

## The Biological Resource Value of Native Forest in Hawaii with Special Reference to the Tropical Lowland Rainforest at Kalapana

by Dieter Mueller-Dombois

*A Report Prepared on Request of Bio Power Corporation  
President Mr. Warren Ramsey*

### INTRODUCTION

A public controversy has arisen over the recent logging and wood chipping operation in native forest at Kalapana. I got involved at a point where the argument of dispute was whether the forest at Kalapana was unique or not. The question of uniqueness is important with regard to future land management of this area, but uniqueness is not the only aspect worth considering. This I will explain later in my conclusions.

A sizeable segment of the interested public considers the forest unique, while the landowner (Campbell Estate Corporation) and the logging company (Bio Power Corporation) are not convinced of the uniqueness of this native forest. Therefore, more information was requested specifically by Mr. Warren Ramsey, the President of Bio Power Corporation, who agreed to mitigate his operation or entirely pull out of the area if more creditable evidence could be given.

Mr. Ramsey's request for such information came to me in form of a letter dated December 27, 1984. His letter was a response to a December 18 letter of mine, which summarized some of the points I had presented in prior meetings with Mr. Ramsey and two of his associates.

### THE COUNTER EVIDENCE

Regarding the 'ōhi'a forest's uniqueness Mr. Ramsey points out in his December 27 letter that the "overwhelming evidence is to the contrary". His statement is based on two documents, a 1957 report by L.W. Bryan entitled *Final Report, Lands of Kahaualea Puna, Hawaii* and on the 1974 *Master Plan for Hawaii Volcanoes National Park*. It is important to first look at this counterevidence, which presents Mr. Ramsey's and the landowner's main arguments against the uniqueness of this native forest in addition to the fact that the area was zoned by Hawaii State Authority as "Agricultural District" some 20 years ago, meaning that the area is legitimately to be used for commercial agriculture.

L.W. Bryan was Territorial Forester on the Big Island at a time when Hawaii was not yet the 50th State in the Union. His report was written for the Estate of James Campbell 28 years ago when there was still more native 'ōhi'a forest left and when there was no awareness as yet that native biota and their ecosystems could be considered a biological resource at some future date. His viewpoint reflects that of an American forester of his time. Slow growing native trees were thought to be of no particular value. Although Bryan refers to the fine forest with over 100 feet tall 'ōhi'a trees and

diameters up to 30 inches, he merely considers the *land* of value and not the forest with its associated native biota. Mr. Bryan discusses the soils and suggests that it would be good to get a bulldozer into the area for digging some trenches, so that one could get a better look at the soils and their potential for agricultural purposes. To use a bulldozer just for studying soil profiles in a native forest ecosystem would be unthinkable today. If a soil scientist or forester would use a bulldozer for such purpose in this day and age, such action would be considered a crime, because for carrying out field work in Hawaii, he would be expected to be better informed about the resource value of the native biota and their ecosystems. In brief, Mr. Bryan's report does indeed support the argument that there is nothing unique about the Kalapana forest. But his report is conceptually very much out of date. Few foresters in Hawaii today would attach such low value to a native 'ōhi'a forest.

The second document, the 1974 Master Plan for Hawaii Volcanoes National Park is only 11 years old. What does it say about the uniqueness of the Kalapana forest? Actually, not very much. The Master Plan refers to Tract 19, an area of some 2,666 acres adjoining the Park in the eastern lowland near Kalapana and suggests deletion of this land because it had earlier been subdivided for development. It is the area now known as the Royal Gardens Subdivision. The area contracted for chipping native 'ōhi'a forest is further to the east. It is quite conceivable therefore that one can draw the conclusion from the Park's Master Plan that the area in question is not unique.

However, if one looks at this document more objectively, it does not really devalue the Kalapana forest in question. It simply ignores it, and that is not surprising. The 1974 Master Plan gives much recognition to the geological features of the Park and does not go deeply into the question of native ecosystem representation within or near its boundaries. The Park has indeed no native lowland rainforest within its boundaries, and that is a major omission. It would have been very appropriate to suggest inclusion of this excellent native lowland rainforest now under contract for chipping. Use as a part of Hawaii Volcanoes National Park would be of far greater potential value for the State of Hawaii than its currently planned use for chipping. The area in question has high interpretive value for understanding Hawaiian rainforest dynamics in primary succession.

This is admittedly again a subjective evaluation on my part at this point, but I will make an effort to back up my assessment.

### EVIDENCE FOR UNIQUENESS SUMMARIZED IN EIGHT POINTS

1. I enclose the only overview vegetation map that currently exists of the Hawaiian Islands, *Exhibit 1*. — The map is a reproduction of Ripperton and Hosaka's (1942) "Vegetation Zones of Hawaii". On this map, the area in question near Kalapana falls into zone D<sup>1</sup> which stands for lowland tropical rainforest. It is here very close to zone C<sup>1</sup>, which refers to lowland mesophytic forest, a transition zone to leeward dry forest and scrub (zone B). The map gives the impression that there is plenty of D<sup>1</sup> = lowland rainforest left on the east-side of the Big Island. The zone stretches from near Kohala in the north in a narrow band along the windward coast to Hilo from where it becomes wider in its southern third to near Kalapana. However, as people acquainted with this territory know, most of this zone north of Hilo has been converted to sugarcane. Even south of Hilo much agriculturally utilizable land has up to now been in sugarcane, while around Keaau up to Mountain View, Pahoa, Kapoo and Kalapana there is rural development combined with agricultural use wherever recent volcanic surfaces allow such activity. The Kalapana lowland rainforest in question is indeed a remnant segment of this once more extensive natural vegetation zone. The rainforest along lower Steinback Highway cannot be considered equivalent since it is much more heavily invaded by alien tree species than the Kalapana rainforest remnant now contracted for chipping.

How about other areas in zone D<sup>1</sup>? There is only a very narrow belt of this zone on the Kona (the western) side of the Big Island. This area is totally converted to agricultural crop use, mostly coffee. And what about native forests in zone D<sup>1</sup> on Kauai, Oahu, Molokai, Lanai and Maui? There is none left as far as I know.

2. A second map perspective regarding the uniqueness of the Kalapana rainforest is given by *Exhibit 2*. It shows the eastern half of the Big Island and the location of 62 forest stand samples which were analysed for a study on the diversity of the montane 'ōhi'a rainforest in connection with the dieback problem. This sample plot map is accompanied by a foldout table which shows seven major vegetation types based on forest structure and species composition. The Kalapana forest in question was not included in this PhD dissertation research of N. Balakrishnan which is currently being completed. However, what this map and foldout table demonstrate clearly is that *not every 'ōhi'a forest is unique, but also that there are a number of unique forest types within even the montane rainforest*. Three of the major forest types are further subdivided at a higher level of similarity. The statistical validity of the differences of these forest types was derived through one of the most sophisticated current methods of multivariate analysis, called TWINSpan (Gauch 1982), a widely used computer program for automated classification. There is little doubt that the Kalapana lowland rainforest, if it were included with an adequate number of sample stands, would come out as a statistically unique forest type.

However, sampling the Kalapana forest with statistical adequacy would require at least two months of work. If this time was available now, the definitive proof of this forest's uniqueness could be given statistically.

