

BIOLOGICAL SURVEY
OF THE
PROPOSED ACCESS ROAD
AND
WELL SITE 1

BLNR DESIGNATED GEOTHERMAL RESOURCE SUBZONE
MIDDLE EAST RIFT ZONE OF KILAUEA
PUNA DISTRICT, ISLAND OF HAWAI'I

November 14, 1987

by

Charles H. Lamoureux

Winona P. Char

Paul Higashino

Maile S. Kjargaard

PREPARED FOR:
TRUE/MID PACIFIC GEOTHERMAL VENTURE

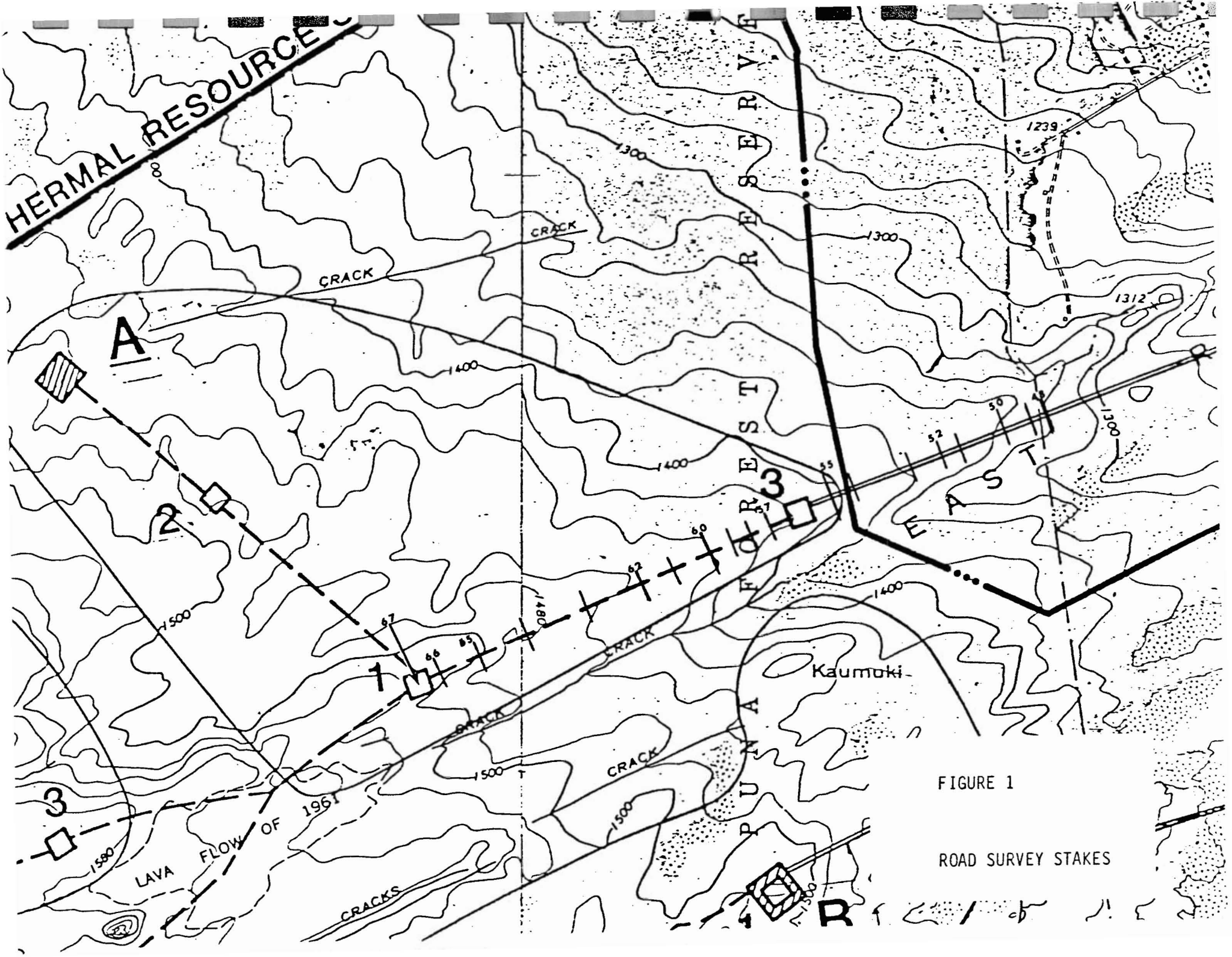
INTRODUCTION

On 14 November 1987 a biological baseline survey was conducted of the proposed access road and well site 1. The road and well site had recently been surveyed and staked; reference is made throughout this report to "stake #__", the surveyor's stakes placed at irregular intervals along the access road. Their locations are indicated on FIG. 1.

