma duperreyi	4.0	5	6.4
8	Acanthurus leucopareius	3.8	8	4.7
9	Chromis vanderbilti	3.8	10	2.4
10	Chaetodon multicinctus	3.2	unranked	1.1

Total species: 44

Total individuals: 503

" 2a) Transect: Drop-Off Lt
Date: 19 November 74

Rank	Species	Abundance Index
1	Chromis agilis	31.1
2	Zebrasoma flavescens	11.8
3	Hemitaurichthys zoster	8.6
4	Chromis hanui	8.4
5	Ctenochaetus strigosus	7.8
6	Thalassoma duperreyi	4.6
7	Chaetodon multicinctus	4.4
8	Chromis verator	2.5
9	Centropyge potteri	2.1
10	Naso literatus	1.9

Total species: 47

Total individuals: 850

"2b) Transect: Drop-Off EH
Date: 19 November 74 (with 1969 data from Hobson)

Rank		Index	1969 Rank	1969 Index
1	Chromis agilis	16.7	2*	11.2
2	Zebrasoma flavescens	12.4	5	4.8
3	Naso hexacanthus	10.5	1	11.4
4	Ctenochaetus strigosus	8.3	6	3.9
5	Hemitaurichthys zoster	7.0	unranked	2.1
6	Chromis verator	5.7	9	3.2
7	C. hanui	5.2	*	
8	Abudefduf abdominalis	5.0	unobserved this habitat	
9	Chaetodon multicinctus	3.2	7	3.8
10	Centropyge potteri	2.8	8	3.5
11	Thalassoma duperreyi	2.2	4	6.6

*Chromis agilis
*C. hanui counted together as C. leucurus

Total species: 54

Total individuals: 598

"3) Transect: Porites compressa LT
Date: 20 November 74

Rank	Species	Abundance Index
1	Chromis agilis	29.4
2	Zebrasoma flavescens	24.8
3	Ctenochaetus strigosus	18.9
4	Chaetodon multicinctus	5.7
5	Naso hexacanthus	3.5
6	Centropyge potteri	2.3
7	Naso literatus	1.8
8	Chromis hanui	1.6
9	Thalassoma duperreyi	1.6
10	Naso brevirostris	1.2

Total species: 37

Total individuals: 513

" 4) Transect: Porites lobata EH

Rank	Species	Index	1969 Rank	1969 Index
1	Chromis agilis	16.7	2*	12.3
2	Zebrasoma flavescens	12.8	3	10.6
3	Ctenochaetus strigosus	9.9	1	15.5
4	Chaetodon multicinctus	9.3	6	4.4
5	Mulloidichthys samoensis	4.8	unranked	0.1
6	Chaetodon ornatissimus	4.5	unranked	1.8
7	Plectroglyphidodon johnstonianus	2.9	9	3.1
8	Thalassoma duperreyi	2.6	5	5.7
9	Chromis hanui	2.6	*	
10	Gomphosus varius	2.2	unranked	1.0
11	Centropyge potteri	2.2	10	2.5

*Chromis agilis
C. hanui counted
together in 1969"

Total species: 54

Total individuals: 312

3. Projects especially applicable to Hawaii Volcanoes National Park.

a. Develop and implement concept of a rare and endemic species laboratory.

The Unit has obtained a special use permit from Hawaii Volcanoes National Park to operate the Hawaii Field Research Center which provides living space for researchers working in the Park. Under the terms of the agreement the Unit Director through his resident facilities manager schedules and coordinates use of the Center and keeps records of occupancy.

The proposed modification of the Job Corps Camp at Hawaii Volcanoes National Park for research purposes has been accomplished. Researchers from the University of Hawaii, Bishop Museum, the National Park Service, the USGS as well as a group of about 20 students from a California College have made use of the facility. Currently, the Hawaii Field research center provides bunking and board facilities for 15 people; with double bunks obtained, up to 30 can be accommodated. Additional equipment will be purchased as funds become available to meet the Unit's needs in both the laboratory and dormitory. Additional funding will be necessary for finishing minor construction details, for routine maintenance of the facility and purchase as well as operation and maintenance of vehicles.

b. Monitor goat exclosures in terms of vegetation change.

Vegetational changes in several areas in the Park where goats have been excluded must be monitored on a high priority basis before valuable data is lost. The Unit intends to pursue this activity as soon as funds are available.

c. Update the herbarium and provide a plant check-list.