3. A third map perspective is given by the enclosed colored map, *Exhibit 3*, which is the Fish & Wildlife Service vegetation map prepared by James D. Jacobi. On this larger-scale map, 2 cm represents approximately 1 km in the field. On map sheet B I have blocked out an area of approximately 460 acres, which in my estimation represents the Kalapana forest now cut over by Bio Power Corporation as of January 1, 1985. One can see on that map that the cut-over forest was mapped as two forest types, the shaded green-yellow part, which is the majority of the area, and the brownish yellow part on the southwest side which comes close to the 1977 lava flow drawn in purple. There is also a very dark colored strip which is recognized as young successional forest with tall *Metrosideros* trees. The shaded green-yellow area is identified as o3Me, 2nt (W:ns-tf-xg). This symbol refers to tall-statured open *Metrosideros* forest with a second story of native trees in a wet (= w) habitat (i.e., rainforest area) with native shrubs, some tree ferns and some exotic grasses in the understory. The brownish-yellow area is distinguished as a similarly tall *Metrosideros* rainforest but with a certain admixture of kukui trees (*Aleurites moluccana*) and a few other exotic (= non-native) trees and shrubs in its understory. In other words, with regard to native species composition the brownish-yellow forest area is not quite as pure and thus less valuable than the shaded green-yellow area. The shaded green-yellow area covers much more territory north of the recent lava flow activity. However, most of this is in montane rainforest, i.e. vegetation zone D<sup>2</sup> as identified on Ripperton and Hosaka's vegetation map. Only a small portion lies below 1500 feet elevation, which is the approximate boundary between lowland and montane rainforest in this area. Moreover, what speaks further for the biological resource value of the lowland rainforest near Kalapana is its proximity to the area with recent lava flow activity.
4. This brings me to the next point, the "seed source" factor which is important for the recovery of new volcanic surfaces. I have no direct evidence that the approximately 460 acres of native forest now already removed from this lowland territory will slow and/or alter the invasion processes of native vegetation on the recent lava flows nearby. ~~But the removal of 3,300 acres of *Metrosideros* forest in this area, as is anticipated under the present contract, will have a definite impact. I can make this prediction by referring to *Exhibit 4*, which is the first installment of a longer-term study relating to the "invasion and recovery of vegetation after a volcanic eruption in Hawaii". A large segment of montane rainforest was destroyed in winter 1959/60 in the "Devastation Area" of Hawaii Volcanoes National Park. Much of the forest there, which was buried under only 50 cm of ash, recovered following this volcanic disturbance. But the recovery of this disturbed forest was mostly in form of vegetative and foliar recovery. As far as anyone knows, this forest has flowered only sparsely and thus produced little or no seed during the past 25 years. Therefore, this *Metrosideros* forest has not yet recovered as a seed source for the adjacent denuded area. To the lee of the disturbed forest is the Kilauea Caldera and the Kau Desert, both are barren of trees and thus represent a naturally denuded territory. The recovery process of the "Devastation Area" has been monitored since 1960. Currently, one of my students is producing an MSc Thesis on this area. What is~~

remarkable here is that *Metrosideros* seedlings have only sparingly become established thus far in spite of an intact *Metrosideros* forest on one side of this volcanically denuded habitat. This example is contrary to other volcanically disturbed areas in the rainforest territory of Hawaii where large cohorts (= one-generation stands) of seedlings have invaded soon after deposition of new volcanic substrates (for example, on the 1955 and 1960 Puna lava flows). From these examples we can conclude that denuding of larger areas (in excess of 1000 acres) around volcanic lava flows and ash deposits will have a marked effect by slowing down or altering the process of invasion and recovery. There is little difference whether removal of seed sources is from volcanic catastrophies or from logging operations, the outcome will be similar. But I question the land use rationale for allowing man-made denudation to add to the natural ones in this area where natural landscars are of frequent and predictable recurrence. The recovery process of new volcanic surfaces with locally adapted native species and communities is a "free service of nature" that we should be very careful not to interfere with. Otherwise we may end up with near permanent landscars, or those that are invaded only by weeds. Man-made restoration to replace these free services of nature would be very costly indeed.

5. In my December 18 letter I pointed out that 'ōhi'a (*Metrosideros polymorpha*) is not a uniform species, but instead is made up of a number of physiologically and genetically different varieties. Evidence for this is given in *Exhibit 5*, which contains two scientific publications on this subject. The 1973 paper by Corn and Hiesey presents the discovery that 'ōhi'a consists of altitudinal races with adaptations to different temperature regimes. Therefore, we can speak of warm-lowland adapted races of 'ōhi'a such as occur naturally in the Kalapana area. A more recent discovery is presented in the 1983 paper by Stemmermann, which points out that 'ōhi'a is split into races also within the same altitudinal belt and further that these races show adaptations to different soils or substrates. Moreover, these edaphic or differently soil-adapted varieties seem to replace each other along a substrate-age gradient. This implies that we can speak of pioneer varieties and successional varieties of 'ōhi'a. These act like different successional species in continental ecosystems, where pines are followed by spruces and later by firs in a successional sequence. This is a remarkable new discovery about the peculiarity of an island ecosystem, which is currently gaining national and international attention. On a local level this means that in order to determine the uniqueness vs. similarity among 'ōhi'a forests in Hawaii, we now have to consider also the varietal composition of 'ōhi'a in each sample stand.

6. Another point of uniqueness relates to the bird fauna associated with the native lowland rainforest ecosystem at Kalapana. It has been said that the native Hawaiian bird species of the Honeycreeper family (the Depranididae) are now largely restricted to the upper montane forest remnants above the 1500 meter contour line (= 4918 feet), because bird malaria is thought to be a limiting factor taking its toll in the more disturbed lowland forests. This observation has been contradicted by recent observations in the lowland forests near Kalapana. *Exhibit 6*. In her 1980 report, Dr. Sheila Conant recorded six endemic bird species from the Kalapana Extension, which is in

the lowland and not far from the logged area. A more recent report in the 'Elepaio Vol. 45 (6): 49 states:

~~"The most important feature of this low-elevation forest is the abundance and predominance of native birds. 'Amakihi (*Hemignathus virens virens*), 'Apapane (*Himatione sanguinea*), 'Oma'o (*Phaeornis obscurus obscurus*), 'Elepaio (*Chasiempis sandwichensis*), 'Io (*Buteo solitarius*), and possibly 'I'iwi (*Vestiaria coccinea*) made up over 90% of the birds heard or seen."~~

This statement relates to a recent walk-through survey of the forests in and around the logging area at Kalapana made by Mr. ~~Dr. Warshawer~~, who has an M.Sc. in Zoology and is a recognized authority on Hawaiian Natural History. His statement implies a definite domination of native over non-native birds.

7. This brings me to the question of native vs. non-native species behavior, which is also important with regard to the uniqueness of an area. *Exhibit 7* contains three scientific papers. Two relate to the dynamic behavior of native vs. non-native plant species and the third to a study of soil-nutrient regimes. The 1980 Phytocoenologia paper (*Exhibit 7A*) reports on a study in two rainforests on Oahu, which has application to the lowland rainforest at Kalapana. The Oahu study compares the rainforest on Tantalus Mountain (at the southern end of the Koolau Mountain Range) with Pupukea (at the northern end). It was hypothesized originally that the reason why non-native plant species were so abundant on Tantalus Mountain was because of its proximity to Honolulu and the high incidence there of man-introduced horticultural plants, which escaped from cultivation and became aggressive competitors to the native flora in this rainforest. However half-way through the study it was realized that the proximity of so many non-native plant species was not so important as the kind and nutrient composition of the soil. It was found instead that very old Hawaiian soils derived from basaltic lava, which develop aluminum toxicity, are much less invaded by non-native species than more fertile and moderately aged soils from volcanic ash. Both soil types are on Tantalus Mountain, and the aluminum-toxic soils there show strong floristic similarity, and share a predominantly native species community, in common with the aluminum-toxic soils prevailing in Pupukea at the northern end of the Koolaus. What this implies about the behavior of native vs. non-native plants at Kalapana is that on very young volcanic substrates (which represent the other extreme) native species composition may also show greater resistance against the invasion and penetration of non-native plants since most of the latter are adapted to more fertile and non-extreme soils. On more fertile soils, which also occur in the Kalapana rainforest, native species are more easily displaced by non-natives. However, much of the native lowland rainforest at Kalapana is on geologically very recent substrates, which show some interesting nutrient imbalances (*Exhibit 7B*). We can therefore expect this area to maintain relatively greater stability in its native species composition than is found in other native forests on nutrient-rich soils. This is not to be taken as an argument for further logging in this area, but as a suggestion that there is a chance, because of the predominance of young volcanic substrates in this area, that the cut-over operation has not yet resulted in irreparable damage. If logging is stopped now, total conversion to alien species is not inevitable.