METHODOLOGY

The study covered the areas between stake # 48 (just outside, or east of, the conservation district boundary) and stake # 67 (at well site 1). The ornithologist proceeded in advance of the botanists, to avoid undue disturbance to birds, and at each stake she conducted a standard 8-minute census of all birds seen or heard.

The botanists surveyed an area of 75 to 100 feet in width with its center line along the center line of the road alignment. In three places where the proposed road alignment deviated to the south of the surveyor's line to avoid geological hazards, (between stakes 48 and 50, with a deviation of 50 feet at stake 49; between stakes 55 and 57, with a deviation of 50 feet at stake 56; between stakes 58 and 60, with a deviation of 150 feet at stake 59), the center line of the survey area followed the proposed road alignment rather than the surveyor's line. At well site 1 an area of about 500 feet square was surveyed, centered on



HERMAL RESOURCE

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FIGURE 1
ROAD SURVEY STAKES

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stake 67, i.e., an area about twice as great as the proposed area to be cleared for well site 1. All vascular plant species encountered were recorded, and notes made of their abundance. Observations of vegetation structure were made, including information on size and condition of dominant tree species, extent of canopy cover, and nature and extent of the subcanopy and understory.

RESULTS

1. FLORA

All species of vascular plants observed are listed in TABLE I. A total of 103 species and varieties were found, of which 68 were native, (51 endemic to the Hawaiian islands, 17 indigenous, native in Hawai'i and elsewhere), and 35 were species introduced to Hawai'i by humans (3 by the Polynesian settlers, 32 since European contact).

Two species were encountered which are being considered for listing by the U. S. Fish and Wildlife Service (1980) as endangered species: Bobea timonioides (Hook. f.) Hillebr. and Tetraplasandra hawaiiensis Gray var. hawaiiensis.

Bobea timonioides is a Category 1 species, one for which the Service had sufficient information to support the biological appropriateness of listing, but for which data still needed to be collected concerning the environmental and economic impacts of listing and designation of Critical Habitat. It has been found in many places in the Puna District in recent years.

Tetraplasandra hawaiiensis var. hawaiiensis is

a Category 2 species, for which the Service had information to support the probable appropriateness of listing as endangered or threatened, but for which sufficient information was not yet available to biologically support a proposed rule. It is not currently considered a high priority item for listing since its range has been shown to be more extensive than previously believed.

2. VEGETATION

The vegetation of the Puna Geothermal Area had previously been described and mapped (Char and Lamoureux, 1985a, 1985b)

Most of the road and the well site are in forest described in earlier reports as Wet 'ohi'a forest with native species and exotic shrubs, and delimited on the vegetation maps in Char and Lamoureux, (1985a) as "ohia-a(2)". This forest is dominated by 'ohi'a-lehua (three varieties of Metrosideros collina), which forms the canopy layer. Trees are mature, ranging from 20 to 60 feet in height. In some places the canopy is closed (>60% cover) with most or all trees healthy, in other places more open and many of the trees are dead. In other words there are patches of 'ohi'a dieback in the forest. The more common subcanopy trees include both native species, (kopiko - Psychotria hawaiiensis, kava'u - Ilex anomala, and hame - Antidesma platyphyllum), and introduced species, (guava - Psidium guajava and strawberry guava - Psidium

cattleianum). Tree ferns (hapu'u - Cibotium glaucum and hapu'u 'i'i - Cibotium chamissoi) are common. The dominant shrub throughout the area is the introduced weedy Malabar melastome (Melastoma malabathricum), but some native shrubs are relatively common, including kanawao (Broussaia arguta), mamaki (Pipturus hawaiiensis), 'ohelo (Vaccinium calycinum), Clermontia parviflora, and Cyrtandra paludosa, along with the introduced thimbleberry (Rubus rosaefolius). In more closed parts of the forest the trees, tree ferns, and shrubs support dense masses of epiphytes, including many ferns (listed in Table I), mosses and liverworts. In more open places there are extensive patches of uluhe ferns (Dicranopteris emarginata and D. linearis) 3 to 8 feet deep.

Between stakes 64 and 66 is an area where the 'ohi'a trees are very widely scattered and the uluhe fern is particularly dense. This area was described as 'Ohi'a woodland with uluhe, and designated as "ohia - uluhe" on vegetation maps in our earlier report (Char and Lamoureux, 1985a).

