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KĪPAHULU VALLEY RESEARCH PLAN

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PREFACE

This proposal of research alternatives is written in response to the Haleakala National Park Natural Resources Project Statement, HALE-N-8. The purpose of the project is to "develop acceptable methods for studying Kīpahulu Valley which take into consideration the valley's fragile nature, and secondly, to determine changes that may have occurred since the 1967 discoveries." This report involves defining "objectives and guidelines which will permit further research to be conducted in Kīpahulu Valley by Service-sponsored researchers [in a manner] that will safeguard the endemic flora and fauna from all undesirable outside influences."

NPS management of Kīpahulu Valley, as discussed in the Park's Draft Statement for Management, indicates that this area is to be managed as a permanent scientific research reserve of international significance and that it is to be isolated and carefully restricted to insure the perpetuation of its natural ecological state.

However, because of past and present human activity in the Hawaiian Islands, various negative influences are becoming evident in the valley. The Park's Resource Managers need hard baseline information on the area's ecosystems and some form of resource assessment procedure so that timely actions can be taken to control and reduce degradation of the resources. This information would be most suitably provided by scientists working closely with Park Management. In carrying out this type of field research there is potential for causing additional impacts upon the fragile resources.

To evaluate the relationship between scientific information to be gathered and environmental impacts which may result from research activities, four alternative approaches are presented for consideration. These are supplemented by draft guidelines for authorizing entry into Kīpahulu Valley and other sensitive areas within Haleakala National Park (Appendix I).

INTRODUCTION

Kīpahulu Valley has a mystique which surpasses that for almost any other area of the Hawaiian Islands. This is particularly true for the environmentally conscious and those who want to get back to a more "natural" way of living. Among native Hawaiians, however, other areas have much greater appeal and meaning to them. However, for those in the mainstream of American culture, Kīpahulu Valley is the ultimate extension of the pristine life-style of the Hāna area of East Maui.

Few have traversed the valley and those who have are generally unwilling to quickly repeat the hardships. The satisfaction of having been there is a mixture of relief from having survived the rigors of the area and the intense excitement which is generated by observing many of the organisms found in the valley. However, it needs a scientist, or someone well-versed in Hawaiian natural history, to really appreciate the virtues of the valley.

The reputation of Kīpahulu Valley was undoubtedly enhanced by the Scientific Report of the Kīpahulu Valley Expedition (Warner 1967). This report, though extolling the pristine nature of the valley and the unique collection of organisms present, gave little idea of the problems that the Expedition faced. The report did mention that one night they had very nearly nine inches of rain and that the terrain was "difficult" and "taxing." Yet the impression that one gains from reading the report is that it was a rather jolly affair. The personal comments of the participants of the 1976 expedition and also several references to Kīpahulu Valley in the files of Haleakalā National Park make it quite obvious that the conditions in the valley demand the greatest respect of anybody about to enter the area. The terrain is difficult and can quickly change from boggy conditions to thick dense vegetation. Within the dense vegetation, there is great

uncertainty as to one's footing because numerous deep, steep-walled gullies intersect the valley with an alarming frequency. In many instances these gullies are impossible to see and hidden lava tubes and sink holes compound the dangers. The denseness of the vegetation makes movement within the valley very difficult, particularly for those people who are carrying backpacks, or any other accessory equipment, etc.

Finally, the almost incessant rainfall dampens one's clothing and spirits very rapidly. Though Warner (1967) concludes the "continually wet clothing and muddy hiking conditions to be the principal difficulties," the fact of the matter is that Kīpahulu Valley is an extremely difficult area in which to operate, let alone to carry out any serious scientific investigation.

LOCATION AND PHYSICAL DESCRIPTION

Kīpahulu Valley is located on the eastern slopes of Haleakalā (Figure 1). The valley extends from about 1,000 ft (300 m) above sea level at 'Ohe'o in a northwesterly direction to Pōhakupālaha and Haleakalā Crater at about 7,350 ft (2240 m). Apart from Kīpahulu Valley, the Kipahulu District of Haleakala National Park also includes the Hāna Rain Forest (formerly the upper portion of the Hana Forest Reserve) to the east of Pōhakupālaha, a considerable portion to the south and east of Kuiki, the eastern *Deschampsia* grasslands of Kalapawili Ridge, and a segment of the ridge descending from Kaumakani to the ocean.

Kīpahulu Valley proper has a floor with two levels separated by a sharp discontinuity, generally referred to as the central ridge or pali. The northern segment of the valley is about 600 ft (180 m) lower than the southern segment of the valley. Both sides of the valley are bound by steep precipitous cliffs or palis, which further isolate the valley from the surrounding regions. Although much of the area is more swampy than not, the valley is cut by two major drainages, the southern segment of the valley being drained by Koukouai Stream, the northern segment by Palikea Stream. However, as mentioned in the introduction, there are many minor streams and gullies which crisscross the valley at all levels.