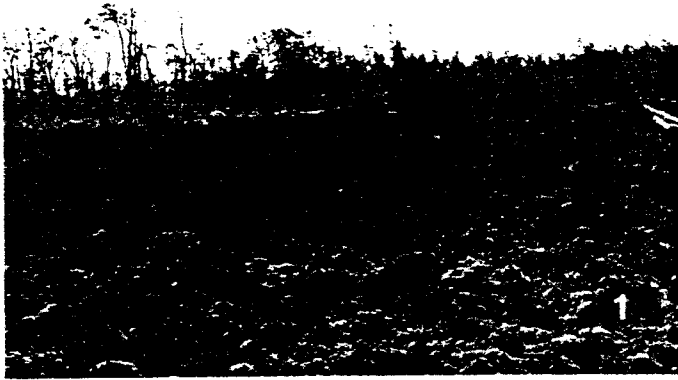


Photo 1, by D. Mueller-Dombois



Photo 2, by D. Mueller-Dombois



Photo 3, by D. Mueller-Dombois



Photo 4, by D. Mueller-Dombois

Another factor is, however, nearness and encroachment of non-native plant species. This becomes critical, particularly when the *Metrosideros* forest canopy breaks down. We have found that in some of our forest-dieback plots (*Exhibit 7C*) non-native species will take advantage of forest canopy openings, provided that such non-native species are present already in larger quantities in the surrounding area. There is some localized precedence for this also in the Kalapana lowland forest. It will therefore be difficult to predict the outcome of native forest recovery in areas that have been logged. This question would require a new study in the cut-over area. Of course, this whole question is obsolete if the logged-over area is actively converted

to uses other than native forest restoration and in particular, if the logging operation is further expanded.

8. Another aspect of uniqueness of the Kalapana logging area and its vicinity is the display of nearly all stages of primary rainforest succession in a relatively small land mosaic, side-by-side. A set of photographs taken on January 1, 1985, will demonstrate this point, see *Exhibit 8*.

*Photo 1* provides a view across the 1977 lava flow on which a shimmer of white-gray color indicates the developing lichen stage with *Stereocaulon vulcani*, which here begins to assume a dominant role in early lowland rainforest succession.



Photo 5, by D. Mueller-Dombois



Photo 6, by D. Mueller-Dombois

Photo 2 shows a more advanced stage where the lichens are still very evident but where also saplings of *Metrosideros polymorpha*, mostly of the lowland pioneer variety *incana*, are now forming an open stand of juvenile trees, almost as if planted by man. The flow probably dates from 1955. Behind this juvenile stand on Photo 2 is an adolescent *Metrosideros* forest on a still older lava flow, probably dating from about 1900.

Photo 3 portrays another immature 'ōhi'a forest with an undergrowth of the matted native ulūhe fern (*Dicranopteris* spp.) and a few other native pioneer forbs, which grow intermixed, such as the native tall sedge *Machaerina angustifolia*.

Photo 4 shows a closed *Metrosideros* forest in an early mature life stage with a few tree ferns (*Cibotium* species) and other native woody shrubs and small trees in its understory. A sizeable segment of this type of early mature forest has already been logged. The photo was taken at the northwest end of the logged-over area where the State Natural Area Reserve begins. A similar forest is seen on Photo 1 across the 1977 lava flow on the right side of the picture. On the left side is a senescing forest with advanced canopy dieback. Although some of the outer trees may have been scorched and killed by the heat of the 1977 lava flow, the inner trees away from the flow's edge probably died primarily due to their advanced life-stage, a phenomenon found characteristically throughout the *Metrosideros* rainforest ecosystem in Hawaii. The forest is made up—as seen on these photos—of one-generation stands of *Metrosideros*. This feature

applies to the entire Hawaiian *Metrosideros* ecosystem and not only to those forest segments growing on very young volcanic surfaces as here near Kalapana.

We have found (Mueller-Dombois *et al.* 1980, 1983 and Mueller-Dombois 1983: reprint on "Dieback and Successional Processes . . ." included here with Exhibit 8) that this life-stage mosaic is perpetuated also on geologically older substrates, that is, *Metrosideros* reproduction occurs effectively only in form of cohorts and in association with canopy dieback. This also means that not all *Metrosideros* stands provide effective seed sources. Certainly the dieback stand on Photo 1 can no longer be counted on as an effective seed source, and neither can the immature stands on photos 2 and 3.

The capacity of *Metrosideros* forest to develop into 30 m tall trees is seen on Photo 5, which represents the mature forest stage. Much forest that has now been cut at Kalapana was of this mature type. In addition to two pioneer varieties of *Metrosideros*, var. *incana* (the pubescent-leaved form) and var. *glaberrima* (the glabrous-leaved form), we found yet a third important variety, *M. polymorpha* var. *macrophylla* forming tall stands in the area. *M.p. macrophylla* is a late-successional variety with large leaves and exfoliating thin bark. An individual of this variety is pictured on Photo 6, standing here alone at the edge of the cut-over forest. It is quite conceivable that the germplasm of superior trees of this variety may be lost forever if no effort is made now to preserve forest segments with a good number of trees of this variety.

## SUMMARY AND CONCLUSIONS

I began by providing some background to the recent resource controversy and by discussing the three items of evidence for the non-uniqueness of the native Kalapana rainforest, as used by Campbell Estate and Bio Power Company. The three items: (1) the zoning of the area as "agricultural" some 20 years ago and still being kept in this land use category, (2) the 28-year old report by L.W. Bryan which draws attention to the agricultural potential of the area and (3) the 1974 Master Plan for Hawaii Volcanoes National Park which ignores the area in question; all three items are pointing in the direction that there is biologically nothing special about the area.

~~I have then tried to point out, with some documentation in form of the accompanying exhibits, that the area is indeed biologically special or unique.~~ This I have done in eight points:

1. By giving an overview map perspective with the help of Ripperton and Hosaka's map of Hawaiian vegetation zones.
2. By providing another map perspective showing the eastern half of the island of Hawaii with 62 forest stand samples, which were statistically analysed by a modern multivariate analysis method. This documentation is evidence that there are a number of different 'ōhi'a forest types in the Hawaiian rainforest and also that not every different locality within this forest is unique. By providing a third and closer map perspective of the disputed Kalapana area, which shows that ~~there is indeed very little acreage of intact native lowland rainforest vegetation left below 1500 feet elevation.~~
4. I have tried to document the "seed source factor" by referring to the Devastation Area in Hawaii Volcanoes National Park, which so far has been very poorly invaded by *Metrosideros* seedlings because of a volcanically induced absence of sufficient seed supply. ~~The inference is made here that we should not add to minimizing seed sources in the volcanically active areas of Hawaii because we would lose these "free services of nature" that have become successfully established over long periods of evolutionary time. Replacing these natural recovery processes by planting on new volcanic surfaces would be an enormously costly management task.~~
5. A new dimension has been added to the question of *Metrosideros* rainforest diversity through the recognition of altitudinal and edaphic races or varieties in 'ōhi'a. These 'ōhi'a races have different ecological functions just as different tree species have in continental ecosystems. This new fact needs to be recognized, because it shows that, in spite of the wide distribution of 'ōhi'a throughout the Hawaiian rainforest, it has important physiological and genetical subcomponents whose population sizes are much more limited in number and area than is the species as a whole.
6. With this sixth point I have tried to demonstrate that the Kalapana rainforest and vicinity should be recognized as a lowland refuge for the native Hawaiian bird fauna. Its distribution ranges have been severely reduced in the past by loss of natural forest habitat. Much federal funding via the U.S. Forest Service, the U.S. Fish & Wildlife Service and the National Park Service has been expended in the

last decade to study the peril and habitat requirements of the unique native bird fauna. This fact must be recognized and with it the need to preserve this last remnant of good native lowland rainforest in Hawaii.

7. The question of alien species invasion into native forest ecosystems has also been the subject of much research supported by federal funding in Hawaii. We have found that native forest areas differ with regard to their resilience against foreign species invasion. ~~The latest information is that extreme soil substrates in Hawaii such as those found in young volcanic areas and at the other extreme in very old soil sites are somewhat naturally protected against invasion of alien plants.~~ Many aggressive alien plant species cannot cope as well with extreme soil-substrate conditions as can the more tolerant native flora. The Kalapana rainforest area in question contains much of the very young volcanic substrate. Therefore the area promises to be relatively more resilient to alien species invasion than other more fertile and deeper soil sites in Hawaii.
8. My final point relates to the unique ecological character of the Kalapana lowland rainforest area. ~~This area displays almost all recognized stages of primary succession, from nearly barren lava flow to mature and senescent rainforest, all in one area and in close proximity side-by-side.~~ This situation is of great research, public educational and interpretive value. It would be a more profitable land use, in the long run, to use this area for the Park Service's program of explaining the adaptive dynamics of the Hawaiian rainforest which evolved in an isolated volcanic environment. This should also be of interest to the Tourist Industry which is still the number one revenue earner in the State.