At well site one the 'ohi'a forest was composed of fairly small trees, 25 to 30 feet tall, with an open canopy. There was a dense understory of Malabar melastome (about 60% cover). This area may have been used by humans in the past, since the only kukui tree (Aleurites moluccana) and 'avapuhi ginger (Zingiber zerumbet) we found were at this site.

We noted signs of feral pig activity throughout the area, and encountered one sow with young during our survey. In places

where pigs have rooted, and in small open wet areas where they have wallowed, are a number of introduced weeds which are usually not found in undisturbed forest. These include a fern (Athyriopsis japonica), broomsedge (Andropogon virginicus), Californiagrass (Brachiaria mutica), Hilograss (Paspalum conjugatum), a sedge (Cyperus haspan), waterpurselane (Ludwigia palustris), St. Johnswort (Hypericum mutilum), drymaria (Drymaria cordata), and fireweed (Erechtites valerianaeifolia). A few small taro plants (Colocasia esculenta) were found in some old wallows.

3. AVIFAUNA

See separate report by Kjargaard attached as APPENDIX I.

ENDANGERED SPECIES

1. Bobea timonioides: Two trees of this Category 1 plant were encountered. One was just at the conservation district boundary, and about 5 feet north of the surveyor's line. At this point the road is planned to veer southward, and if the curve to the south begins perhaps 50 feet outside the conservation district line, instead of right on the line, this tree can be avoided. The second tree is about 50 feet east of stake 58 and about 5 feet north of the surveyor's line. The road is planned to veer south starting at stake 58. If the curve to the south were to begin perhaps 100 feet east of stake 58 this tree can be avoided.

2. Tetraplasandra hawaiiensis: About half a dozen trees of this Category 2 species were found. All but one was more than 20 feet from the centerline of the proposed road should not be damaged by road construction. The one exception is close to the first Bobea tree, right at the conservation district boundary, but about 10 feet south of the surveyor's line. At this point the road is supposed to veer southward. If, as suggested in the paragraph above, the southward curve were to begin slightly outside the conservation district, instead of just at the boundary, this tree could be avoided too.

3. Adenophorus periens: A special search was made for this Category 1 plant. We did not find any. This area is below the elevation the elevation where this fern is known to occur in Puna. Also, most of the 'ohi'a trees in the area are characterized by having bark that peels off in large strips. Since these trees shed their bark regularly, they do not develop the dense coating of mosses and liverworts on their bark which forms the substrate on which A. periens grows.

4. Buteo solitarius: The Hawaiian hawk, or 'I'o, was not encountered during our survey, although it undoubtedly occurs in the area. The proposed construction would be unlikely to have significant adverse effects on the hawk population, unless nests were to be destroyed. We did not find any nests along the proposed road or at the well site.

RECOMMENDATIONS

1. No listed endangered species were encountered during our survey, but three trees were found which could be damaged by road construction. We recommend that, in the two places specified above, the planned southward deviation of the road from the surveyor's line should begin a few feet east of the places indicated on the surveyor's plan, thus avoiding these trees.

2. The area now contains a large population of introduced woody shrubs and trees, particularly Malabar melastome, strawberry guava, and guava. It is unlikely that construction activities will have much effect on their abundance or distribution. However, there are several other weeds that could increase in numbers and become more widely distributed as a consequence of opening up the forest as construction occurs. These are the species currently associated with pig-disturbed areas, such as broomsedge, Californiagrass, Hilograss, Cyperus haspan, and fireweed. Other weeds, not now in the area, could also enter. To avoid this we recommend that:

a. road construction methods should be planned to involve as little disturbance as possible beyond the edge of the road. This might include using soil and rocks from high points to fill in low spots rather than bulldozing them into ridges at the sides of the road.

b. the well site and road margins be monitored for weeds, and that appropriate weed control methods be used on all cleared

areas. (Appropriate methods might include both mechanical methods and judicious use of approved herbicides such as weed oil or Roundup).

3. Our observations elsewhere suggest that unpaved road margins and open roadsides are prime sites for weed colonization. Most weedy species require high light intensities to grow well, and such sites are open to full sunlight. If such areas are kept shaded they are less likely to be colonized by weeds. Thus as few trees as possible should be removed from roadsides. During construction if trees are simply bulldozed aside and, with other vegetation, rocks, and soil are piled up into windrows, these rubble piles will soon be covered with weeds. In the construction process many 'ohi'a trees will be cut. The wood they produce may constitute a resource valuable enough to make it worth selling and trucking the logs off the site, which would significantly reduce the volume of rubble piles. We recommend that you look into the feasibility of this.