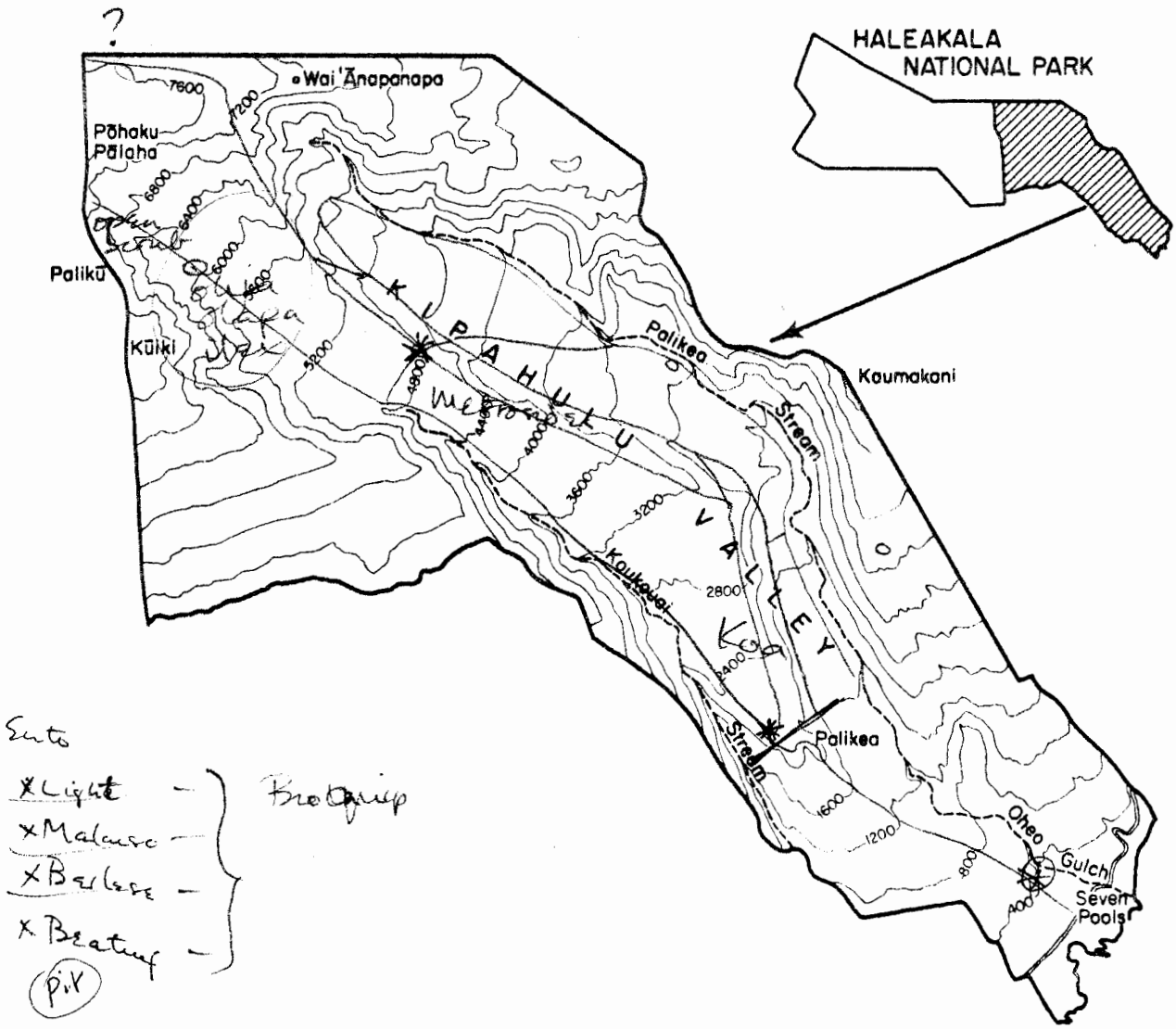

FIGURE 1. Map showing location of Kipahulu District of Haleakala National Park, Maui.

LITERATURE REVIEW

The first major report of any consequence describing the biology of Kīpahulu Valley was the Scientific Report of the Kīpahulu Valley Expedition (Warner 1967). This report details major aspects of the ecology, botany, entomology, ornithology, and mammalogy of the valley. Since 1967 several other minor reports have been published on work conducted in the general area.

Soils

There are four principal soil types in the Kīpahulu District of Haleakalā National Park (USDA 1972). The lower portion of Kīpahulu Valley, i.e. below 1600 ft (490 m), has a Maka'alae silty clay. This soil has an upper layer about ten inches thick, with moderate permeability; there is only a slight hazard of erosion.

The major portion of the valley, the forested areas of the slopes of Kuiki, and part of the forest region of the Hāna Rain Forest have a Hydrandepts-Tropaquods soil association. The soil is well- to poorly drained and has developed from volcanic ash, cinder, and other igneous rock. This soil association normally supports a very heavily-vegetated forest. Disturbance of the vegetation can result in severe erosion. A more serious threat to the area comes from the irreversible changes which occur in the soil when it dries out. However, dehydration is unlikely to occur, even in the severest drought, unless the vegetation has been disturbed quite considerably.

Kaumakani Ridge, the pali separating the two levels of Kīpahulu Valley, the Wai'ānapanapa area, the head of Kīpahulu Valley, and portions of the slopes of Kuiki are classified as rough, mountainous land. Generally, the surface is not very stony but the soil is not deep; however, in some areas it may be over one meter in depth. The erosion hazard is high, particularly when the ground cover is disturbed.

Finally, the upper slopes of Kuiki are covered by what has been called cinderland which is an aggregation of material from cinder cones and magmatic ejecta. However, the activity of feral goats and pigs at the summit of Kuiki has reduced approximately ten acres of cinderland into a very stony and rocky area with little or no soil or other material, interspersed with a very sparse, heavily grazed scrub.

Climate

Because of the difficulty of access of Kīpahulu Valley precise information on the climate of the valley is unavailable. The average annual rainfall is about 68 inches (180 cm) at sea level and conservatively approximated at 200 inches (510 cm) in the upper reaches of the valley (Tagliaferro 1959). Little is known about fog drip; however, it is extensive and may even exceed rainfall in total volume.

The heaviest rains in the valley occur during winter storms from October to April. According to most people familiar with the area, the driest portion of the year is August and September (see also USGS 1976).

The surface winds in the valley tend to blow up the valley from the northeasterly tradewinds which average 18 knots/hour. Most of the winds come from the north to northeast, and the general tendency is for the winds to be funneled up the valley and spill over into Haleakalā Crater above Palikū.

Although the average temperatures decrease with increasing elevation (Table 1), frost remains a rare occurrence and is limited to valley headwalls above 6,000 to 7,000 ft (2000-2300 m) elevation. The calculated temperatures at the head of the valley are approximately 20°F (11°C) lower than those at sea level.

The closest monitoring station for evaluating the temperatures at the head of Kīpahulu Valley is the summit weather station at 10,000 ft (3050 m). The temperatures at

TABLE 1. The average maximum and minimum winter and summer temperatures for four stations in Haleakala National Park.

Location	Winter		Summer	
	°F	°C	°F	°C
HALEAKALA SUMMIT				
Minimum	28	-3	32	0
Maximum	45	7	60	16
HEAD OF VALLEY (calculated*)				
Minimum	37	3	41	5
Maximum	54	12	69	21
SEA LEVEL				
Minimum	60	16	69	21
Maximum	80	27	85	29
PARK HEADQUARTERS				
Minimum	34	1	38	3
Maximum	69	21	85	29

*Calculated using the adiabatic lapse rate of 3°F/1000 ft.

the head of the valley at approximately 7,000 ft (2130 m) should be significantly higher than at the summit and may approximate those at Park Headquarters which is at a similar elevation. The adiabatic lapse rate for the average temperature per thousand feet is 3°F/1000 ft. The calculated values given in Table 1 are probably quite accurate because the area is above the inversion layer and not subject to insulation by clouds. For a further discussion of the use of lapse rates in determining average temperatures in Kīpahulu Valley see Smathers (1967, p. 82).

Terrestrial Ecosystems

1. Plant communities

There are several papers describing the plant communities within the Kīpahulu District: Forehand (1970), Vogl (1971), Vogl and Henrickson (1971), DeWreede (1967), Jacobi (1976), Smathers (1967), and Higashino and Mizuno (1976). All are preliminary in nature and discuss the general community types within the valley. The only quantitative study to date is Forehand's (1970) analysis of the alpine tussock grassland on Kalapawili Ridge. This study has been used as a baseline for some work by Jacobi (1976), studying the influence of feral pigs on the alpine grassland. Though this latter work is not complete, the impact of feral pigs in the area has been quantitatively assessed by Jacobi. Pigs appear to have an extremely destructive impact on high-elevation grasslands by disturbing the native plants and substratum and allowing exotic plants to invade the area.

Vogl (1971) described four community types on the northeast outer slopes of Haleakala: the tussock grassland dominated by the mountain pili grass *Deschampsia;* the montane bogs dominated by *Carex montis-eeka* and *Deschampsia;* the heath scrub dominated by species of *Vaccinium* and *Styphelia tameiameiae;* and the montane forest dominated by 'ōhi'a-lehua *(Metrosideros collina)*. These general community

types are probably applicable to the undisturbed areas of the summit of Kuiki and the rough, mountainous terrain skirting the head of Kīpahulu Valley.