~~Finally, I should say that considerable sums of federal funding have been spent in the last 15 years on the study of Hawaii's biota and native biological systems.~~ For example the U.S. Forest Service

spent in the range of \$300,000 to \$400,000 per year during the 1970s on the *Metrosideros* dieback problem. Additional sums of money were spent during the last decade on Hawaiian bird surveys and recovery research, as already mentioned. During the Hawaii International Biological Program (IBP) from 1971-76, the University of Hawaii and B.P. Bishop Museum received in excess of \$1.5 million to study the evolution and relative resilience of the native biological systems, and we put much of our research effort into studying the special character of island ecosystems, which are generally known to be more fragile than continental ecosystems of the same biome type. For further explanation I enclose a xerox copy of the concluding two chapters of the Hawaii IBP synthesis volume as *Exhibit 9*, which represents the research synthesis of 35 field scientist that worked on this project for six years. It would require another analysis to summarize all the research and educational funding that has been brought to Hawaii over the last two decades, because of the fact that Hawaii contains such special biota and ecosystems. A case could probably be made that such research and educational funding has become an important revenue for the State of Hawaii and further that this revenue will increase in the future provided that a sufficient number of unique areas and representative ecosystems are reasonably preserved.

Even though it is still difficult to attach a monetary value to the native Hawaiian biota and its ecosystems, we refer to them now legitimately as biological resources. This means that we associate

with them a high resource value. This is similar to the fact that it was always common knowledge that 'ōhi'a makes good firewood. However, no one ever dreamed of this important native ecosystem builder as being considered a bio-energy resource, not even L. W. Bryan or the originators of the 1974 Master Plan. This new resource concept has come about merely through latter-day economics and technological developments. ~~We should be fair then in calling the current controversy a resource-use conflict, and look for appropriate ways to resolve it.~~ Eucalyptus and other non-native plantation forests have similar bioenergy resource value, but native forests have at the same time a high biological resource value. What can we do about this? The answer should not be too difficult if we are serious about resource development with good conservation practices in mind.

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(Editors' note: the following exhibits were attached to the original report.)

Exhibit 1 Map of Hawaiian Vegetation Zones by Ripperton and Hosaka.

Exhibit 2 Statistical Forest Type Map by N. Balakrishnan.

Exhibit 3 Kalalua and Kalapana Vegetation map by J.D. Jacobi.

Exhibit 4 Invasion of Recovery of Vegetation after a Volcanic Eruption in Hawaii.

Exhibit 5 Evidence for racial segregation in 'ōhi'a (Corn and Hiesey, Stemmermann).

Exhibit 6 Native Birds in the Kalapana Forest Area by S. Conant.

Exhibit 7 Native vs. non-native species behavior and soil-site variation.

Exhibit 8 The life-stage mosaic of 'ōhi'a stands at Kalapana.

Exhibit 9 Concluding Survey of IBP Research in Hawaii.

## LIHUE, KAUAI, CHRISTMAS BIRD COUNT - 1984

Winona Sears

Count day (15 December) this year was beautiful and clear, with clouds increasing gradually until the late afternoon was overcast. The count areas were all clear. We noted that for the first time we saw Lesser Golden-Plover in small flocks instead of lone birds, although most were still alone. The Cattle Egret population has had an "explosion", being about 50% increased. Warbling Silverbills have arrived, probably from Oahu on their own since they were not introduced. The Ringneck Parakeets and Java Sparrows on last year's list have been seen, but not during count week nor on count day.

A newer map of Kauai has been made, giving the three count circles more specific centers. These are: for Kapaa, same latitude and longitude, center Leleiwi Peak in the

Anahola Mountains, and where it overlaps slightly the Lihue Circle, the Kapaa Circle counts north of the north fork of the Wailua River; for Lihue Circle, 21° 58' N and 159° 26' W, center one mile north of Halfway Bridge, and where it overlaps slightly the Kapaa Circle, the Lihue Circle counts south of the north fork of the Wailua River; for the Waimea Circle, 22° 04' N and 159° 40' W, the center one mile southwest of Waimea Canyon Lookout.

## SECTORS COVERED

1. Wailua River to north side of Lihue, including airport road and holding ponds west of Lihue
2. Nawiliwili Harbor, Huleia Stream, Mene-

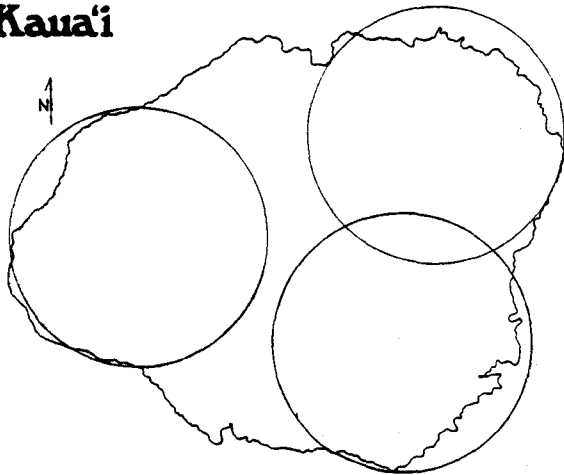
	Sectors	1	2	3	4	5	6	7	Total
White-tailed Tropicbird	.	.	.	1	.	3	.	.	4
Brown Booby	.	.	6	.	.	.	.	.	6
Great Frigatebird	.	.	1	.	.	.	.	.	1
Cattle Egret	70	53	407	2692	61	5	17		3305
Black-crowned Night-Heron	.	.	1	.	.	.	.	.	2
Hawaiian Duck (Koloa)	12	.	18	.	.	.	.	.	30
Erckel's Francolin	.	.	.	.	.	.	.	1	1
Red Junglefowl	1	5	15	.	9	8	.	.	38
Ring-necked Pheasant	.	.	6	2	.	1	4	.	13
Common (Hawaiian) Moorhen	1	.	8	.	4	.	.	.	13
American (Hawaiian) Coot	10	.	51	2	4	.	.	.	67
Lesser Golden-Plover	22	12	66	22	5	4	1		132
Black-necked (Hawaiian) Stilt	2	.	5	4	.	.	.	.	11
Wandering Tattler	1	.	2	5	.	.	.	.	8
Ruddy Turnstone	3	.	.	.	.	.	.	.	3
Sanderling	.	.	.	2	.	.	.	.	2
Spotted Dove	6	8	68	8	27	5	8		130
Zebra Dove	84	151	286	45	19	130	3		718
White-rumped Shama	1	2	5	3	7	6	7		31
Greater Necklaced Laughing-thrush	.	1	.	.	1	.	.	.	2
Melodious Laughing-thrush	.	6	.	.	13	.	.	.	19
Northern Mockingbird	.	2	1	1	2	.	6		12
Common Myna	123	197	173	116	18	60	35		722
Japanese White-eye	20	14	8	16	42	15	34		149
Northern Cardinal	12	2	.	15	7	6	11		53
Red-crested Cardinal	.	4	.	4	.	2	1		11
Western Meadowlark	5	1	14	1	1	.	4		26
House Finch	10	8	15	.	68	2	11		114
House Sparrow	37	49	15	59	10	43	10		223
Warbling Silverbill	.	.	.	16	.	.	.		16
Nutmeg Mannikin (Spotted Munia)	22	25	142	19	7	7	10		232
Chestnut Mannikin (Black-headed Munia)	.	.	.	.	35	.	6		41
No. of Individuals	442	548	1307	3032	343	294	169		6135
No. of Species	19	20	21	19	20	14	17		32



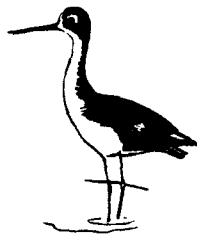
- hune Fishpond, Kauai Surf Golf Course
- 3. South of Lihue to Knudsen Gap Road, including Kipu Ranch and Waita Reservoir
- 4. Omao Road, Koloa town and Poipu
- 5. Pacific Tropical Botanical Gardens
- 6. Lihue town
- 7. Kalaheo, including Kukiolono Park

Twenty-six observers, 20 in 10 parties, plus six at feeders. Observers were: Stephen Au, Clark and Vada Bowen, Stuart Bradley, Sophie Cluff, Zipporah Douglas, Madeline Erick, Leilani Fehr, Holbrook Goodale, Mary and Nat Guerrero, Henri and Milton Kushkin, Dan, Hannah, Linda, and Mary Moriarty, Gilbert and Muriel Parfitt, Lisa and Robin Rice, David and Winona Sears (Compiler), Virginia Siewertsen, Reva Stiglmeier, and William Theobald.