4. A lot of good quality tree fern (hapu'u and hapu'u-'i'i) will also have to be removed during construction. The fern logs should be marketable to orchid growers or nurseries, and should more than repay the cost of hauling them off the site. However, the top foot or two of each fern stem, containing the apical bud, should be retained and replanted on the site. This would meet the state requirement that any landscaping be done with native species. More importantly, it would provide a quick source of shade on rubble piles and road margins, which should reduce the

weed problem.

5. We have looked at the area around the proposed well site to see if there are nearby areas where clearing the site would have different environmental impacts. The site now designated is an area of 'ohi'a s-(2) forest, but just to the east is a more open 'ohi'a - uluhe woodland. Selecting a well site in the woodland would involve cutting fewer trees than in the forest. However, the forest at the designated site is botanically degraded, with a very dense understory of Malabar melastome. The uluhe fern in the woodland is a native Hawaiian species, which results in the percentage of cover of native species being higher in the woodland than in this particular patch of forest. No rare species were found in either site. Thus, from a botanical standpoint the currently designated well site seems appropriate. On the other hand, there is a resident population of a native bird, the Hawai'i 'elepaio in the forest site but not in the woodland. While birds are able to move to avoid construction activities, the 'elepaio tends to be territorial in its habits and may not move as easily as some other species. It was rare along the proposed roadway, and the largest population encountered was at the well site. The 'elepaio is not listed as an endangered species. Taking all this into account, there is no compelling environmental reason to shift the well site a few hundred feet eastward, but you may want to consider this option if the geology of the site is as favorable as that at the currently designated site.

LITERATURE CITED

CHAR, W. P. and C. H. LAMOUREUX. 1985a. Puna Geothermal Area Biotic Assessment, Puna District, County of Hawai'i. Prepared for Hawaii State Department of Planning and Economic Development. April 1985. 126 pp. plus appendices.

CHAR, W. P. and C. H. LAMOUREUX. 1985b. Botanical Survey of the Potential Geothermal Areas in State-Owned Land in the Middle East Rift Zone of Kilauea, Puna District, Island of Hawai'i. Prepared for True/Mid Pacific Geothermal Venture. 41 pp.

U. S. FISH AND WILDLIFE SERVICE. 1980. Endangered and Threatened Wildlife and Plants. Review of Plant Taxa for Listing as Endangered or Threatened. Federal Register 45(242):82480-82569.

TABLE 1. PLANT SPECIES CHECKLIST

Families are arranged alphabetically within each of three groups: Ferns and Fern Allies, Monocotyledons, and Dicotyledons. Taxonomy and nomenclature of the Ferns and Fern Allies follow Lamoureux's unpublished checklist of Hawaiian ferns; taxonomy and nomenclature of the flowering plants (Monocotyledons and Dicotyledons) follow St. John (1973) except where more commonly accepted names are listed. Hawaiian names used in the checklist are in accordance with Porter (1972) or St. John (1973).

For each species the following information is provided:

1. Scientific name with author citation.
2. Common English or Hawaiian name, when known.
3. Biogeographic status of the species. The following symbols are used:

E = endemic = native to the Hawaiian Islands only,
not occurring naturally elsewhere.

I = indigenous = native to the Hawaiian Islands and
also to one or more other geographic
areas.

P = Polynesian = plants of Polynesian introduction;
all those plants brought by the
Polynesian immigrants prior to contact
with the Western world.

X = exotic or introduced = not native to the Hawaiian
Islands; brought here intentionally or
accidentally by man after Western contact.

TABLE I.