The HVNP herbarium was recently updated and returned to the Park. The plant checklist has been completed by F. R. Fosberg, and as Technical Bulletin #5, is being distributed separately.

d. Integrate the IBP and RBI data into an ecosystem computer modeling system.

A synthesis volume is being prepred by Dr. Dieter Mueller-Dombois integrating all of the IBP data. As soon as the summer 1975 RBI projects are completed, the accumulated data may be prepared for inclusion into an ecosystems computer modeling system. This is expected to be a task of the National Park Service Science Center.

e. Map the intertidal zone and describe its populations.

Drs. Robert Kinzie and John Stimson have expressed interest in developing a checklist of marine organisms along the Halape coastline in the future.

f. Climate monitoring.

The Unit is continuing and hopes to expand the weekly record from the weather stations established along the Mauna Loa Truck Trail. While at present these data are being added to the data bank as initiated under the International Biological Program, the Unit's current funding is not such that this can be continued. After some date in the next very few months the data can only be held in the Unit's files on the standard forms from which they may be copied by interested individuals.

g. Map Kalapana natural history values with greater accuracy and precision.

The mapping of the natural history values of Kalapana by

Richard Warshauer is still in progress. A report is anticipated by late summer of this year.

4. Projects especially applicable to Haleakala National Park.

A Cooperative National Parks Studies Unit research assistant has been in residence at Haleakala National Park since November, 1974. He has prepared a proposal to establish base camp facilities in the Park. These would facilitate research by Unit principal investigators as well as other cooperators especially in respect to obtaining RBI information for later interpretive and management use. It appears personnel and financing have been obtained for about one man-years work on a combination of insects, plants and birds already. Thus, the Unit as taken steps to initiate in-depth research in Haleakala National Park.

a. Prepare an atlas. Provision of the empirical information relative to management problems in Haleakala National Park and especially Kipahulu Valley are a major concern of the Unit. It follows that research should be concentrated in this area. However, the Unit will continue to approach research in the Valley itself with extreme caution. The present policy of the Unit is to engage in or encourage "approach studies" to determine research priorities and develop research methods which will have minimal effect on the delicate environment. As a first step it is proposed to assemble the large amount of presently known information and produce the manuscript for an initial biological "Atlas of the Valley" of the Park.

b. Prepare a geological map. Dr. Gordon Macdonald of the University of Hawaii Geology and Geophysics Department, has been working on this project for the past few years during his leisure time.

Because of other responsibilities, he is unable to predict when he will be able to complete the mapping.

c. Update the herbarium and provide a plant check-list. The collection, preparation and revision of the herbarium at Haleakala National Park is now underway. However, due to the absence of most of the existing plant representatives in the current herbarium, an exhaustive collection of the flora must be made, and many of the plants to be collected will not be in flower or fruit for several months. Much of the collecting will be accomplished in Summer 1975 when the basic inventory work described in Area B.1-c commences.

d. Establish a baseline of freshwater fauna and flora in the Seven Pools area.

It is anticipated that research in the Hana-Seven Pools area of the Park can commence during the 03-year. A proposal has been submitted to the Unit to establish a checklist of fresh water biota in the Seven Pools area by two of the Resource Group. Wet conditions and the absence of camping facilities for researchers in this area will lead to the extensive use of the field laboratory-truck combination purchased during the 01-year.

5. Projects especially applicable to Kipahulu Valley.

The proposed RBI work due to commence during the Summer of 1975 will provide checklists of the biota within Haleakala National Park as well as those adjacent to the Park boundary and bordering Kipahulu Valley, e.g., the Lake Waianapanapa area.

This RBI project will assess the impact of habitat alteration and also help refine the study techniques which could be applied to Kipahulu Valley at a future time.

In addition, the feral pig control methods as proposed for study are directly applicable to Kipahulu Valley once the techniques are perfected.

a. Study recovery of Waihoi and Upper Hana Trails and the impact of exotic invasion. The most recent and pertinent data concerning this area have been collected by students working on the Hana Rain Forest Project sponsored by the Entomology Department of the University of Hawaii and funded by National Science Foundation. The information gathered by the students on this project has not yet been distributed, but an abstract prepared by John Kjargaard, which follows, outlines at least some of their findings of significance to the present and future work of the Unit.