In preliminary assessment of the vegetation of Kīpahulu Valley using aerial photographs and minimal ground proofing, Smathers (1967) described and mapped 19 vegetation types within the valley. He also provided a topographic vegetation profile of Kīpahulu Valley. Most of the vegetation types are described in some detail with regard to the dominant species present and frequently some cover estimates are also given using a modifed Braun-Blanquet technique. The impact of four main ecological factors--climate, physiography, soil, and the living organisms--was assessed for each vegetation type. This analysis is perhaps the most complete to date and is a very useful preliminary description of the ecology of Kīpahulu Valley. It is by no means complete and much further work needs to be done.

2. Plant species present

Table 2 summarizes the current knowledge of the number of species of plants within the Kīpahulu Valley area.

If anything, the flora of ferns and flowering plants within Kīpahulu Valley and adjacent areas is known with a certain degree of completeness. Personal communication with Lamoureux and others has suggested that further expeditions will undoubtedly turn up some new species or additions to the checklist; however, these additions will have little substantive effect upon our knowledge of the area. Reference to Table 2 demonstrates the very high proportion of native species within the Kīpahulu Valley ecosystem. It should also be noted that at least 75% of the exotic flowering plants found within the valley were recorded by Kjargaard et al. (1975) whose study covered the lower portion of Kīpahulu Valley, i.e., that area which is now grazed and severely disturbed by agricultural practices and other human disturbances. The best way to describe the flora of

TABLE 2. The number of native and exotic species of ferns and flowering plants in the Kipahulu District of Haleakala National Park. Lamoureux (1967) is used as the baseline list. Only new records are added from subsequent papers.

Source	Area Studied	Ferns and Fern Allies		Flowering Plants	
		Native	Exotic	Native	Exotic
Lamoureux 1967	Kīpahulu Valley	79	1	150	27
Henrickson 1971	Outer NE slope, Haleakalā	7	1	19	8
Higashino and Mizuno 1977	Kuiki (western side)	3	0	6	2
Lamoureux and Stemmermann 1976	Kīpahulu Valley	0	0	2	0
St. John 1971	Kīpahulu Valley and NE slope	0	0	15	0
Kjargaard et al. 1975	Lower Kīpahulu Valley	4	3	20	71
		93	5	312	108

Kīpahulu Valley is that it is a very interesting, almost pristine, remnant of the Hawaiian flora, with an unusual number of rare and endangered species.

Hoe (1967) reported 70 species of moss collected in the valley. However, he cautions that the reported flora can only be considered provisional. He further suggests that the number of species present in the valley could well be double the current record. No records of liverworts of lichens are available.

3. Animals

A. Insects

There are a number of papers on the insect fauna of Kīpahulu Valley, including Carson (1967), Iwamoto (1967), Wilson (1967), Kjargaard et al. (1975), and Kinzie and Ford (1977). These lists produce a very fragmented picture of a fauna which appears to be extremely rich and very poorly known. All the reports that have been made to date discuss the lack of adequate coverage of the groups collected and the area studied. There are several putative new species from the valley which will remain tentative until further adequate collections are made.* All of the reports also note the extremely interesting fauna collected within the area and suggest that a more comprehensive entomological survey be carried out in this valley.

B. Birds

Two important papers on the avifauna of Kīpahulu Valley were published in the Scientific Report of the Kīpahulu Valley Expedition (1967). The first paper by Banko (1967) reported the rediscovery of the Maui Nukupu'u and one sighting of the Maui Parrotbill. The report summarizes that "the

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*D. Elmo Hardy, Senior Professor, Entomology, University of Hawaii at Manoa, personal communication.

occurrence of four rare birds in Kīpahulu Valley, one previously considered extinct, points up the importance of retaining this area in a natural condition...." Warner (1967) discusses some basic interactions of the endemic species of birds and plants in the valley, noting the feeding biology of seven species in relation to the plants. Apart from this, very few studies have been carried out on the birds of Kīpahulu Valley. We really do not have any idea of the population size or distribution of any of the species in the valley. It is probably of some importance that the distribution and population size of the Maui Nukupu'u and Maui Parrotbill be assessed as soon as possible. (The U.S. Fish and Wildlife Service plans to enter the valley for this purpose in 1980).

C. Mammals

There are several reports which deal with the mammals of Kīpahulu Valley and adjacent areas. However, the five most pertinent to the area being evaluated are Banko and Wilson (1967), Gon (1976), Jacobi (1976), Lamoureux and Stemmermann (1976), and Kinzie and Ford (1977). As noted by Banko and Wilson (1967), all of the mammals which exist in Kīpahulu Valley (with the possible exception of the native Hawaiian bat which has been reported from Manawainui) are introduced species. These include the feral pig and goat, three species of rat, one of mouse, and the mongoose. The mammals of immediate major concern for resources management within the valley are the feral goat and pig. The goats occur in the upper reaches of the valley in the rough, mountainous land which encircles the head of the valley and adjacent regions. In this area they have done considerable damage by disturbance of the steep, mountainous areas and browsing on the native plants including some rare and endangered species (Yocom 1967). Their interaction with the feral pig population at the summit of Kuiki (Gon 1976) has resulted in a very serious erosional problem where the

topsoil has been completely stripped from a significant area of the Kuiki summit, exposing underlying boulders and denuding the summit of most of its native vegetation. Jacobi (1976) discusses the impact of feral pigs on the alpine *Deschampsia* meadows of the outer north slopes of Haleakalā.

Lamoureux and Stemmermann (1976) and Kinzie and Ford (1977) have commented on the feral pig population in the lower portion of the valley. Lamoureux and Stemmermann (1976) were concerned with the very high population of pigs in the Palikea area of Kīpahulu Valley where the fern understory of the koa and *Metrosideros* forests has now been almost totally destroyed leaving only an extensive mud wallow. Kinzie and Ford (1977) expressed concern with the impact of feral pigs in the area bordering the Palikea Stream system and the impact of pig-induced erosion on the stream flora and fauna. They have noted that there is considerable evidence of siltation within the stream during heavy rains, which they have suggested may be the result of pig activity.

The mongoose and various species of rat could have a serious impact on the endemic bird population. However, little information is available on the size or interaction of the populations of either birds or mammals in the valley.

Freshwater Ecosystems

Within the Hāna Rain Forest just to the north side of the head of Kīpahulu Valley lie two small bodies of water, Wai'ānapanapa and Wai'ele'ele; which represent one of the rarest types of ecosystem within the State. Wai'ānapanapa probably dries up during long dry periods and is therefore considered a palustrine habitat. Wai'ele'ele can be considered a lacustrine habitat (a true lake) in that has several small streams flowing in, one stream flowing out of it, and probably does not dry up during long periods of drought. Maciolek (1967) briefly described the flora

and fauna of these two high-elevation lakes, commenting that they were both species-poor but supported large populations of the species that were present.

Two major streams drain Kīpahulu Valley: Palikea Stream to the north and Koukouai Stream to the south. The only stream to have been analyzed in any detail is the Palikea Stream system (Kinzie and Ford 1977). Their qualitative analysis of 'Ohe'o, Pīpīwai, and Palikea Streams as high as the USGS gauging station (1546 ft [471 m]) indicates a low diversity of species though Pīpīwai has a much higher species diversity than the other two. However, one of the species encountered in Pīpīwai Stream was the endemic goby *Lentipes concolor* ('o'opu 'alamo'o), listed as rare and endangered by the Endangered Species Committee of the American Fisheries Society (Miller 1972).