### Kauai



New count circles for the Kauai Christmas Count.



## NO NA LEO 'OLE

### OHIA CHIPPING

Drs. Jack Lockwood and Michael Pennington and Friends of the Forest sued Biopower Corp. for an injunction to stop further chipping of the native ohia forest on Campbell Estate land in Kalapana. As a result, Biopower agreed to delay chipping of trees in "critical" areas for two years, to allow study before clearing. Biopower is a major threat to Hawaii's forests. They recently announced grandiose plans to create sales in the millions from Hawaiian hardwoods such as koa, as well as import \$30.6 million worth of "teak" from Samoa.

Biopower, the only bidder, was awarded last month the right to cut and chip state-owned eucalyptus stands in Waiakea. Biopower president, Warren Ramsey, claimed that the State Department of Land and Natural Resources (DLNR) red tape would further delay their move to Waiakea for at least 30 days. State Forester, Libert Landgraf, has said, however, that Biopower could start chipping in Waiakea immediately upon picking up and completing the proper forms and, in fact, DLNR was urging them to do so.

The real issue is this: Will we sacrifice Hawaii's native forests on the altar of alternate energy or will we decide to the contrary and plan ahead now? With the potential collapse of the sugar industry in Hawaii, a significant part of outer island electrical production provided by burning bagasse will have to be made up by something else. As we have seen at the Puna sugar facility, ohia had been chosen as the energy business's preferred fuel. We have been told that there are not enough eucalyptus stocks to substitute for ohia burned at the Puna mill alone. It is time for Hawaii to realize that we must plant or purchase alternate fuels rather than use our native forests for this purpose. The threats to our remaining ohia forests are very real and our current legislature has taken a "what-me-worry" attitude to protecting our forests.

Woodchipping on Campbell land in Kalapana has already destroyed the best remaining lowland tropical rain forest in Hawaii and the U.S., a rare low elevation habitat for native forest birds.

### KOA FORESTS IN JEOPARDY

What is left of the Kilauea koa forest, long considered the most pristine and rich koa forest in Hawaii, is now being threatened by

proposed logging. The Bishop Estate recently announced intentions to log the forest's magnificent koa trees for their valuable lumber.

Koa, once one of the most common trees in Hawaii, is now much depleted throughout its former range. Less than 15% of the original koa forests in the state are still intact and dominated by native plants. Protracted commercial cutting and conversion to pasture and other agricultural uses have occurred for so long that all ongoing and proposed logging of koa has significant impacts on the depleted koa forest ecosystem and the endangered organisms dependant on it.

As koa has become more and more scarce and the demand for it increased, its commercial value has risen enormously. This has increased the incentive for private land owners to log their koa forests. Compounding the problem are "pirate" koa operations which have illegally cut and removed trees from state owned lands at Puu Waawaa, Ka'u forest reserve, and elsewhere. In 1984, the DLNR gave a permit to a private firm to log koa in Kokee State Park calling the clear-cutting a "maintenance activity". In 1983, a larger koa operation removed an estimated 50 to 70 truckloads of koa from Western Kokee State Park and the adjoining forest reserves. For this service, the state paid Royal Contracting Co. \$281,270. The koa removal was reportedly for road clearing and fire prevention purposes following Hurrican Iwa. It has been reported that the current rate of koa removal from the Big Island is 10,000 board feet a day to which at least five small saw mills on private lands contribute.

It behooves all of the people of Hawaii to not support the koa products market which fuels the shortsighted view that koa trees are commodities to be cut and sold for profit rather than the main element of a precious and disappearing natural ecosystem. Koa, like the sandalwood of the last century, is not an unlimited resource of these islands. It is much depleted and we need to preserve what little is left.

#### THE THIRTEENTH LEGISLATURE: AN UNLUCKY NUMBER FOR THE ENVIRONMENT

By March 8th, the midpoint of the 1985 legislative session, nearly all of the environmental bills supported by HAS were dead. Important bills protecting forest reservations and native forests were not even given public hearings in House of Representatives committees. The Senate committee on Economic Development heard testimony from HAS, Sierra Club,

Conservation Council for Hawaii, and Rick Warshauer supporting a bill designed to protect our fragile watersheds. Opposing the bill was the DLNR and a hunter lobbyist who testified that the bill was "anti-hunting" and "anti-gun". The committee did not pass the bill. Action of the environmental front is now mainly limited to what can be done through resolutions which are merely legislative directives and requests and are not statutory.

The strong pro-business bent of this legislature is further revealed by the number of bills regarding pesticide use that were dead or gutted by mid-session. Despite vigorous public outcry and headline news coverage of Hawaii's pesticide problems, only a couple bills of the more than two dozen introduced still have even a slight chance of becoming law. One survivor is Senate Bill 906 which could prohibit use of a pesticide in Hawaii after it has been detected in drinking water at levels which may endanger public health.

Bills still likely to pass include those which would dismantle Hawaii's landmark land use process and which are supported by the Ariyoshi administration, Hawaii Sugar Planter's Association, tourist industry representatives, and some large land owners.

#### 'ALALA SANCTUARY

HAS, other conservation organizations, Hawaiian civic groups, and the DLNR gave testimony to a House joint committee in support of a resolution which encourages "the state to proceed immediately with implementing the management programs outlined in the Alala restoration program." The committee passed the resolution with an amendment adding the request for the Governor's executive order necessary for the establishment of the first portion of the 'Alala sanctuaries at Puu Waawaa.

The 'Alala is one of the most critically endangered birds in Hawaii and perhaps, the nation. Wildlife biologist, Jon Giffin, has estimated there are twenty or fewer birds left in the wild. The nine 'Alala kept at the Pohakuloa Endangered Species Breeding Facility have not successfully produced offspring for the past few years. Crow expert, Dr. Fern Duval, suggested at a recent seminar that complex 'Alala social behavior may seriously hamper breeding in captivity.

#### PUU WAAWAA NATURAL AREA RESERVE

In 1913, the famous Hawaiian botanist,

Joseph Rock, called Puu Waawaa "the richest floral region of any in the whole Territory." Requests from government officials and others to preserve the unique dry forests of Puu Waawaa go back to the turn of the century. For ten years HAS has been urging the creation of a natural area reserve at Puu Waawaa. Now, finally, a portion of this "jewel of Hawaii" may be preserved. The Natural Area Reserves System (NARS) Commission has voted to recommend to the Board of Land and Natural Resources (BLNR) a proposal to create a natural area with a portion of the approximately 80,000 acres withdrawn from the Puu Waawaa Ranch lease last fall.

Ecological, biological, and practical reasons for recommending to the BLNR an extended 12,000 acre natural area, including the originally proposed 3,000 acre natural area, were presented to the Commission by Rick Warshauer and Dr. Clifford Smith, NARS Commission Member. It was pointed out to the Commission that the larger natural area would neither affect Puu Waawaa Ranch's productivity, nor require additional fencing to exclude cattle. It would provide the full range of dry forest vegetational and successional stages present, including many rare species not in the 3,000 acre DLNR proposal; provide a self-sustaining biological community; and make a connection with the proposed 'Alala sanctuary which would allow birds to move in a protected corridor between the dry forest and their breeding grounds in the sanctuary.

Bob Lee, NARS administrator, surprisingly opposed the extended 12,000 acre proposal on the grounds that it is unmanageable. Dr. Smith, however, reminded the Commission that essentially none of the natural areas in Hawaii are actively managed by NARS. Commission Member Dr. William Theobald, in a rare appearance at a Commission meeting, said that management would require forest "restoration" by out-planted nursery stock. Rick Warshauer and Dr. Smith, who had both recently visited Puu Waawaa, countered that natural regeneration would readily follow removal of cattle from the natural area but that preservation of a large sample of the different dry forest successional stages was required to sustain the dynamic dry forest ecosystem "in perpetuity", a directive of the NARS law.