> "The Hana Rain Forest Project presented the opportunity to design and conduct what may turn out to be one of the most significant field ecological research projects in the history of the State of Hawaii. The study area encompassed approximately 2 1/2 square miles of rain forest and alpine grassland from 4900 feet to 8900 feet on the northeast slopes of Haleakala Volcano on the island of Maui.
>
> "From early June to mid-December, the study involved over 1000 man days of living and working in parts of the Upper Hana and Koolau Forest Reserves, probably two of the wettest areas in the World with extrapolated annual rain falls of over 400 inches. Access to the study area was by helicopter only in good weather or by backpacking fourteen miles each way above 7000 feet.
>
> "Through the study of epiphytes, mosses, vascular plants, insects, mammals, birds, soils, meteorology, ecology

and vegetation ecology, the Hana Rain Forest Project is expected to produce an environmental reference work designed to provide State and Federal agencies, as well as private organizations, with a great deal of information needed to preserve and protect this unique area.

"Research was conducted in four major ecosystems. Approximately 300 acres of Deschampsia grassland extends from the Haleakala ridge tops at 8000 feet down to about 7300 feet. From 7300 to 7100 feet there stretches a long narrow band of shrub scrub characterized by Vaccinium and Rubus thickets. The dense, wet predominately Metrosideros forest extends four to six miles from here down to the pastures and guava thickets above the Hana Highway. Interspersed throughout the study area from 5000 feet to the middle of the grasslands are Carex bogs underlayed with treacherous lava tubes and populated with beautiful greensword and Lobelia plants. In the upper reaches of the forest are Lakes Waianapanapa and Wai Ele'ele.. The former is technically only a pond, while the latter is one of Hawaii's two true lakes.

"Three recording hygrothermograph stations and 37 rain gauges were maintained from early June through early December. Rainfall estimates varied from 146 inches at 7000 feet to 438 inches at 5000 feet. The highest recorded rainfall intensity was 17.4 inches in 24 hours. Studies were alsc done on fog drip and cloud patterns.

"To date, 13 of the families, including two very rare mosses, have been identified. The bulk of the bryoflora,

however has yet to be identified. A total of 49 families, including 136 species of vascular plants, 121 of which are native, have been included in a preliminary checklist of the vascular plants of the upper Hana and Koolau forest reserves. Among the specimens as yet unclassified are apparently nine as yet undescribed species.

"The entomological research was designed to provide a general understanding of the insect fauna and some of its ecological roles. Considerable work was done on the insects of the East Maui greensword thought to be extinct until more than 5000 specimens were found by project members. It was discovered that the larvae of a tephritid fly was infesting the apical meristems of nonblooming greesword plants. The presence of the larvae caused the young leaves to become sealed together in a conical shape, forming a shelter over the meristematic tissue on which the larvae feed. The amount of damage done runs from severe stunting to no apparent effect at all, and is possibly a function of the extent of blooming at the time of infestation.

"The following mammals (all exotic) were in the project study area: feral pigs, feral goats, feral cats, small Indian mongoose, rats and the house mouse. The overall limiting factors for each rodent species are most likely: adverse climatic conditions; availability of food; and interspecies competition for food and nesting sites. Predators were scarce and their effect on the rodents was negligible. Goats were found only in the upper Deschampsia grassland portion of the study area.

The places most drastically affected by the goats are the inside walls of the summit. Here Sophora tree-shrubs can be found growing only on cliff faces and other such areas inaccessible to goats. The project has recommended to the National Park Service that the feral goats should be totally eliminated from Haleakala by whatever practical means which does not affect the natural aspects of the native ecosystem. The Service has already taken preliminary action to fence the entire park and hopes to hire additional personnel for feral animal control. Feral pigs were found throughout the study area. The shrubland below Puu Alaea was literally laced with hundreds of pig trails which increase gully erosion during heavy winter rains. The project will recommend to the Department of Land and Natural Resources and to the National Park Service that control measures such as poisoning, chemosterilants, or intensive hunting should be considered for use in Hawaiian Forests.

"The purpose of the soils research was to characterize and classify the various soil types of the study area with special emphasis on the bogs. The investigation included describing the soils sampled physically and characterizing them by chemical analysis.