All of these freshwater ecosystems are extremely delicate and potentially unstable. As pointed out by Kinzie and Ford (1977), there is a danger that any activity or unnatural processes within the valley could have an adverse impact upon the Palikea Stream system. Another problem is that because the number of species is low the loss or impairment of one species could have serious repercussions on all the species present. There is particular concern with the situation in Kīpahulu Valley at present due to an increase in siltation especially in the 'Ohe'o Gulch area. The increased siltation will have an effect upon the ability of the benthic (attached) algae to survive which in turn will affect the food supply of the stream's animal population. If siltation continues to increase at the rate that it has recently, the total ecosystem of the Palikea Stream system could be seriously disturbed within a very short period of time.

CONCLUSION

Much of the Kīpahulu District of Haleakala National Park represents unique and fragile ecosystems containing many rare and endangered plant and animal species, areas about which we have great gaps of information. One such area is the Hāna Rain Forest, which has been studied in some detail by an NSF-sponsored Student Originated Studies Team led by John Kjargaard. Unfortunately, their findings are not yet available. Apart from that study the status outlined in Figure 2 is correct.

Our understanding of the ecology of the area is weaker than our knowledge of the major groups of organisms present. All of the plant communities studied have been described in very general, though sometimes semi-quantitative, terms. These descriptions are far from adequate as baseline information.

Considerable attention in past literature has been paid to the pristine nature of the middle section of Kīpahulu Valley. At the same time, inferences have been made that the valley ecosystem is very delicate. This latter point appears to be an overstatement. The 1976 expedition had great difficulty locating the 1967 trail which indicates that regeneration in the rain forest is rapid and effective. The activities of the 1967 Nature Conservancy Expedition were quite considerable in that a substantial trail was blazed up the valley and used extensively. Short-term activities in the area, therefore, appear to be acceptable as long as adequate precautions are taken. Continuous activity in a particular area, e.g., trails, campsites, etc., over a number of years is another matter.

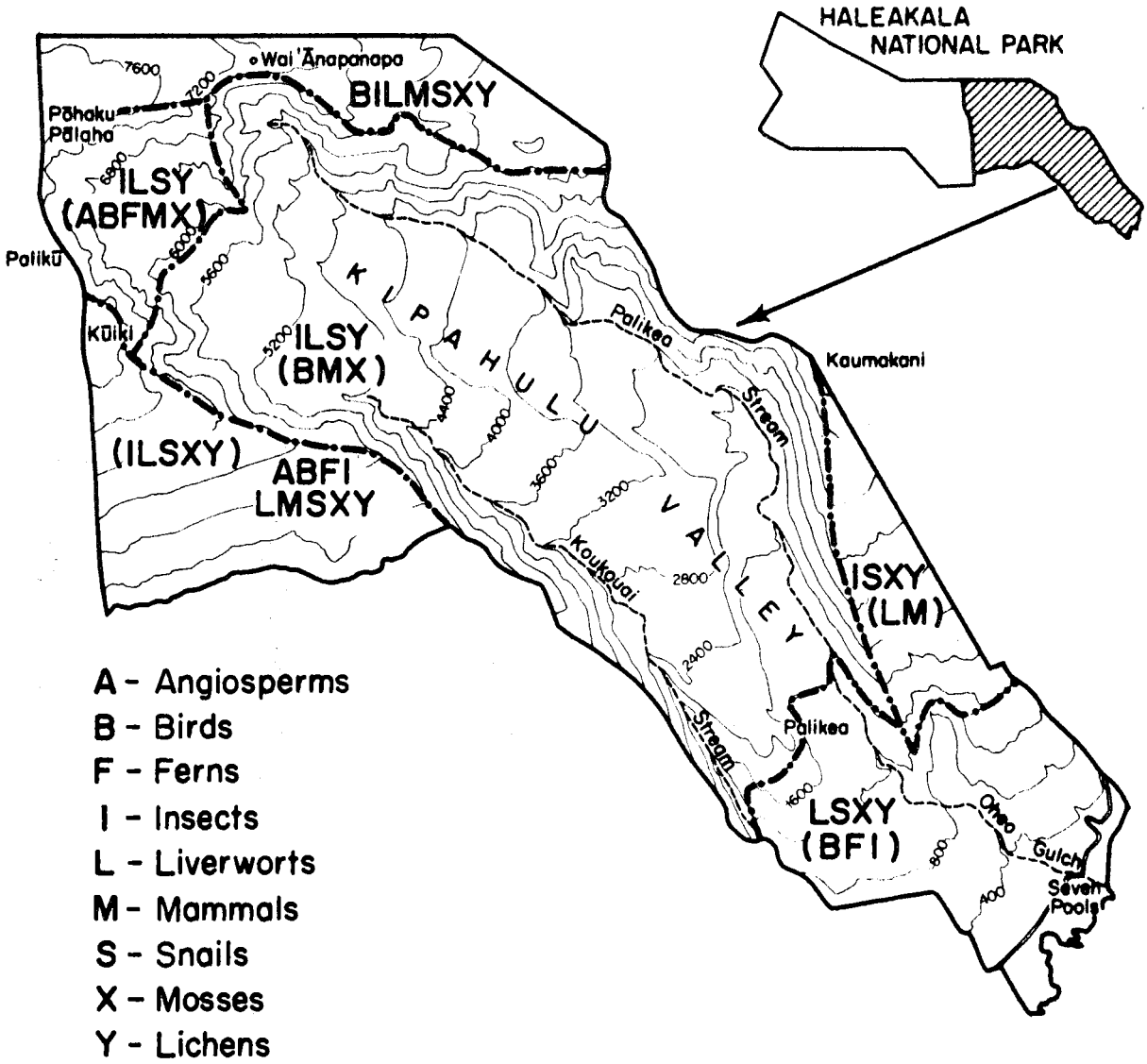

FIGURE 2. Map of the Kipahulu District of Haleakala National Park, Maui. The letters indicate the groups about which we have little information in the respective areas. Letters in parentheses indicate that information is available but inadequate. The Wai'ānapanapa area has been studied but the information has not yet been published.

RESEARCH ALTERNAT

Four alternative approaches are suggested and discussed. They are:

A. To allow no research in the protected area of Kīpahulu Valley. Research conducted in adjacent areas would be extrapolated to the valley if information for management purposes were needed;

B. To assess the status of the protected area of Kīpahulu Valley from aerial photographs. A short exploratory visit to the valley would be made to verify the interpretation of the aerial photographs. Small expeditions to monitor the valley would be conducted annually. Detailed on-site research would be conducted in similar adjacent areas only and the results extrapolated to the valley;

C. To conduct research on clearly established and defined resource management needs only. Other research would be conducted in adjacent areas. Included in this program are two possible methods that could be used to identify resource management problems;

D. To allow all bona fide research programs proposed for the Kīpahulu District. A comprehensive inventory of the natural resources in the entire Kīpahulu District would be sponsored by the National Park Service. A vegetation map, vegetation profile, and detailed ecological descriptions of the District would be produced.