PUNA GEOTHERMAL AREA
PLANT CHECKLIST: ACCESS ROAD AND WELL SITE 1

Page 1

STATUS	BOTANICAL NAME	COMMON NAME
PLENIACEAE		
I	<i>Asplenium lobulatum</i> Mett.	pi'ipi'i-lau-manamana, 'anali'i
I	<i>Asplenium nidus</i> L.	'ekaha
ATHYRIACEAE		
X	<i>Athyriopsis japonica</i> (Thunb.) Ching	
E	<i>Diplazium sandwichianum</i> (Presl) Diels	ho'i'o
ECHINACEAE		
X	<i>Blechnum occidentale</i> L.	blechnum fern
MINSTRAEDTIACEAE		
I	<i>Microlepia strigosa</i> (Thunb.) Presl	palai, palapalai
CYKSONIACEAE		
E	<i>Cibotium chamissoi</i> Kaulf.	hapu'u-'i'i
E	<i>Cibotium glaucum</i> (J. Sm.) Hook. & Arn.	hapu'u
LAPHOGLOSSACEAE		
E	<i>Elaphoglossum alatum</i> Gaud. var. <i>parvisquamum</i> (Skottsb.) Ands. & Crosby	'ekaha-ula, hoe-a-Maui
E	<i>Elaphoglossum crassifolium</i> (Gaud.) And. & Crosby	'ekaha-ula, hoe-a-Maui
E	<i>Elaphoglossum hirtum</i> (Sw.) C. Chr. var. <i>micans</i> (Mett.) C. Chr.	'ekaha-ula, hoe-a-Maui
E	<i>Elaphoglossum pellucidum</i> Gaud.	'ekaha-ula, hoe-a-Maui
E	<i>Elaphoglossum wawrae</i> (Luer) C. Chr.	'ekaha-ula, hoe-a-Maui
ICHENIACEAE		
E	<i>Dicranopteris emarginata</i> (Brack.) Rob.	uluhe
I	<i>Dicranopteris linearis</i> (Burn.) Underw.	uluhe
GRAMMITACEAE		
E	<i>Adenophorus hymenophylloides</i> (Kaulf.) Hook. & Grev.	pai, palai-huna
E	<i>Adenophorus pinnatifidus</i> Gaud.	
E	<i>Adenophorus tamariscinus</i> (Kaulf.) Hook. & Grev. var. <i>tamariscinus</i>	wahine-noho-mauna
E	<i>Adenophorus tripinnatifidus</i> Gaud.	
E	<i>Grammitis tenella</i> Kaulf.	kolokolo, mahina-lua
PHLEBOPHYLLACEAE		
E	<i>Callistopteris baldwinii</i> (Eaton) Copel.	
I	<i>Gonocormus minutus</i> (Blume) v. d. Bosch	
E	<i>Mecodium recurvum</i> (Gaud.) Copel.	'ohi'a-ku
E	<i>Sphaerocionium lanceolatum</i> (Hook. & Arn.) Copel.	palai-hinahina
E	<i>Sphaerocionium obtusum</i> (Hook. & Arn.) Copel.	Palai-lau-li'i

STATUS	BOTANICAL NAME	COMMON NAME
E	<i>Vandenboschia cyrtotheca</i> (Hillebr.) Copel.	
E	<i>Vandenboschia davallioides</i> (Gaud.) Copel.	palai-hihi
PSAEACEAE		
I	<i>Sphenomeris chinensis</i> (L.) Maxon	pala'a, palapala'a
PODIACEAE		
E	<i>Lycopodium phyllanthum</i> Hook. & Arn.	wawae-'iole
PTIDIACEAE		
E	<i>Marattia douglasii</i> (Presl) Baker	pala, kapua'i hoki
PSIDACEAE		
I	<i>Nephrolepis cordifolia</i> (L.) Presl	ni'ani'au, kupukupu, 'okupukupu
I	<i>Nephrolepis exaltata</i> (L.) Schott	ni'ani'au, kupukupu, pamoho
X	<i>Nephrolepis multiflora</i> (Roxb.) Jarrett ex Morton	hairy sword fern
PSITTACACEAE		
E	<i>Ophioglossum pendulum</i> L. ssp. <i>falcatum</i> (Presl) Clausen	puapua-moa
PODIACEAE		
I	<i>Pleopeltis thunbergiana</i> Kaulf.	'ekaha-'akolea, pakahakaha
PSITTACACEAE		
I	<i>Psilotum complanatum</i> Sw.	moa, pipi
I	<i>Psilotum complanatum</i> X <i>nudum</i>	hybrid moa
I	<i>Psilotum nudum</i> (L.) Beauv.	moa, pipi
PSITTACACEAE		
E	<i>Selaginella arbuscula</i> (Kaulf.) Spring	lepelepe-a-moa
PSITTACACEAE		
X	<i>Christella dentata</i> (Forsk.) Brownsey & Jermy	downy woodfern
X	<i>Christella parasitica</i> (L.) Levl.	woodfern, oakfern
X	<i>Macrothelypteris torresiana</i> (Gaud.) Ching	
E	<i>Pneumatopteris sandwicensis</i> (Brack.) Holtt.	
PSITTACACEAE		
P	<i>Colocasia esculenta</i> (L.) Schott	kalo, taro
PSITTACACEAE		
X	<i>Cyperus haspan</i> L.	
X	<i>Kyllingia brevifolia</i> Rottb.	kili'o'opu, kyllingia
I	<i>Machaerina mariscoides</i> (Gaud.) Kern ssp. <i>meyenii</i> (Kunth) Koyama	'uki, 'aha-niu