"Prior to the Hana Rain Forest Project, the Upper Hana and Koolau Forest Reserves had not been explored ornithologically. During the study new methods had to be developed for population counts in this dense forest. Notes were made on bird feeding habits and preferences, Also, significant work was done on the breeding biology of the Maui Creeper about which nothing was

previously known. The native bird fauna as a whole was most remarkable in that all but one of the native forest birds ever recorded on Maui were sighted.

"Undoubtedly one of the most striking achievements of the project was the discovery of a new bird genus since described as Melamprosops. When codiscoverers Tonnie Casey and James Jacobi first presented drawings of the unidentified bird to professional ornithologists, it seemed incredible that in 1973 a totally new species existed. The most astonishing aspect is that, prior to this discovery, no new forest bird had been found in Hawaii since before the turn of the century. A technical description of the new bird is being prepared for publication by Casey and Jacobi with the assistance of Dr. Dean Amadon of the American Museum of Natural History, the recognized authority on the taxonomy of Hawaiian Honeycreepers. It is the only known species in this new genus of the family Drepanididae, a family restricted to the Hawaiian Islands.

"The ecological study of the Hana and Koolau Forest Reserves is far from complete as many lifetimes could be spent observing and analyzing this unique native rain forest, one of Hawaii's last. We hope, however, that the achievements will encourage further research in the area. The final report of the Hana Rain Forest Project should be published in book form within a year and, as such, is expected to become the major reference work on the ecology of montane rain forest and bogs in Hawaii."

b. Develop pig control in the lower valley. A proposal has been submitted to implement an experimental approach to the control of feral pigs utilizing hunting, trapping or poison methods. This program hopes to discover the most effective means of control methods on the environment.

c. Extend inventory of lower Kipahulu Valley. A summer RBI project is proposed to begin in June 1975 which will provide checklists of the flora and fauna in most areas of Haleakala National Park. Transects are also planned for establishment in areas adjacent to Kipahulu Valley to obtain preliminary checklists and establish research methods which will have a minimum effect on the ecosystems of the Valley itself.

d. Upon invitation, provide information for Resources Management plans. This will be done as a matter of course unless a significant amount of unexpected effort and work is required. If such work becomes necessary, a proposal requesting additional funding will be prepared and submitted.

e. Develop monitoring of changes. After completion of the summer RBI work, it is planned the transects will be so described that they can be monitored at intervals to determine changes in vegetation, bird populations and insects.

AREA C. Rare and Endangered Species

Separately, Drs. Andrew J. Berger (University of Hawaii), Sheila Conant (currently Hawaii IBP) and James Smith (University of British Columbia) have proposed to conduct various ecological, behavioral and pathological studies of the flora and avifauna in Haleakala

and Volcanoes National Parks. This work should provide essential knowledge and understanding of the relationship between causes and effects of factors surrounding Hawaii's rare and endangered species.

1. Special group of qualified consultants

The following persons have agreed to work as informal consultants in the Unit's approach to the complex problems of rare and endangered species.

Dr. Jack Beardsley (Entomology)

Dr. Andrew Berger (Ornithology)

Dr. Hampton Carson (Genetics)

Dr. Sheila Conant (Ornithology)

Dr. F. R. Fosberg (Plants)

Dr. Wayne Gagne (Entomology)

Dr. Frank Howarth (Entomology)

Dr. Alison Kay (Marine Biology)

Dr. Robert Kinzie (Animal Ecology)

Dr. Yoshio Kondo (Terrestrial Molluscs)

Dr. Charles Lamoureux (Botany)

Dr. John Maciolek (Limnology)

Dr. Dieter Mueller-Dombois (Plant Ecology)

Dr. Clifford Smith (Botany)

Dr. Leighton Taylor (Marine Biology)

2. Accumulate, evaluate and refine lists of rare and endangered species. The work to be conducted during the Summer 1975 RBI project is designed to uncover new information pertinent to rare and endangered species. Refinement of the too many faults in the

insect list in the checklist of HVNP has been accomplished in manuscript.

3. Locate and describe stocks of rare and endangered species. The proposed work of Drs. Berger, Beardsley and C. Smith, as a summer project should aid in the location and description of the population and environment of further rare and endangered species of birds and plants in Haleakala National Park.

A proposal submitted by Dr. Charles Lamoureux entails locating and mapping the rare plants in Hawaii's Parks. This mapping project to begin in 1976 will take several years.

