DESCRIPTION OF A NEW LARGE-SCALE VEGETATION MAPPING PROJECT IN HAWAI'I

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INTRODUCTION

Vegetation mapping is a method which is often used to display the distribution of plant communities or vegetation types in a two-dimensional format. It entails the delineation and description of more-or-less homogeneous patterns of the vegetation as interpreted usually either from aerial photographs or on the ground. The degree of homogeneity in the map units depends on what types of vegetation characteristics are being viewed, and what the overall purpose of the map is.

Two research projects are currently being conducted in the native forests of Hawai'i, for which it was considered essential to have an adequate map of the vegetation patterns in the different study areas. One of these projects, the Hawai'i Forest Bird Survey conducted by the U. S. Fish and Wildlife Service (USFWS), is attempting to determine the status and distribution of the native forest birds, with emphasis on the listed rare and threatened species on all of the islands. Field work for this survey is presently being conducted on the island of Hawai'i.

In the second project, the 'Ohi'a Forest Study, aspects of the dynamics of the native montane rain forests are being examined in detail, with particular emphasis on the phenomenon known as the 'ohi'a dieback. This project, directed by Dr. Dieter Mueller-Dombois of the University of Hawaii, was funded from 1975-1977 by a grant from the National Park Service.

An attempt was first made to utilize existing vegetation maps for these two projects. However, none of the available maps were found to be suitable for this purpose. Therefore, a new vegetation mapping project was initiated which will eventually cover the native forest areas on all of the major islands. This mapping project is supported primarily by the USFWS; however, additional support has come from the 'Ohi'a Forest Study for work on the windward side of the island of Hawai'i where the study areas overlapped.

In the following paper, a quick summary is made of the types of vegetation maps which currently exist, particularly for the island of Hawai'i, and the new mapping project is described in detail.

Discussion of Map Scale

A major factor to be considered when working with vegetation maps is the scale at which they were produced. A small-scale map shows units which are rather generalized and includes a considerable amount of variation. A large-scale map, on the other hand, shows map units which are quite detailed and includes considerably less variability. Table 1 gives a general summary of the different ranges of map scales and indicates the kinds of information which each can display.

Review of Some of the Vegetation Maps Which Have been Published for Hawai'i

There have been numerous different vegetation maps published for Hawai'i, some depicting the general vegetation on all of the islands, while many others deal with small specific areas in greater detail.

Probably the most familiar map is one published by Ripperton and Hosaka (1942) entitled Vegetation Zones of Hawai'i. This map fits into the intermediate-scale range of maps with all of the islands except Hawai'i mapped at approximately 1:500,000. The island of Hawai'i was mapped at the scale of 1:1.5 million, so all of the islands could be included on a single small map sheet.

Ten different vegetation zones are distinguished on this map which depict a combination of both actual and potential vegetation coverage as determined mainly by climatic and edaphic conditions. This map is useful for getting a general overview of the vegetation; however, it is difficult to work with in any detail on the ground.

Several other maps are available at this general scale which are very similar to Ripperton and Hosaka's, most notable being maps published by Knapp (1965) and Lamoureux (1973).

At the large map scale range, all areas on all of the major Hawaiian Islands were mapped at 1:62,500 by Honda and Klingensmith (1963), as part of the Hawaii Forest Type-Map series produced by the U. S. Forest Service and the Hawaii Division of Forestry. The map units in this case describe (a) land use class, (b) forest type (i.e., tree species composition), (c) density of tree cover, and (d) tree stand size class in terms of sawtimber classes. These vegetation types were interpreted from aerial photographs taken in 1954, but were compiled with only a minimal amount of ground verification.

Another large-scale map was published by Mueller-Dombois and Fosberg (1974) which describes the vegetation types of Hawaii Volcanoes National Park (HVNP). The vegetation patterns in this case were also interpreted from the 1954 photographs, and were ground checked in detail in the more accessible area. The map units were based primarily on dominant species and structural criteria (such as plant spacing and height) of the vegetation.