STATUS	BOTANICAL NAME	COMMON NAME
E	<i>Rhynchospora lavarum</i> Gaud.	kuolohia, pu'uko'a
POACEAE		
X	<i>Andropogon virginicus</i> L.	broomsedge
X	<i>Axonopus affinis</i> Chase	narrow-leaved carpetgrass
X	<i>Brachiaria mutica</i> (Forsk.) Stapf	Californiagrass
X	<i>Oplismenus hirtellus</i> (L.) Beauv.	honohono-kukui, basketgrass
X	<i>Paspalum conjugatum</i> Berg.	mau'u-Hilo, Hilo grass
X	<i>Paspalum orbiculare</i> Forst. f.	mau'u-laiki, ricegrass
X	<i>Sacciolepis indica</i> (L.) Chase	Glenwoodgrass
DIOSCOREACEAE		
E	<i>Smilax sandwicensis</i> Kunth	hoi-kuahiwi
ORCHIDACEAE		
X	<i>Arundina bambusaefolia</i> (Roxb.) Lindl.	bamboo orchid
X	<i>Spathoglottis plicata</i> Bl.	Philippine ground orchid
DIAPYCNACEAE		
E	<i>Freycinetia arborea</i> Gaud.	'ie'ie
ZINGIBERACEAE		
P	<i>Zingiber zerumbet</i> (L.) Roscoe	'amapuhi kua hiwi
NYCTAGINACEAE		
E	<i>Alyxia olivaeformis</i> Gaud.	maile
ILEXACEAE		
E	<i>Ilex anomala</i> Hook. & Arn.	kama'u
ELMACEAE		
E	<i>Tetraplasandra hawaiiensis</i> Gray var. <i>hawaiiensis</i>	'che
RYOPHYLLACEAE		
X	<i>Drymaria cordata</i> (L.) Willd. ex R. & S.	drymaria, pipili
COMPOSITAE		
I	<i>Adenostemma lavenia</i> (L.) Ktze.	kamanamana
X	<i>Ageratum conyzoides</i> L.	ageratum, maile-hohono
X	<i>Ageratum houstonianum</i> Mill.	ageratum
X	<i>Erechtites valerianaefolia</i> (Wolf) DC.	fireweed
X	<i>Eupatorium riparium</i> Regel	Hamakua pamakani
ERICACEAE		
E	<i>Vaccinium calycinum</i> Sm.	'chelo-kau-la'au

STATUS	BOTANICAL NAME	COMMON NAME
EUPHORBIACEAE		
P	<i>Aleurites moluccana</i> (L.) Willd.	kukui
E	<i>Antidesma platyphyllum</i> Mann	hame
GESNERIACEAE		
E	<i>Cyrtandra paludosa</i> Gaud. var. <i>integrifolia</i> Hillebr.	
E	<i>Cyrtandra paludosa</i> Gaud. var. <i>irrostrata</i> St. John	
HYPERICACEAE		
X	<i>Hypericum mutilum</i> L.	St. Johnswort
CLERMONTIACEAE		
E	<i>Clermontia hawaiiensis</i> (Hillebr.) Rock	'oha-kepau
E	<i>Clermontia parviflora</i> Gaud. ex Gray	
CUPHEACEAE		
X	<i>Cuphea carthagenensis</i> (Jacq.) Macbride	cuphea, puakamoli
MELASTOMACEAE		
X	<i>Melastoma malabathricum</i> L.	Malabar melastome
MYRSINACEAE		
E	<i>Myrsine lessertiana</i> A. DC.	kolea-lau-nui
METROSIDERACEAE		
E	<i>Metrosideros collina</i> (J.R. & G. Forst.) Gray var. <i>glaberrima</i> (Lvl.) Rock	'ohi'a-lehua
E	<i>Metrosideros collina</i> (J.R. & G. Forst.) Gray var. <i>incana</i> (Lvl.) Rock	'ohi'a-lehua
E	<i>Metrosideros collina</i> (J.R. & G. Forst.) Gray var. <i>macrophylla</i> Rock	'ohi'a-lehua
X	<i>Psidium cattleianum</i> Sabine forma <i>cattleianum</i>	strawberry guava, waiami-'ulua
X	<i>Psidium cattleianum</i> Sabine forma <i>lucidum</i> Deg.	yellow strawberry guava, waiami
X	<i>Psidium guajava</i> L.	guava, kuama
PISONIACEAE		
I	<i>Pisonia umbellifera</i> (J.R. & G. Forst.) Seem.	papala-kepau
LUDWIGIACEAE		
I	<i>Ludwigia octovalvis</i> (Jacq.) Raven	kamole, primrose willow
X	<i>Ludwigia palustris</i> (L.) Ell.	water purselane
PEPEROMIACEAE		
E	<i>Peperomia cookiana</i> C. DC.	'ala'ala-wai-nui
E	<i>Peperomia hypoleuca</i> Miq. var. <i>hypoleuca</i>	'ala'ala-wai-nui
E	<i>Peperomia latifolia</i> Miq.	'ala'ala-wai-nui