4. Determine causes of rarity and/or endangerment. A proposal to study the life histories of rare plant species in Hawaii is being submitted by a combination of the Research Group. Preliminary studies of rare species of plants would be made to categorize the probable environmental or physiological factors responsible for the rarity of the species.

5. Determine means of alleviating pressure against rare and endangered species or of propagating them. Upon completion of the summer RBI, the preliminary assessment and evaluation of the existing rare and endangered species recognized will be used in drawing plans for their preservation and propagation. Proposals for alleviating the causes of the rarity or endangerment can be then encouraged in accordance with priorities.

A proposal for the propagation of rare plants in Hawaii is being encouraged. This project, probably to be carried on initially at the Harold L. Lyon Arboretum, would seek to utilize a wide range of plant propagation methods (e.g., seed, cutting, air layer and tissue culture techniques) as the Wildlife Management program may require.

6. Define the factors controlling the territoriality of the endemic birds. Refer to the proposals of Conant and of Berger.

7. NENE project. Dr. Andrew Berger is currently attempting to determine the extent of predation by owls on NENE, alive or as carrion, in Haleakala National Park. This is being done now by examination of owl pellets, observations on possible predators, study of the NENE themselves in order to get information of use to management in Haleakala National Park in overcoming the decline in their populations.

AREA D. Biology of Exotic Plants and Feral Animals

1. Recommend visitor carrying capacity in some key areas.

Ms. Ruth Gay of the University of Hawaii Botany Department conducted a preliminary survey of visitor impact at one of the cabin sites located within Haleakala Crater. Her report follows; also, a proposal is being drafted by Ms. Gay for submission in the near future to continue the work.

A reconnaissance trip through Haleakala Crater and into the Upper Hana Rain Forest was made during the week of January 6 by Gay. Due to extremely adverse weather conditions, four days were spent at Paliku in the crater before entry into the Hana Rain Forest became possible. The single remaining day in the Rain Forest Area was insufficient to obtain information needed to set up a trail recovery survey. However, photographs and records of previous trail and campsite use in this area are being collected; so a future trip can determine the feasibility of a survey more easily.

During the four-day stay at Paliku, the campsite area was examined in terms of its potential as a key study area for determining carrying capacity through the measurement of impact by campers on the existing vegetation. The campsite area is located in an open scrub community on the lower, south-facing slope of the crater wall. It is a popular site for campers leaving the crater through the Kaupo Gap, for hunters traversing the Lauulu Trail and for visitors making the circle trip through the crater.

The majority of the herbaceous plants observed at the individual campsites were exotic species, which were found in even greater abundance around the nearby Paliku Cabin and along the long-established Lauulu Trail leading up the crater wall. The majority of the shrubs at the campsites were native species of more widespread distribution within the crater.

Various types of vegetation disturbance were observed at the nine casually established campsites within the designated campsite area. At campsites where shrubs were present, campers had cut into the woody vegetation to establish partially-protected sites along the generally exposed slope. A gradation of impact on herbaceous vegetation was suggested by the cover: different sites varied from erect, native bunch grasses to matted, native and exotic grasses and exotic herbs, to bare ground. These preliminary observations indicate that heavy camper impact at these sites could lead to:

a. a general reduction of native shrub cover,
b. the replacement of native herbaceous vegetation with exotic herbs and
c. erosional problems associated with the complete loss of ground cover.

A preliminary sketch of established campsite locations was drawn, and photographs of the general area and of specific campsites were taken using infrared and color film. A proposal is being prepared to determine the carrying capacity of these campsites through a monitoring system of campsite use and measurements of changes in the vegetation.

2. Preservation of the endemic tree populations on Kaupo Pali.

Preliminary investigations of the status of the endemic tree populations in the vicinity of Kaupo Gap have disclosed several factors which are thought to be instrumental in the decline of various endemic trees.

One of the most apparent deterrents to the regeneration of the growth of the MAMANE (Sophora chrysophylla) trees in this area are the large herds of feral goats. Kaupo Gap appears to be one of the most heavily goat-populated areas in the Park. The feeding behavior of the feral goat has not only prevented the MAMANE trees from regenerating but has opened up the land to the invasion of exotic plants such as Eupatorium and Hypocharis.