The emphasis is on research in the restricted areas of Kīpahulu Valley proper. It has been assumed, perhaps incorrectly, that areas in the Kuiki and Hāna Rain Forest are less sacrosanct and that detailed on-site research activities in these areas will be possible. The lower reaches of Kīpahulu Valley, i.e., below 1,600 ft (490 m), have only been considered in Alternative D because the area is currently so heavily impacted by grazing and direct human activity.

ALTERNATIVE A

Program

This program would forbid any research activity in Kīpahulu Valley. All research activities would have to be conducted in adjacent areas of Haleakalā National Park.

Environmental Impact of Program

The absence of any research-related human activity in the pristine or protected areas of Kīpahulu Valley would result in no direct human impact upon the biotic resources; however, it would not preclude impact from emergency park operations or illegal trespass. Knowledge of the apparent negative impact of exotic organisms will remain largely unknown.

Discussion

Though the general resource management philosophy that "no management is good management" (alternatively called management by benign neglect) was generally followed prior to 1970, the acceptance of the Leopold Report (USDI 1970) in that year suggests that a more scientifically based management policy be established. However, this does not mean that areas have to be actively managed. The Leopold Report emphasizes that areas should be maintained in as pristine a condition as possible.

The implementation of this alternative simplifies park administration of the area since entry into the closed area would be limited to National Park Service personnel on emergency operations. However, our current knowledge of the valley ecosystems is incomplete and probably inadequate to support such a rigid policy.

There are indications that the resources within the valley are deteriorating as a consequence of the inroads

being made by exotics, particularly from the activities of feral pigs. For example, Lamoureux and Stemmermann (1976) specifically comment on two problems: the disturbance of the vegetation by feral pigs, and the invasion of disturbed areas by strawberry guava *(Psidium cattleianum)*. It is yet to be determined whether the strawberry guava is being actively disseminated by pigs or whether the invasion is a passive distribution following the path of pig activity, whereby the guava invades recently disturbed areas.

The pig damage to the rain forest is a problem in itself, but it also introduces secondary problems. For example, Kinzie and Ford (1977) refer to increased siltation in the Palikea Stream system in Kīpahulu Valley. In that report it is suggested that this impact should be considered a negative influence, because it is likely to have a deleterious impact on the endemic fauna of the stream. The increased rates of erosion themselves would be a problem in that topsoil would be removed and this in turn would have a negative impact on the recovery of the vegetation. Disturbance of this nature could result in the production of a grassland habitat or open barren areas.

The guava problem is of major significance. This species forms self-perpetuating thickets in most Hawaiian habitats. These thickets shade out the majority of other forms of plant life: thus the native forest eventually would be almost totally replaced.

Other possible problems could arise in the future. Unless some form of baseline study is completed, there will be no way to monitor changes and developing trends within the valley. If the valley is to be maintained in as pristine a condition as possible, changes to the ecosystem effected by agents introduced in historical times must be detected as early as possible. The longer a detrimental action is allowed to continue, the longer and more expensive the remedy. Also, the longer the disturbance, the less likely the system will revert to its original condition.

Finally, the acceptability of applying information obtained from surrounding areas to the problems of Kīpahulu Valley is questionable. The situation in Kīpahulu Valley is particularly subject to misinterpretation for two reasons. First, our current knowledge of the area is quite inadequate. Second, studies in Waiho'i (Kjargaard 1975) and in Manawainui (Peterson 1976) Valleys demonstrate a remarkable variation in biotypes over very short distances. It is also extremely unlikely that a research scientist would agree that results obtained in one area were applicable to another area unless there was substantial evidence to suggest that the two areas were similar.

ALTERNATIVE B

Program B

To allow no research or other activity in Kīpahulu Valley other than that necessary to monitor the area. Research required to provide information for the management of the natural resources would be conducted in adjacent areas and the results extrapolated to Kīpahulu Valley.

This program would provide a map of vegetation units with semiquantitative descriptions of each community. This map could serve as a baseline study for the assessment of future resource management policies. After completion of this study, no further research would be conducted in Kīpahulu Valley except that necessary to assess the status of the vegetation. Research would be allowed in areas adjacent to the valley, that is, Kuiki and the Hāna Rain Forest.

Environmental Impact of the Program

The impact of the research needed to conduct this program in Kīpahulu Valley would be minimal. Lamoureux and Stemmermann (1976) have concluded that the impact of the 1967 Nature Conservancy Expedition had essentially disappeared. The activities of the researchers needed in this alternative would have little or no lasting impact on the valley.

Discussion

The use of aerial reconnaissance photography in management of natural resources is increasing. One of its most frequently used applications to date is in the mapping of vegetation units within given areas. (As an example see Mueller-Dombois and Fosberg 1974.) For this purpose aerial photographs are eminently suitable, but all vegetation units so described

have to be verified by ground observations. Measurements of selected areas to quantify differences in the different vegetation units, if any, must also be made.

Photography effectively measures the upper stratum of vegetation that occurs in any particular area. In a forest this would be the tree canopy layer. In most instances there is no indication of the status of the understory vegetation. In a few instances, particularly when there are dramatic differences in the dominant tree species, educated guesses can be made of the structure of the gross morphology of the understory. However, in Kīpahulu Valley, where the dominant species in most areas are 'ōhi'a *(Metrosideros)* or koa, the ability to analyze the sub-canopy vegetation is minimal.

As a way of illustrating this particular point, reference is made to the Haleakalā National Park Crater District Resources Basic Inventory (Berger et al. 1975). Observations from the Palikū area give the impression that the surrounding cliffs are covered by a continuous mesic 'ōhi'a forest. However, closer analysis of the situation has shown that the area is dissected by deep gullies. Within these deep gullies there is a very different vegetation type. Personal communication with various people who are familiar with Kīpahulu Valley confirms that a similar situation exists in the valley proper. Within the valley there are numerous deep gullies which support a different vegetation type compared with the general forest floor. Since these drainages are not very wide, they are not observable using aerial photography.

Analysis of aerial photographs taken by the U-2 over the last three to four years, and those taken by the USDA Soil and Conservation Service over 12 years ago, have failed to demonstrate any significant structural changes in the canopy of the forest in the Palikea area of Kīpahulu Valley.

In 1967, the Nature Conservancy sponsored an expedition in Kīpahulu Valley which reported that there was a substantial understory of ferns in the Palikea area. Lamoureux and Stemmermann (1976), after a recent trip down Kīpahulu Valley, noted an almost total eradication of the fern understory in the Palikea area. The differences illustrated in the two reports cannot be attributed to different authorship. Lamoureux, an author of the latter report, was also present on the 1967 Kīpahulu Expedition. He remarked several times that the destruction of the understory in the Palikea area since 1967 is a major concern.

The lack of any evidence of this type of damage on aerial photographs taken over a 12-year period demonstrates that aerial reconnaissance on its own is unreliable as a natural resources monitoring tool in heavily forested regions. Ground observation is essential, and monitoring by people traveling through the forest is probably the most effective method.