STATUS	BOTANICAL NAME	COMMON NAME
I	<i>Peperomia tetraphylla</i> (Forst. f.) Hook. & Arn. var. <i>tetraphylla</i>	'ala'ala-wai-nui
ROSACEAE		
X	<i>Rubus rosaefolius</i> Sa.	thimbleberry
RUBIACEAE		
E	<i>Bobea timonioides</i> (Hook. f.) Hillebr.	'ahakea
E	<i>Coprosma ochracea</i> Oliver var. <i>rockiana</i> Oliver	pilo, kopa
E	<i>Gouldia terminalis</i> (Hook. & Arn.) Hillebr.	manono
X	<i>Paederia foetida</i> L.	maile pilau
E	<i>Psychotria hawaiiensis</i> (Gray) Fosb. var. <i>hawaiiensis</i>	kopiko
URTIACEAE		
E	<i>Pelea clusiaefolia</i> Gray var. <i>cuneata</i> St. John & Hume	alani
XIFRAGACEAE		
E	<i>Broussaisia arguta</i> Gaud.	kanamao
CARYOPHYLLIFERAE		
X	<i>Centella asiatica</i> (L.) Urban	Asiatic pennywort, pohekula
URTICACEAE		
E	<i>Pipturus hawaiiensis</i> Levl.	mamaki

APPENDIX I

Baseline avian survey, proposed access road and wellsite A1, geothermal resource subzone, Puna Forest Reserve, Puna, Hawaii.

Maile S. Kjargaard, Volcano, Hawaii
November 14, 1987.

A. Methods

I conducted standard eight minute censuses (see Ramsey and Scott, 1979 for methods) at designated stake numbers from the conservation zone boundary to the wellsite. All birds seen or heard were counted during these intervals. Observations of unusual species or pertinent biological details made between stations were also noted.

B. Annotated species list

Status symbols follow Pyle (1983) (see attached sheet), scientific and vernacular names follow the 6th edition of the AOU Checklist of North American Birds (1983).

FAMILY PHASIANIDAE (QUAILS, PHEASANTS, FRANCOLINS)

Lophura leucomelana Kalij Pheasant

Fn

Rare; apparently not particularly selective about subcanopy composition where it occurs in the survey area since it was found in both major vegetation types.

FAMILY TIMALIIDAE (BABBLERS)

Garrulax canorus Melodious Laughing-thrush

F1

Common in the lower portion of the study area; rarer in the less disturbed regions near the proposed wellsite.

FAMILY TURDIDAE (THRUSHES)

Phaeornis obscurus obscurus 'Oma'o, Hawaii Thrush

Re

Present in low numbers throughout, but more frequently observed in the upper part of the site (stations 56-67).

FAMILY MUSCIPIDAE (OLD WORLD FLYCATCHERS)

Chasiempis sandwichensis sandwichensis Hawaii 'Elepaio

Re

One substantial population present at the upper part of the study area, otherwise rare. Vigorous low elevation populations of this species are no longer as common as they once were as recently as a decade ago.

FAMILY ZOSTEROPIDAE (WHITE-EYES)

Zosterops japonicus Japanese White-eye

F1

Abundant and widely distributed, present in all habitat types.

FAMILY FRINGILLIDAE (FINCHES, CARDINALS, HAWAIIAN HONEYCREEPERS)

Cardinalis cardinalis Cardinal

F1

One population occurred in the more disturbed lower portion of the study area.

Carpodacus mexicanus House Finch

F1

Present in the lower part of the site; the occurrence of this species appeared to be positively correlated with the presence of dense stands of strawberry guava.

Hemignathus virens virens Hawaii 'Amakihi

Re

Found in low numbers throughout the site, but slightly more common in the upper portion of the proposed road and in the vicinity of the wellsite.

Nest construction by an individual of this species observed at stake 53.

Himatione sanguinea sanguinea 'Apapane

Re

Widely distributed and common, most abundant in the upper half of the study site. Highest densities occur in all vegetation types which have a healthy population of Metrosideros; stand-level dieback areas had significantly fewer native bird species as a whole.

Vestiaria coccinea 'I'iwi

Rare. One questionable detection of this species occurred at station 52.