Another factor to be considered is possibly poor soil conditions due to erosion, rock slides and extreme weather.

An approach to the preservation of the endemic flora could be based upon these preliminary observations. An in-depth survey of the possible cause and effect of the apparent current floral decline will be implemented when funds are made available.

3. Complete Hiiaka burn study. Unfortunately management removal of Myrica faya from the study area (probably about 1974) has destroyed the usefulness of the Hiiaka Fire Burn area for natural

change studies; but while terminating the initial project, the removal does provide a unique control to maintain for comparison with adjacent areas. The Annual Report for 1969 of the NPS Office of Natural Science Studies includes a detailed report by Dr. Garrett Smathers "Hiiaka Fire Burn Study....(HAVO-N-14)" that concludes with the following details. The more significant findings are repeated here to provide a record for those relying on these Tehcnical Bulletins.

"a. The native phanerophytes and woody camaephytes exhibit some fire-resistance. This is especially evident among the hard-leaved forms. Possibly, this condition is closely associated with their origin and evolution in the dynamic environment, where fire and similar pyro-conditions have prevailed since the Hawaiian Islands first began to appear above the sea.

"b. The explosive growth and apparent secure position that the non-native broom-sedge grass holds in seral communities seem to indicate the presence of an open niche in the native communities. Preliminary investigations indicate a paucity of related native grass life forms which might also be fire-resistant or fire-propagated chamaephytes (or hemicryptophytes) and which would fill this particular niche in the native communities. The native UKI, a sedge of life form similar to the absent grasses co-dominated the original cover but was completely destroyed by the fire. The few specimens found in the 16-month observation period were those that were but superficially scorched at the time. No seedlings were seen.

"The Hiiaka fir has provided us with sufficient proof that Andropogon is among the most fire-adapted grasses known, a fact

that has been pointed out by Komarek (1965) and others. Thus, contrary to some previous suggestions, controlling Andropogon by fire does not seem likely to succeed--at least by direct means.

"The evidence of many open niches in the Hawaiian flora indicates the vulnerability of this insular flora to exotic invasion. Also, it points out the futility of trying to control some of the well-established nonnative plants which is sometimes unnecessary anyway. Here, in Hawaii Volcanoes National Park, the broom-sedge grass (Andropogon virginicus) has a unique history. It was not listed in Fagerlund's (1947) checklist of exotic plants in this Park. However, by inspecting the 1955 aerial photos used by Doty and Mueller-Dombois (1966), it was found to be a dominant or co-dominant in most of the vegetation types below 4500 feet about 12 years later.

"Another broom-sedge grass, A. glomeratus, which was first reported for the Park in 1961, tends to replace the A. virginicus communities. What was once an A. virginicus grassland in the Hilina Pali area of Hawaii Volcanoes in 1963, in 1969 was completely replaced with A. glomeratus.

"c. The native geophytes--mostly ferns--indicate a tolerance of fires, and some species such as the false staghorn fern may depend on firest for mat regeneration. Decadent mats of this fern, up to 2 meters thick, originally occupied the burn-site, and, also, dominated the ground cover. The fire-sweep removed this dead or low vigor material and did not harm the underground rhizomes. The appearance of new shoots from the rhizomes indicates the return

of this superior life form, and it seems likely that this native may eventually replace the Andropogon grass cover--providing there is not another fire or similar disturbance. Native life forms, such as the staghorn fern, may prove useful as biotic controls of some undesirable exotic species in certain types of communities.

"d. The flash appearance of nonnative therophytes (annuals) into the open, burned area indicates the environmental conditions that favor these forms and, also a paucity of species of this life form in the native flora. The fact that they were practically eliminated by the broom-sedge grass indicates the importance of some nonnative species in dynamic native communities. Here is an important area for additional research in the restoration or maintenance of some native vegetation types.

"More information is needed on the various disseminule sources and dispersal agencies. This is one of the most important aspects of any type of plant succession study. However, the following conclusions can be made with a fair degree of reliability:

(a) wind has been the most important agency in disseminule dispersal. This is especially true for both native and nonnative chameophytes (hemicryptophytes). It is probably the most important factor in the explosive spread of broom-sedge grass in some areas. There is evidence that strong winds have been able to carry small fruits, normally dispersed by birds or pigs, into the margins of the burned area. Here, the source is plants in the nearby unburned areas.