Commission credibility was discussed. Those members desiring that the Commission's recommendation be biologically and ecologically sound rather than solely politically expedient, were in favor of the extended natural area. The majority of the commissioners sided with Bob Lee's view that credibility is best maintained by not asking for "too much". The

Commission finally agreed to recommend to the BLNR that the original 3,000 acre proposal be considered as the minimum size for the Puu Waawaa natural area and that as much of the 12,000 acre proposal as possible be included.

The fate of the unique dry forest of Puu Waawaa, the last of its kind in Hawaii and the world, is now in the hands of the Land Board members. Letters of concern from HAS members urging the BLNR to include the full 12,000 acres may help to influence their decision. A letter to the Governor may also help. This is our last chance to save this valuable forest ecosystem.

#### TRI-FLY LETTERS STILL NEEDED

Please write your elected representatives and let them know that Hawaii does not want the USDA Tri-fly eradication program. See the January and March, 1985 issues of the 'Elepaio for more details. If this program goes through, it will be a major disaster for Hawaii. Important addresses are listed below.

Senator Daniel K. Inouye, 722 Hart Senate Office Bldg., Washington D.C. 20510. Senator Spark M. Matsunaga, 109 Hart Senate Office Bldg., Washington D.C. 20510. Representative Daniel K. Akaka, 2301 Rayburn House Office Bldg., Washington D.C. 20515. Representative Cec Heftel, 1034 Longworth House Office Bldg., Washington D.C. 20515.

#### GET ACTIVE

Anyone wishing to make an active contribution to the protection of Hawaii's natural heritage is welcome to join with the HAS conservation committee. Your help is always needed. See the committee members listed, with their phone numbers, on the second-to-the-last page of this issue.

*Libby Powell and Rick Warshauer*

## KAPIOLANI PARK FIELD TRIP REPORT -NOVEMBER 1984-

The Hawaii Audubon Society's November 1984 field trip took place on the 18th at Kapiolani Park, Oahu. After meeting the trip leader, Mike Ord, at 7:30 a.m., the group of about 12 birders set forth to explore the environs of the park. We were able to closely observe the usual introduced species in preparation for December's Christmas Count. These included Zebra and Spotted Doves, Pigeons (Rock Doves), House Sparrows, House

Finches, Mynas, Red-vented Bulbuls, and Red-crested and Northern Cardinals.

Among the more unusual introduced species seen were Java Sparrows and Yellow-fronted Canaries. Several Shama Thrushes were sighted in the trees at the base of Diamond Head and at least two Gray Francolins were heard calling from the slopes. A flock of parrots flew over the park several times, consisting of seven Amazon Red-headed and one Double Yellow-headed Parrots. Two Rose-ringed Parakeets were also visible for a short time along the north edge of the park.

The native White Terns and wintering Lesser Golden-Plovers were also seen throughout the park.

Although the sun rarely showed itself, there was hardly any rain, and we enjoyed a cool, pleasant morning.

*Paul and Janice Sweet*

## KANAHA POND FIELD TRIP REPORT -FEBRUARY 1985-

The first Hawaii Audubon outing on Maui for 1985 (on February 10) was a great success. At the observation hut area, we had a chance to see the usual Northern Shovelers, a Sanderling, several Black-crowned Night-Herons, Hawaiian Coots, Hawaiian Stilts, and Lesser Golden-Plovers. We then drove around to the back of the pond into the area that has many World War II bunkers and is still called NASKA (Naval Air Station Kahului).

On the back side of the pond there were more Lesser Golden-Plovers, Wandering Tattlers, Ruddy Turnstones, and Northern Shovelers. We saw one female Lesser Scaup, a flight of six Northern Pintails (one male and the rest females), two female Mallards in flight, one Pectoral Sandpiper, one Bonaparte's Gull, and one Laughing Gull. We had asked our visiting expert from California to identify the latter: "I don't know. Gulls are so common we don't bother with them!" Even a lowly gull can be uncommon and interesting.

Probably the most interesting and uncommon sighting came at the very end of the road. Someone spotted two coots feeding on an islet. One was definitely a Hawaiian Coot while the other displayed all the characteristics of an American Coot: no white frontal shield but a very prominent red button and a dark ring around its bill. A third coot made an appearance that was even more interesting; it was smaller than either of the other two, had a combination of the white frontal shield and

red button along with a faint ring around its bill and had bright yellow legs and feet. Evolution in the making?

It was an extremely interesting day for all, and many, many thanks to our knowledgeable and entertaining leader, Dr. Cameron Kepler.

*Mary Evanson*

*(Editors' note: three morphs of coot shield have been documented in Hawaii. In addition to the "normal" large white frontal shield, there are a small percent of "large red" frontal shield coots, and "small red" frontal shield coots.)*

## USFWS PROPOSES TO ESTABLISH A REFUGE FOR ENDANGERED HAW. FOREST BIRDS

The U.S. Fish and Wildlife Service (USFWS), in cooperation with The Nature Conservancy (TNC) of Hawaii, and the State of Hawaii, Department of Land and Natural Resources, Division of Forestry and Wildlife (DOFAW), is pursuing establishment of a 31,000 acre Upper Hakalau National Wildlife Refuge on the Island of Hawaii for endangered Hawaiian forest birds. As the federal agency with primary responsibility for carrying out programs under the Endangered Species Act of 1973, the USFWS is proposing to acquire this area for the long-term conservation of endangered Hawaiian forest birds. TNC, which has an ongoing program to conserve endangered Hawaiian forest bird habitat, will be assisting USFWS in discussions with landowners. DOFAW is the State agency charged with management of endangered species and they administer management of large acreages of forest land adjacent to this project area. The long-term objective of these agencies is to manage this project area and the adjoining State-owned Conservation District and Natural Area Reserve lands as one intact koa-ohia/ohia rain forest ecosystem.

The Upper Hakalau forest area, the subject of this proposed refuge, is made up of several privately owned parcels located between the 3500' and 6500' elevation on the Hamakua coast on Mauna Kea. This area is primarily a rain forest habitat with some of the finest koa-ohia and ohia forest remaining in Hawaii. The primary purpose of this refuge would be for the conservation of endangered Hawaiian forest birds, although it would also serve to maintain habitat for many different species of unique Hawaiian plants and animals

as well as protecting a vital watershed. Accomplishment of this project would be a major step towards recovery for five endangered Big Island forest birds.

Over the last eight years the USFWS, with the assistance of DOFAW, has been involved in the Hawaii Forest Bird Survey, an extensive field survey intended to assess the status and distribution of the native Hawaiian forest birds throughout the State. The information collected during these surveys has been used to identify the key habitat areas on Hawaii, Maui, Molokai, and Kauai, and determine which areas are in need of additional protection and management.

The Hakalau area was found to support some of the largest and most significant remaining populations of the endangered and more common native forest birds on the Big Island. The bird species include the endangered 'Akiapola'au, Hawaiian 'Akepa, Hawaii Creeper, Hawaiian Hawk, and 'O'u, as well as large populations of almost every other native forest bird species still found on the Big Island. The Hakalau area also contains a number of rare and unique plant species, including a number of endemic Hawaiian lobeliads (oha) such as *Cyanea shipmanii* or *Clermontia lindseyana*.

The USFWS has identified this area as a top priority for efforts to protect and manage endangered forest birds and native forest habitat in Hawaii. With the interest and efforts of Senator Daniel Inouye and Congressman Daniel Akaka, the USFWS has received an appropriation to be used to protect key areas of endangered Hawaiian forest bird habitat such as the Upper Hakalau area. The USFWS has developed a Draft Environmental Assessment for the Upper Hakalau habitat protection project and has identified establishment of a National Wildlife Refuge as the best long-term means to protect the habitat. The Draft Environmental Assessment has been distributed for review and comment by concerned parties. Copies are available at the State library in Honolulu, as well as the local libraries in Hilo and Kailua-Kona. Comments should be sent to the Pacific Islands Administrator, U.S. Fish and Wildlife Service, P.O. Box 50167, Honolulu, HI 96850.