C. General field observations and recommendations

1. Native bird observations were most frequent in the less disturbed upper portion of the study area. Within these areas, densities of the honeycreeper species appeared to be more correlated with the vigor and density of Metrosideros than with the composition of the understory flora. 'Elepaio and Thrush densities were probably more sensitive to the characteristics of the subcanopy since neither are nectivorous ('Elepaio feed primarily on insects, while Thrush will take both fruit and insects).

2. Extraordinarily high mosquito densities at stations 53 through 61 did not appear to be negatively correlated with presence of native forest birds. My inability to stand quietly during census periods at these stations may be partially responsible for the precipitous drop in species diversity after station 53 (though see comments below, #4).

3. No Hawaiian Hawk were found in the area. However, this species is notoriously difficult to census in forested areas, and

they are undoubtedly present here as the habitat is appropriate for them, and there are high densities of Hawk in nearby locations (pers. obs.).

4. Alien bird species diversity declined noticeably after station 53 (with the exception of the Japanese White-eye). The species that dropped out here were those that feed primarily on seeds and fruit (eg., the Cardinal, House Finch and Melodious Laughing-thrush), indicating that the decline may be correlated with a decrease in density of certain food plants such as waiwi and strawberry guava.

5. This area remains viable as avian habitat in spite of invasion of numerous weedy plant species; such habitat in low elevation areas is becoming more and more scarce as developmental demands increase. My preference would be for geothermal development to be concentrated in locations that have already been perturbed rather than opening up new parcels of forest; as such is obviously not an option in this case, the following recommendations for mitigation are appropriate:

a) If possible, deviate the road away from present avian "hot spots" such as the 'Elepaio population at stations 66 and 67, and the vigorous stands of Metrosideros in the vicinity of stations 60 and 61.

b) Impact on native forest bird populations could be reduced by locating power plants and well sites in areas of stand-level dieback and/or high alien plant species density where native bird populations have already been depressed.

D. Raw data

The table below gives the results of 20 censuses performed at designated stake numbers along the proposed access road and at the proposed wellsite, expressed as number of individuals of each species.

SPECIES	STATION																				
	48	9	50	1	2	3	4	5	6	7	8	9	60	1	2	3	4	5	6	7	
<u>Lophura leucomelana</u>						1									1						
<u>Garrulax canorus</u>		3	4	1	1	2													1		
<u>Phaeornis o. obscurus</u>		1							1	1		1		2			2				
<u>Chasiempis s. sandwichensis</u>						1														4	2
<u>Zosterops japonicus</u>	7	3	4	2	3	2	2	2		3	1	4	5	2	5	3	4	3	4	6	
<u>Cardinalis cardinalis</u>				1	2	2															
<u>Carpodacus mexicanus</u>				4	1	2	1	2													
<u>Hemignathus v. virens</u>		1	1			1		1		1				1			1	2	1	3	
<u>Himatione s. sanguinea</u>	2	3	1		2	1	3	6	4	6	4	3	3	9	8	6	4	4	3	9	
<u>Vestiaria coccinea</u>						1*															

*uncertain record, not visually confirmed.

E. Literature cited

American Ornithologist's Union (1983) Check-list of North American Birds, ed., Baltimore, AOU.

Pyle, R. (1983) Checklist of the birds of Hawaii. 'Elepaio 44:47-58.

Ramsey, F. L., and J. M. Scott (1979) Estimating population densities from variable circular plot surveys. In R. M. Cormack et. al., eds., Sampling Biological Populations. International Cooperative Publishing House, Fairland, Md.

STATUS SYMBOLS

RESIDENT SPECIES; NATIVE

- Re = Resident--endemic at species level;
not extinct
- Ri = Resident--indigenous species;
Hawaiian form not endemic
- Ris = Resident--indigenous species;
Hawaiian subspecies endemic

FOREIGN OR INTRODUCED SPECIES; RESIDENT

- Fl = Foreign--long-established;
breeding for more than 25 years
- Fn = Foreign--new introduction;
apparently established and breeding,
but for less than 25 years

BREEDING SPECIES IN HAWAI'I; NATIVE; MOST INDIVIDUALS LEAVE HAWAI'I WHEN NOT BREEDING

- Bi = Breeder--indigenous species;
Hawaiian form also breeds elsewhere
- Bis = Breeder--indigenous species;
Hawaiian subspecies breeds only in
Hawaiian Islands

VISITOR SPECIES; BREEDS ELSEWHERE; OCCURS IN HAWAI'I WHEN NOT BREEDING

- Vr = Visitor--regular migrant

ENDANGERED SPECIES (*)

An asterisk preceding the scientific name of the bird indicates that the species is currently on the federal list of endangered species (U. S. Fish & Wildlife Service 1979).