(b) birds and other animals account for very few new arrivals. Only some of the larger-fruited species, such as the native OHELO

(Vaccinium reticulatum) seedlings found toward the center of the burned area, could have been carried by animals.

(c) the large number of seedlings that appeared 9 months after the fire, especially broom-sedge grass and OHELO, suggests that some dormant seeds survived on the ground, and the fire-opened environment favored their germination and ecesis. Also, those species that were heavy seeders (especially Andropogon) tended to get established earlier and spread rapidly.

(d) most of the invasion along the fire-scar boundary is by the creeping-crawling life form types such as the nonative molasses grass and the native false staghorn fern. These forms are able to estend their range and cover by producing runners and vegetative shoots.

"Future planning for the now-abandoned study included quadrats and belt transects being analyzed annually; however, greater attention was to be given to the edaphic and biotic factors. A more intensive and extensive evaluation was to be made of disseminule sources and dispersal agencies. Major consideration was to be given to;

(a) evaluation of the phenological and dispersal characteristics of available disseminules.

(b) recognition and observation of disseminule sources and dispersal agencies relative to dispersal time and habitat conditions for germination and ecesis.

4. Continue the vegetation dynamics study of Kilauea Iki ash fall, the devastation area.

This project is in the hands of the National Park Service Science Center and is dropped from the Unit's list of projects.

5. Remove Tilapia and Restock Royal Fish Ponds, Honaunau.

This project has been completed insofar as the Unit is concerned.

6. Research on Andropogon ecology with management remifications.

Dr. Mueller-Dombois is currently studying the role of Andropogon and other exotic plants in endemic species recovery following management's commendable success in removing the goats. (See also Garrett Smather's conclusions about Andropogon invasion and ecology under no. 3 above).

7, Forecast fire effects in Hawaii Volcanoes National Park.

Refer to Garrett Smather's work above (Hiiaka Fire Burn Study). The Unit intends to continue work on this problem.

8. Ecology and biology of feral pigs. Refer also to Area B5, (Projects especially applicable to Kipahulu Valley).

Attempts to determine effective ways of feral pig control are being studied jointly by HVNP research biologist Mr. Ken Baker and management biologist Mr. Don Reeser. Various trapping techniques are being employed and evaluated for effectiveness. Hunting measures may be used at a later time to assist in reducing the pig populations of Hawaii Volcanoes National Park.

A proposal has been submitted to further implement the experimental approach being employed on Maui to control feral pigs by utilizing hunting, trapping or poison.

The results of this program should suggest more effective means of control, refined techniques of application, and the effect of control techniques on the environment.

9. Avian malaria. Dr. Andrew J. Berger has submitted a proposal to study avian pathobiology of the endemic birds of Haleakala National Park during the 03-year period. This project would include an analysis of the range of mosquito vectors, the rate of incidence of avian diseases at elevational extremes, and would certainly hope to accomplish a better understanding of the overall epizoology of avian diseases and their relationship to the endangered Hawaiian avifauna.

10. Exotic birds. Refer to the Berger and Conant proposals discussed in Area C, above.

11. Describe values of goat exclosures in terms of vegetation change. Dr. Mueller-Dombois is monitoring two goat exclosures in the Hilina Pali are of Volcanoes National Park. This monitoring of changes in vegetation cover is an ongoing project funded by the Unit.

AREA E. Resources Management Development

1. Carrying capacity. Ms. Ruth Gay has begun preliminary work in Haleakala National Park in the Paliku area on carrying capacity, and is now preparing a proposal for further work (refer to Area D above).

2. Modification of resources management plans. National Park Service Cooperative Unit staff have maintained close contact with Park personnel and are ready to offer what advice or help they can in updating Park resource management plans. As the work of

the Unit expands we envision that the results of the research to be conducted will be extrapolated into management schemes.

3. Biological control of feral pigs and population monitoring. (Refer to Cooperative Unit plans outlined in Area B5 for projects especially applicable to Kipahulu Valley).

4. Develop restocking methods for native species. Stephen Montgomery has submitted a proposal to include propagation of Hibiscadelphis, a rare and endangered plant (See Area C-5, above in the Unit's program). Also, a specific project is being carried out over the next few months, funded by the Unit, to obtain a better understanding of the causes of stability or decline of the NENE populations in Haleakala National Park.