A combination of aerial surveillance and on-site observation would be a realistic method for monitoring the valley. After the various ecological communities have been identified within the valley on aerial photographs, a small party would go down the valley, and each ecosystem would be subjectively sampled. In each community type, a number of relevés would be established. The species composition in each relevé would be recorded, along with the frequency of each species, using the Mueller-Dombois modification of the Braun-Blanquet technique (Mueller-Dombois and Ellenberg 1974). Though subjective, this procedure on analysis is fairly reliable. It is not very time-consuming, and does not require the use of large or cumbersome equipment. The sampling system is readily modifiable to measure the community structure in difficult terrain, and still yield meaningful results.

In Kīpahulu Valley, where movement is difficult, the working conditions are not optimal, and research activity is

to be kept to a minimum, the Braun-Blanquet technique is the most useful semiquantitative technique. More truly quantitative techniques require equipment that would be cumbersome or an extra burden on the researchers working in the valley's difficult conditions.

No attempt would be made to collect any samples, unless they were needed for taxonomic identification. No collections would be made for deposition in herbaria or verification of the ecologists' taxonomy. The research team would operate with minimum equipment to enable them to move about the valley as rapidly as possible.

This approach would concentrate on and analyze the status of the flowering plant communities only since it is assumed that significant resource management problems would have their immediate and greatest impact on this type vegetation. Invasion by feral animals and exotic plants would be evident before their impact on the ecosystem became dramatic as long as the research team visited the valley every year.

ALTERNATIVE C--RESEARCH ON RESOURCE MANAGEMENT PROBLEMS

Program

Research within the closed areas of Kīpahulu Valley would be restricted to monitoring the resources and investigating clearly identified resource-management problems. Research in other areas of Kīpahulu District would be allowed subject to the normal review procedures.

This alternative would require a formally established monitoring program including general observations from the upper or lower regions of the valley, and either (1) a program of annual or biennial treks down through the valley or (2) the production of a baseline map with descriptions (e.g., Alternative B) and consequent reconnaissance visits.

Environmental Impact of the Program

The environmental impact of resource management research would have to be identified in the research proposal. Once the methodology to be used is known, the consequences of its application can be assessed.

Monitoring activities in the valley should be inconsequential. A certain amount of trail and study site marking is inevitable but there are methods available which will not damage the ecosystem. A drawback to marked trails is that they would make illegal trespass into the valley easier and safer.

Monitoring

This program would be very dependent upon an adequate monitoring program. The assessment of resource management problems within the valley would best be accomplished by either of two methods.

1. Expeditions. A three-man team of at least one scientist and one National Park management officer, with an assistant to the scientist acting as collector-recorder, etc., would conduct expeditions through the valley, probably every two years, though there may be a case for suggesting annual programs.

2. Aerial reconnaissance. A program such as suggested in Alternative B would provide documentation for resource management decisions. It is considerably more expensive, but does not rely on the services of the few qualified people who have worked in the valley. They may have conflicts in schedules or be reluctant to visit the valley on such a regular basis. (It would also be less subjective.)

In either approach, stations should be set up at intervals through the valley at which photographic records would be taken by the expedition from known locations. These stations would act as formal recording stations for long-term analysis of the situation within the valley, although assessment would not be confined to them.

The establishment of formal sampling and recording sites would require that some form of trail and sitemarking system be devised, which would have a minimal impact upon the valley ecosystem. A reasonable plan could probably be devised without too much difficulty. The 1976 expedition noted that the marks of the 1967 xpedition were still visible in places. It would be assumed that if the party were to travel down through the valley every two years, the impact of the previous expedition would still be evident, if flags were used or physical marks were made on trees, etc.

There are other techniques which should also be implemented for assessing the situation within the valley. For example, Palikea and Koukouai Streams should be monitored every two to three months using turbidity plates, etc. If a reasonable program is established, these readings would give some measure of the amount of erosion that is taking place higher up in the valley. This is a problem

which has already been identified by Kinzie and Ford (1977). However, before this type of program could be instituted a certain amount of basic on-site research needs to be done to establish an adequate monitoring system. Once the research program has been completed, the monitoring could be carried out by the Park personnel at 'Ohe'o Gulch, Koukouai, and Palikea Streams.

Discussion

This program is in keeping with National Park Service sponsored research policy because it recommends research that addresses management needs. The choice of monitoring program to be used depends upon the documentation that will be needed to support initiation of a corrective resource management program. The semiquantitative approach (Alternative B) would provide evidence that would have a good chance of withstanding a legal challenge. The use of people familiar with the Kīpahulu Valley ecosystem relies on established reputations without any quantitative backup. The latter approach has a distinct advantage in that problems would tend to be identified earlier than in the former technique.

A major drawback to Alternative C is one that is inherent to almost all active resource management programs. Research addressing a resource management problem will study the problem and recommend remedial action. However, without an adequate understanding of the ecosystems involved, the impact of the initial problem, the research program, and consequent management activity could become a serious negative influence. The problem for the resource manager is that research on resource management problems may offer one or more solutions but without an adequate understanding of the ecosystems, the solution could itself produce a problem.

It is unfortunate that the adage "problems rarely come singly" is as true in natural areas as in human society. Previous management policies on fire in continental forests are a classical example in this respect. Recent experience in Hawaii Volcanoes National Park also illustrates the problem. The control of feral goats has increased plant growth much of which is highly combustible and a fire hazard. Coupled with this problem, many of the colonizing species are weeds. It has not been clearly established yet whether or not these weeds will be replaced by native shrubs and trees. The answer may not be available for ten years or more. Kīpahulu Valley, which is internationally recognized for its pristine endemic ecosystems and unique biological resources, is especially important in this respect. It is well known as a pristine area and an important biological resource. We do not have enough information to be able to answer questions such as "if we do x, then y will happen!"

However, the practical problems facing most resource managers cannot wait for comprehensive ecosystem analyses. Resource management plans are based on the best current knowledge. Management cannot wait for answers that may be ten to twenty years away. The possibility for catastrophe is too great.

ALTERNATIVE D--A FULL SCALE STUDY OF THE KĪPAHULU DISTRICT

Program

This approach to research within the valley would allow for all bona fide research programs which met Park Management needs. In addition, it could expand to accommodate non-management related research activities when these could be conducted in conjunction with an approved project and without any demonstrable negative impacts upon the resources. Initially, the National Park Service would sponsor a comprehensive RBI of the sensitive areas in segments. This would produce lists of species, their density and distribution, vegetation maps, profiles, and detailed quantitative ecological descriptions of each segment within the District. During this process management concerns and needs could be developed and appropriate research laid out to deal with them.

Environmental Impact of the Program

The impact of the research activities in the district would be dependent on the scale and scope of each program. The destructive effects of human activity in Kīpahulu Valley appear to have been overemphasized whereas the rigors of working in the valley and consequently the safety of operating there have been underemphasized. Lamoureux and Stemmermann (1976), whose main objective was to assess the impact of the 1967 Nature Conservancy Expedition, were effectively lost most of the time they were in the valley. This fact is highly significant because Lamoureux had been on the 1967 Expedition as had Terry Lind who is also a native of Kīpahulu and familiar with much of that region. Lind and John Kjargaard, another highly experienced person in Hawaiian rain forests, led the 1976 party down the valley. The only reasonable conclusion to this is that the vegetation had completely recovered.