USFWS News Release

## HELP WITH 'ELEPAIO

The May issue of the 'Elepaio will be put together the 20th of April (Sat.) at 1415 Victoria St., beginning at noon. Call Marie at 533-7530. Help is always needed and appreciated; no experience necessary.

## APRIL FIELD TRIP: ULUPAU HEAD

The Sunday, April 14 field trip will be to visit the nesting colony of Red-footed Boobies at Ulupau Head, Kaneohe Marine Corps Air Station (KMCAS). Other seabirds will also be seen. Spotting scopes will be set up to permit viewing of seabirds on the offshore islet of Moku Manu. If time permits, the group will visit Kalua Puhi Pond, also at KMCAS.

Participants should meet at 8:00 a.m. next to the State Library on Punchbowl Street in Honolulu, or at 9:00 a.m. at the parking lot next to the main (H-3) KMCAS entrance gate. We will be escorted onto the base by the KMCAS community relations officer. The field trip will end by lunchtime. Participants should bring a hat and sunscreen. Bring binoculars or spotting scope if available. Leader is Bob Pyle; call 262-4046 for more information.

## FEBRUARY MEETING REPORT

The 25 February 1985 meeting featured Craig Harrison, a biologist who has studied seabirds in the Northwestern Hawaiian Islands, and who is now a Honolulu attorney. Harrison narrated and presented a slide show on "Wildlife of East Africa", based on his trips there in 1971 and 1972, and the summer of 1984. Kenya and Tanzania, with their national parks and wild animal refuges, were the featured countries.

Arusha Park in Tanzania has three kinds of habitat: montane, lake, and scrub and bush. Crown Cranes, Wart Hogs, Saddle-billed Storks, Cape Buffalo, and Giraffes were among the animals and birds depicted. Harrison pointed out that one-fourth of the land in Tanzania is in parks and reserves, and the number of birds and mammals is unimaginably great. He saw 260 species of birds, but there are easily 400-500 species. Among other famous wildlife parks he visited were Amboseli and nearby Kilimanjaro Parks, also the great Ngorongoro Crater Park, 10 miles in diameter. Wildebeest migrate by the thousands from Serengeti Park twice a year, following the seasons and available forage. There were wonderful shots of a pair of Cheetahs (rare, but he felt remaining in stable condition), hippos, both Black and White Rhinos (the latter almost extinct in plains areas), Grant's and Thomson's Gazelles, zebras, ostriches, elands, a baboon mother with baby,

Ground Hornbills, Egyptian Geese (the largest species), and rock hyraxes (hardly larger than a rabbit, but whose closest relative is the elephant). There was also a graphic sequence (a mite gory for the squeamish) of lionesses hunting and killing a zebra, and the order of feeding among the dominant (and very handsome) male, the females, and the cubs. In the wild, said Harrison, the mortality rate of lion cubs is about 50%.

Birds abounded with captivating slides of Maribou Storks, Nubian Vultures (largest species), six or eight species of kingfishers (despite the name, many are insect eaters), colorful sunbirds (30-40 species), bee eaters, and bulbuls similar to those introduced to Hawaii.

Harrison pointed out that hunting has been outlawed in Kenya's parks since 1977, but poaching remains a problem. Concluding his trip, he visited the oceanside of Kenya, near Somalia, with excellent snorkeling, far exceeding anything in Hawaii as to numbers and species. During his visits to Africa, Harrison stayed in lodges (the Ark, similar to famed Treetops), but felt closer to nature and the real Africa when camping out in the parks. Other interesting facts: the Sahara is equal in size to the U.S.; also, the pressure of population has led to famine, as the death rate increases with the birth rate.

*Betty L. Johnson*

## 5-YEAR INDEX NOW AVAILABLE!

The 5-year 'Elepaio index (for Volumes 36-40) is now available. It may be obtained by sending a \$2.00 check or money order (made out to "Hawaii Audubon Society") to: Hawaii Audubon Society, P.O. Box 22832, Honolulu, Hawaii 96822. This small fee covers the cost of reproducing the index and also includes postage.

A big "Mahalo" to Sol Cushman, who compiled this 5-year index, and did such an expert job. Also our thanks to Susan Schenck, who compiles our yearly indices, without which there would be no 5-year index!

## APRIL PROGRAM:

### BIRDING IN AUSTRALIA'S NATIONAL PARKS

The guest speaker for the Monday, 15 April general meeting is Peggy Hickok Hodge, with a program on "Birding in Australia's National Parks".

The late Bill Hodge and his wife, Peggy, have planned and taken adventure trips throughout the world over the last 20 years. These veterans of the outdoors have especially enjoyed hiking and bird watching.

Peggy Hodge is also an author, and among her books is "Favorite Hawaiian Legends". She was born and raised in Hawaii, and has been an Audubon member for the last 20 years.

The meeting will be held at McCully-Moiliili Library at 2211 S. King St., Honolulu, at 7:30 p.m. As always, the public is invited to attend.

## PUBLICATIONS OF THE SOCIETY

HAWAII'S BIRDS by the Society (1984). This is the best field guide to our birds, and includes colored illustrations of all native and well-established nonnative species..... \$4.95 plus postage: 85¢ (surface mail) or \$1.03 (air). Hawaii residents only: add 20¢ for tax.

FIELD CHECKLIST OF BIRDS OF HAWAII by R. L. Pyle (1976). A pocket-size field card listing 125 species found in Hawaii with space for notes of field trips. (Postpaid).....\$ .25  
(ten or more, 10¢ per copy)

GUIDE TO HAWAIIAN BIRDING by members of the Society and edited by C. J. Ralph (1977). Where to go and some idea of what you are likely to see. For the islands of Kauai, Oahu, Lanai, Molokai, Maui and Hawaii (Postpaid).....\$1.50

CHECKLIST OF THE BIRDS OF HAWAII by R. L. Pyle (1983). An authoritative compilation of all species naturally occurring in Hawaii as well as those introduced by man which are currently established as viable populations. Gives each species' status. (Postpaid).....\$2.00

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	George Campbell	941-1356

## 'ELEPAIO

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CALENDAR OF EVENTS

- Apr. 8 (Mon.) Board meeting at the home of George Campbell, 1717 Ala Wai Blvd., Apt. 2303, Honolulu, at 7:00 pm. Call 941-1356 for info.
- Apr. 14 (Sun.) Field trip to Ulupau Head, KMCAS, Oahu to see seabirds. Call Bob Pyle (262-4046) for more info or see page 107.
- Apr. 15 (Mon.) General meeting with Peggy Hickok Hodge on "Birding in Australia's National Parks". McCully-Moiliili Library at 2211 S. King St., at 7:30 pm.

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HAWAII AUDUBON SOCIETY  
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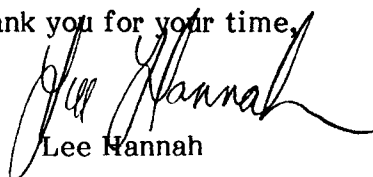
April 11, 1984

Mr. Manabu Tagomori  
Department of Land and Natural Resources  
State of Hawaii  
1151 Punchbowl St.  
Honolulu, Hawaii

Dear Mr. Tagomori,

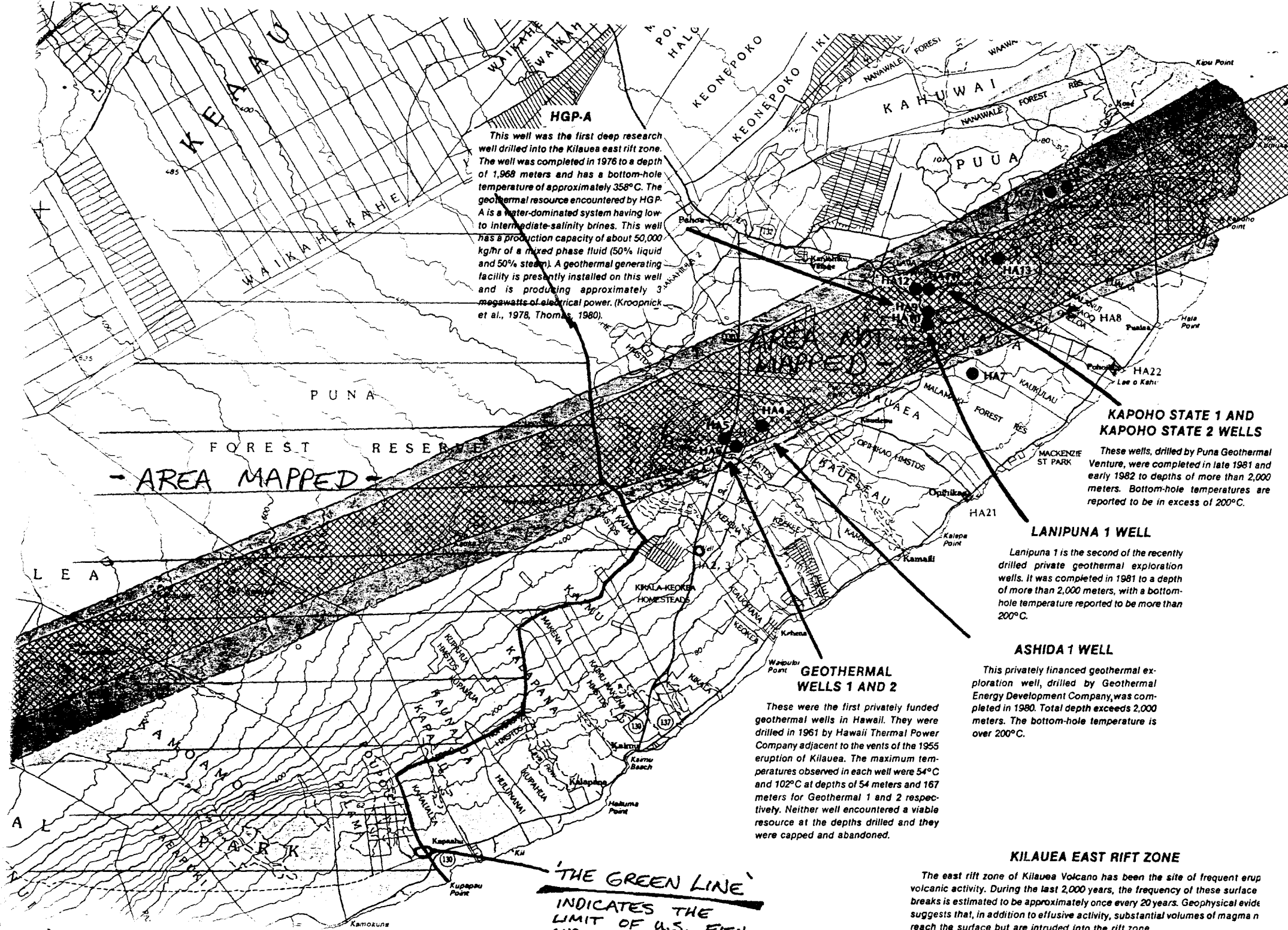
As per our conversation of 4/9, I am writing to give you an estimate of the cost to date and future cost of our portion of the environmental information gathering for the geothermal subzone assessment. The Environmental Center has to this time expended just over \$500 for supplies, travel expenses, and other costs. Our most recent itemization of these costs is attached. This itemization does not include recent phone bills, and is therefore somewhat under the true figure. Future costs of the project will include travel costs to the Big Island and to Maui, per diem, and rent-a-car (4WD) at the very least. This will permit library research to collect existing written records and spot-check site visits by myself to verify that the library information is current and accurate. A more desirable situation would be to hire a botanist who is a resident of the Big Island to perform the field checks in the East Rift Zone and use my travel expenses to quickly check the site or sites on Maui against the information we gather here in town. I would not feel comfortable under any circumstances about making statements about the biology of areas I have not even visited. The third and final level of effort that could be undertaken in this project, and the one I would feel best about in the long run, would be to do our library work here, hire the Big Island botanist to do spot checks, and then go in with a field crew and survey inaccessible areas. This is desirable because it is not safe for a person to hike into undeveloped areas of the East Rift Zone alone, due to the presence of cracks, poor footing, and other hazards which may be difficult to detect due to the thick forest. Therefore, while a botanist could conduct spot checks near roads and established trails without assistance, a support team would be desirable in some of the areas we may need to examine. I have attached a table which indicates these three of effort and itemizes the cost associated with each. The key in each case is that the U.S. Fish and Wildlife Service has already completed a very good vegetation survey for part of the rift zone, so the area we have to recover is reduced. The area that has been mapped by USFWS is indicated on the attached figure (the boundary of their map is indicated by the green line). As you can see, while they have covered a good portion of the rift zone, much of the area of geothermal interest remains to be surveyed. This area is not small, and the sooner we can make our plans and get started the better. If you have any questions please don't hesitate to contact me. Dean and I should be in close communication in any event.

Thank you for your time.



Lee Hannah

AN EQUAL OPPORTUNITY EMPLOYER



**HGP-A**  
 This well was the first deep research well drilled into the Kilauea east rift zone. The well was completed in 1976 to a depth of 1,968 meters and has a bottom-hole temperature of approximately 356°C. The geothermal resource encountered by HGP-A is a water-dominated system having low to intermediate-salinity brines. This well has a production capacity of about 50,000 kg/hr of a mixed phase fluid (50% liquid and 50% steam). A geothermal generating facility is presently installed on this well and is producing approximately 3 megawatts of electrical power. (Kroopnick et al., 1978, Thomas, 1980).

**KAPOHO STATE 1 AND KAPOHO STATE 2 WELLS**  
 These wells, drilled by Puna Geothermal Venture, were completed in late 1981 and early 1982 to depths of more than 2,000 meters. Bottom-hole temperatures are reported to be in excess of 200°C.

**LANIPUNA 1 WELL**  
 Lanipuna 1 is the second of the recently drilled private geothermal exploration wells. It was completed in 1981 to a depth of more than 2,000 meters, with a bottom-hole temperature reported to be more than 200°C.

**ASHIDA 1 WELL**  
 This privately financed geothermal exploration well, drilled by Geothermal Energy Development Company, was completed in 1980. Total depth exceeds 2,000 meters. The bottom-hole temperature is over 200°C.

**GEOTHERMAL WELLS 1 AND 2**  
 These were the first privately funded geothermal wells in Hawaii. They were drilled in 1961 by Hawaii Thermal Power Company adjacent to the vents of the 1955 eruption of Kilauea. The maximum temperatures observed in each well were 54°C and 102°C at depths of 54 meters and 167 meters for Geothermal 1 and 2 respectively. Neither well encountered a viable resource at the depths drilled and they were capped and abandoned.

**KILAUEA EAST RIFT ZONE**  
 The east rift zone of Kilauea Volcano has been the site of frequent eruptive volcanic activity. During the last 2,000 years, the frequency of these surface breaks is estimated to be approximately once every 20 years. Geophysical evidence suggests that, in addition to effusive activity, substantial volumes of magma reach the surface but are intruded into the rift zone. In spite of the very extensive volcanic activity in this area, surface geothermal resources are limited, being restricted to isolated areas of steaming ground.

**'THE GREEN LINE'**  
 INDICATES THE LIMIT OF U.S. FISH AND WILDLIFE SERVICE

**AREA MAPPED**

<u>LEVEL I</u>	Additional Personnel	Cost Itemization	Information Generated
	none	Airfare (3RT)@\$84 \$252 4-WD (14d)@\$50 \$700 per diem (14d)@\$45 \$630 Supplies \$100 <hr/> Total \$1,702 <i>FOR ENVIRONMENTAL + 400</i> <i>WARRANT</i> # <i>2,102</i>	Library research. Catagorized vegetation map above 'green line'. Detailed vegetation map above green line. No mapping below green line.
	1 Botanist (1 mo)	Botanist Salary \$1,600 <hr/> Total \$3,302	Library research. Catagorized and detailed vegetation maps above green line. Catagorized vegetation map below green line, based on very general field observations, no detailed supporting map below green line.
	Temporary Field Crew	1 Field Botanist (14d)@\$70 \$980 1 Trail Crew (14d)@560 \$560 Weekend pay for regular botanist (4d)@\$70 \$280 Field Supplies \$200 <hr/> Level III subtotal \$2,020	Library research. Catagorized vegetation maps above and below green line, supported by detailed vegetation maps based on systematic field work above and below green line.
		TOTAL \$7,024	