Certain rules of conduct and procedure, above those normally enforced in the Park, should be established for entry into highly sensitive and closed areas (see Appendix I).

Discussion

This alternative would operate on the assumption that all responsible research in the District would directly or indirectly contribute to our understanding of the Kīpahulu ecosystem and thus lead to a continuously updated resources management plan. Inherent in this approach is an assumption that the benefits of bona fide and responsibly executed research will outweigh any negative effects of that research program on the environment. All research proposals should contain detailed descriptions of the research methodology and their probable impact before any work is permitted. It should also be expected that all research programs not sponsored by the National Park Service demonstrate that the research can only be conducted within the District. It should be noted that as more is known about an area there is a tendency for more research to be done in the area. The problems and possibilities identified in previous research programs encourage further investigation. This could result in a dual approach to research within the areas as follows:

1. National Park Service sponsored research would be conducted on projects directly relevant to resource management needs, and

2. other bona fide scientific research, which was not related to park management concerns, could be provided for under certain conditions and controls.

In order to survey the District properly, a full-scale inventory should be conducted. A comprehensive resources management plan cannot be devised unless the total resources of the area are known. However, the impact and cost of such an investigation would be seriously limiting factors on such an approach. The survey could not be carried out along

the lines of the recent Haleakala National Park Crater District Resources Basic Inventory, because access to the area and operation within it and very serious safety concerns are major obstacles. However, this does not mean that a reasonable plan cannot be devised and implemented that will be effective in producing a definitive assessment of the bioecology of the valley proper.

A comprehensive baseline study of the widest scope possible is the best available documentation that Park management could have to answer resource management questions, to fully identify problems, and to assess the impact of management activities in the district. The more complete our understanding of the district, the greater is the ability of resource managers to immediately respond to problems that may occur within the area. For several years now there has been discussion on the impact of weeds in Kīpahulu Valley. It would have been a relatively easy matter to check the present distribution of weeds against that previously recorded, if a baseline study had been conducted in the past and a report of the distribution or at least a baseline distribution map for all species had been prepared. From such an assessment a very rapid and valid evaluation could be made of a problem identified by some interested party.

As another example, the introduction of a pest to the ecosystem could be equally assessed in terms of its impact upon the ecosystem. Had the pest been previously unknown in the valley, then resource management activities might have to be instituted in order to control it if it entered the valley. However, had the species been previously recorded in the valley, it would be an unwise resource management practice to move in and carry out control procedures. The situation should first be evaluated to assess whether or not the threatening species had somehow gained an advantage. It might be in balance in that particular ecosystem. Though sometimes very useful, it is not possible to use information garnered from other areas

to totally assess the impact of any pest in an ecosystem such as Kipahulu Valley, particularly from the 2,000- the 6,000- 7,000-foot (610 m to 1,830 m or 2,130 m) level. An area of this nature has been poorly studied in most island ecosystems and the behavior of most exotic species in those circumstances is poorly known.

Finally, one cannot assess from what quarter some inquiry or challenge may be made to the park management concerning resource management activities in their domain. Currently the most sensitive areas are things such as rare and endangered species of plants and birds. However, if in future years some specialist in a rather obscure area comes here and is sufficiently vociferous, that person may be able to generate a considerable controversy concerning the validity of some resource management activity within the valley.

The scope of any survey should be as comprehensive as is possible with the personnel currently available to the CPSU at the University of Hawaii and elsewhere. The total survey would of necessity be long term, and would probably take ten years to complete. This is a long time for completion of such a project but it is necessary. Because of the attitude of most people about the area every precaution must be taken to ensure that each research program is in keeping with the National Park's objectives and the public concern. Segments of the proposal could be initiated at various times. The projects could be ranked in order of their priority for a comprehensive understanding of the valley, and should funds be unavailable in future years the projects of lower priority could be dropped. However, this does not mean that they should be dropped. Their priority could increase with the updating of the rare and endangered species lists of various groups. The current program within the Office of Endangered Species at Washington is to start with the higher organisms and work down phylogenetically. In future years this could mean that a project of relatively low priority such as an evaluation of

the lichen flora within the valley may be of some importance because of a recently declared list of rare and endangered species of lichens.

The Kīpahulu District is here arbitrarily subdivided into seven field regions:

1. the agricultural area at the base of the alley below 1,600 ft (490 m)
2. Kaumakani Ridge
3. Hāna Rain Forest
4. the head of Kīpahulu Valley above 6,000 ft (1830 m)
5. Kuiki
6. South platform of Kīpahulu Valley between 1,600 and 6,000 ft (490 and 1830 m)
7. North platform of Kīpahulu Valley between 1,600 and 6,000 ft (490 and 1830 m)

It may be appropriate to study each area separately and delay research in areas 6 and 7 until all other studies have been completed since this central valley area is one of the most significant biological resources in the state. By following the above approach the National Park Service would avoid impacting the central valley, while learning from mistakes, if there are any, in less fragile or dangerous areas. The extra time and the new information from these studies would allow for a more soundly based operation for research in the area if it were to be allowed at all. Such an approach would still require that the resources in the central valley area be monitored. It is recognized that there may be some research projects which do not lend themselves to this piecemeal approach. Justification for deviation from the above will be based on the individual merit of the specific proposal.

The two areas which should be surveyed first are areas 4 (the head of the valley) and 5 (Kuiki). Not much is known about either area though both are heavily impacted by goats and/or pigs in many places.

Area 3 (Hāna Rain Forest) has been the site of a large-scale scientific study though the results have not been published yet. Since most of the area studied is now under National Park Service jurisdiction it would be helpful if the Service would encourage and expedite the publication of the investigation reports.

Areas 1 (the base of the valley) and 2 (Kaumakani Ridge) have been surveyed in a preliminary manner. However, both areas need further study in order that the multiple uses to which these areas are put are neither inconsistent with the overall objectives of the National Park nor the breeding ground of organisms potentially hazardous for the wilderness areas.

Each area would be surveyed separately to provide at least:

1. a checklist of all species of birds, insects, molluscs and other invertebrates, mammals, flowering plants, ferns, mosses and liverworts, and lichens in the area

2. a vegetation and soils map of the area with supporting quantitative data describing the vegetation units identified in the area

3. recommendations on any current or potential resources management problems within the area

RECOMMENDATIONS

A reasonable position to take on these four alternatives would be to implement Alternative A or B immediately. If and when resources management problems are identified initiate Alternative C. Finally, in carefully controlled and monitored conditions begin sponsoring and/or allowing research projects which develop Alternative D. As any phase of Alternative D is initiated, provision should be made to monitor the impact of each research program for several years after its completion. If this monitoring is conducted, its ultimate product would be an evaluation of the susceptibility of the area to change after research activities with recommendations concerning future entry restrictions into the area.

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APPENDIX I

GUILDLINES PERTAINING TO AUTHORIZED ENTRY INTO SENSITIVE AREAS OF HALEAKALA NATIONAL PARK

Haleakala National Park and adjacent lands support numerous unique and fragile endemic ecosystems and niches which contain many rare and endangered plant and animal species, as well as a wealth of unique biological information. Loss of native habitat and pressure from aggressive exotic species--often abetted by man's activities--is a constant threat to these resources.

The 1967 Nature Conservancy expedition through Kīpahulu Valley recognized this threat and the scientific community recommended that indiscriminate entry not be allowed. This has been official park policy since 1969 when the area was added to the NPS, and it has subsequently been expanded to include the Hāna Rain Forest and other sensitive areas within the park.

Controlled entry for approved management programs and scientific research in support of these programs may be allowed under permit from the Area Manager. To minimize and control potential negative impacts upon park resources the following guidelines are in effect as part of the formal authorization to enter these sensitive areas.

Entry as well as deviations from these guidelines will be by written permit. Activities viewed as being detrimental to area resources will be terminated; however, comments from the scientific community will usually be sought as part of the review process. Failure to comply may result in future restrictions, and possible court citation. In some situations an NPS employee may be required to accompany or monitor the activity.

A. General

1. Party size is to be the smallest possible consistent with the activity and safety needs, but no smaller than two individuals.
2. Entry is limited to only those individuals essential to the activity--no free rides.
3. The time spent within the sensitive area is to be limited to only that which is necessary to accomplish the authorized activity.
4. Proposed activities are to be supported by a formal detailed request in writing to the Park Superintendent. Authorization to enter will not be given (in writing) until review and scientific consultation have been completed.
5. Requests must demonstrate (justify) that the activity can not be effectively conducted in other less sensitive areas.

6. Individual proposals may need to be supported by an Environmental Assessment--determination to be made during the review process.
7. Entry into specific econiches (e.g., small bogs, etc.) is prohibited without specific written authorization from the Area Manager.
8. Exotics (particularly the more aggressive species) found outside of their established range should be mapped and destroyed whenever time permits; however, care must be taken to avoid impacting native species or creating new seed beds.
9. A separate collecting permit, issued by the Area Manager, is required prior to taking of any specimens.
10. Discussion of authorized activities in Kīpahulu Valley, etc., should be considered sensitive and on a need to know basis since general public knowledge will tend to encourage unauthorized entry into these areas.

B. Decontamination

Obviously, the potential for accidental introduction of exotic species into nearly pristine endemic ecosystems is greatly increased by any activities within these areas. YOUR COOPERATION IS NEEDED TO KEEP THIS POTENTIAL TO A BARE MINIMUM.

1. General.--Every effort will be taken by participants to eliminate any opportunity for accidental introduction of exotic plants and animals and other foreign material.
   a. Clothing, footwear, packs, equipment, food supplies, etc., will be carefully inspected and cleaned of mud, seeds, leaves, insects, etc., prior to entering the park (preferably before arrival on Maui).
   b. Food items are not to contain viable seeds.
   c. In preparation for entering the area, participants are to avoid ingesting seeds 48 hours in advance (and don't munch on wild guava, thimbleberry, etc., while hiking along the trail).
2. *Clidemia hirta* is not present yet and we intend to keep it out since it can totally replace the native understory in wet upland areas. Seeds are small and inconspicuous and easily transported in the mud on lug soles, and possibly in folds and seams of equipment, clothing, etc.
   a. Footwear which has been used in areas where this exotic is known to be present are banned from use within the park.
   b. Clothing, packs, tents, etc., which have been used in areas with *Clidemia* should be thoroughly cleaned before arrival on Maui.
3. Local weed seeds may become attached to clothing, packs, etc., while enroute and these must be removed prior to entering the sensitive areas. The District Rangers will designate "dumping sites" for this which can then be monitored for appearance of exotic seedlings.

a. All clothing and gear being worn/carried externally should be shaken, brushed, and slapped clean of seeds, soil, vegetable matter, etc., that may have clung to them.

4. Helicopter operations are to be monitored by the Ranger in Charge. Passengers, baggage, and the 'copter's runners are to be checked for undesirable materials and decontaminated as appropriate prior to entering the sensitive areas.

C. Safety

Some areas of the park, and particularly Kīpahulu Valley, represent extreme safety hazards. To attempt a rescue within these areas poses major logistical problems and may prove to be nearly impossible. In addition to becoming a major safety problem in itself, this activity could seriously impact the fragile resources, open up new seed beds, and introduce exotics. Therefore, safety considerations must receive top priority in all aspects of the proposed activity.

1. All participants will be interviewed by the park for physical and mental fitness, planning, equipment, and contingency preparations to deal with emergencies.
2. The park is to be kept informed of itinerary and deviations from proposed travel routes, etc.
3. Communication arrangements are to be made with the park in advance of entry.
4. Field activities are to be conducted under a "buddy system."
5. Adequate first aid supplies are to be carried.

D. Movement Within the Area

1. Existing trails and natural openings are to be used whenever possible.
2. Cutting, brushing, or widening trails or openings is not permitted.
3. Widening areas to avoid muddy sections of trail is not permitted.
4. Under no circumstances are rare, threatened, or endangered species to be disturbed; activities are to be directed away from and around such specimens and negative impact avoided at all costs.

E. Camping

1. Camping sites are to be selected with the goal of lowest possible impact upon the area.
2. Camp sites are to be as compact as possible and local impact minimized by use of natural openings and avoidance of trampling native understory.
3. In order to monitor and control potential introduction of exotic species, camping sites will be limited and placement controlled by the park.

F. Trail Construction and Support Activities

1. Certain projects will require some low key trail construction or other support activities which will obviously have some local impact. These situations are to be approved in advance by the Area Manager and supervised by a person knowledgeable in native biota.
2. Trailcutters, etc., are to be taught in advance and on-site what to avoid chopping or impacting.
3. Under no circumstances are rare, threatened, or endangered species to be disturbed; impact upon native species in general is to be avoided wherever and whenever possible.
4. Use of flagging tape and color is to be cleared in advance. Unless authorized, it must be removed upon completion of the project.

G. Sanitation

1. Biodegradable wastes not containing exotic seeds may be buried in the top 6 inches of soil a minimum of 100 feet from any water source. All other trash, waste, equipment, etc., must be packed out and properly disposed.
2. When feasible, body wastes are to be deposited in a small pit, treated with chlorine tablets and periodically covered with a layer of fresh dirt. Such pit sites should be mapped for future monitoring for appearance of exotic seedlings.
3. Negative stool samples may be required prior to entering watershed areas.

H. Equipment and Personnel

It is recognized that nearly everyone has personal preferences when it comes to camping equipment. However, due to the extreme safety considerations certain items of field equipment (in good condition) will be required as a condition to entering the area.

1. At least one member who is experienced in travel in Hawaiian rainforests. The park may also require the presence of at least one member who is familiar with the local area.
2. A topographical map of the area.
3. An altimeter (compass is not always effective due to local magnetic anomalies).
4. Heavy duty raingear.
5. Adequate supply of food to last through unanticipated delays.
6. Approved first-aid supplies.
7. Adequate tenting or equivalent shelter.
8. Flashlight and extra batteries.
9. Well broken-in footwear; extra heavy duty socks; moleskin for blisters.
10. Adequate sleeping gear (dry) if staying overnight.
11. Contingency plan.
12. Etc.

Hugo H. Huntzinger
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