Both the Hawaii Forest Type-Maps and the HVNP map are at the map scale at which actual patterns of the vegetation are displayed with sufficient detail to serve as base maps for the Fish and Wildlife Service Forest Bird Survey and the study of the dynamics of the 'ohi'a rain forest. Unfortunately, the Hawaii Forest Type-Maps were not ground checked adequately and are, therefore, too inaccurate for practical use. The HVNP map, on the other hand, is much more accurate for what is displayed. However, it covers only a small portion of the forests in which we were interested. Additionally, since it was based on photographs taken nearly 25 years ago, it is unusable in areas in which the vegetation has changed considerably, particularly as the result of land clearing, and of 'ohi'a dieback in the 'Ola'a Tract forest section of the Park.

We, therefore, decided that the best way to approach the problem at hand was to produce a new vegetation map series, also at the large-scale level.

The Current Mapping Project

In the current project the vegetation types in most habitats dominated by native species on all of the major Hawaiian Islands will be mapped. The Fish and Wildlife survey was initiated in the summer of 1976 on the island of Hawai'i, and we expect to finish field work on Kaua'i in the summer of 1981. An attempt is being made to keep the vegetation mapping running concurrently with the field survey work for each of the different study areas.

Figure 1 shows the areas which will be mapped for the island of Hawai'i. To date, the map for one area, the Ka'u Forest, has been finished and is currently being published (Jacobi, in press). The preliminary mapping has been completed for the Hamakua, Waiakea, 'Ola'a, and Mauna Kea sections, and the final versions for each of these areas will be completed in the very near future. Currently, field work is being concentrated in the Hualalai and Kona regions.

Description of the Map Units

In this new map series, the vegetation is displayed at two levels of resolution. The first level shows the distribution of the general plant associations which in this case are defined by the predominant species composition of the dominant vegetation layer. So far at least 10 different general plant associations

have been identified which include, for example, alpine and subalpine scrub, grassland, 'ohi'a forest, 'ohi'a-koa forest, and tree fern dominated communities. For this purpose, the tree layer was considered to be dominant in open and closed forest stands.

The second level of resolution describes the vegetation in much greater detail. In this case, four major components of the vegetation are taken into account in determining the map units: (1) tree canopy crown cover, (2) tree canopy height, (3) dominant species composition of the tree layer, and (4) understory or groundcover composition. Tables 2 and 3 show the possible attributes fo each of the vegetation components. An example of a vegetation type symbol is shown in Table 4.

Mapping Procedure

Preliminary map units are first delineated on aerial photographs with the aid of a mirror stereoscope. Several types of aerial photos have been used for the different areas mapped so far. For the Ka'u Forest and Mauna Kea maps, the 1965 black and white EKL series photos (Soil Conservation Service) at the approximate scale of 1:24,000 were used. For the Hamakua, 'Ola'a, and Waiakea maps, two sets of photographs were used, one being a set of true color photos at the approximate scale of 1:12,000 taken in 1972 for the State Division of Forestry, and the other a set of color infrared photos, roughly at the scale of 1:50,000, taken by NASA in 1974-1975. Recently the U. S. Geological Survey has released an excellent set of air photos covering all of the island of Hawai'i and most of the other islands. These black and white photos were taken in 1976-1977, and are at the approximate scale of 1:40,000. We plan to use this series of photographs for most of the future mapping work on this project.

Once the preliminary mapping for an area has been completed, the boundaries on the photographs are compiled into an undistorted map overlay at the scale of 1:24,000. This involves optically transferring the vegetation boundaries onto a rectified (i.e., corrected for photo distortion) base map.

Field Verification of the Map Units

One of the most important steps in preparing any type of map is verification of the map units in the field. For this project, the preliminary map units are checked in two ways: from the air in a small airplane or helicopter, and on the ground. The air reconnaissance has proved to be extremely valuable for getting a tree-top view of the different vegetation types. Many of the problem areas identified in the preliminary air photo mapping can be resolved in this way.

Verification on the ground is carried out along transects running mauka-makai at 2-mile intervals through the study area (Fig. 2). These are the same transects on which the bird census is conducted by the Fish and Wildlife survey teams (Scott 1979). The advantage to working along these transects, besides increased access into the forest, is that sampling points called "stations" have been regularly and accurately located along each line (12 stations/mile).

Once the preliminary maps have been corrected, new overlay maps are drawn which will be overlain onto USGS topographic quadrangle maps for final publication. For ease of use, the scale of the final printed maps will be reduced to 1:48,000.

Applications of the Vegetation Maps to Other Studies in the Native Forests

The major objective in producing this new series of vegetation maps is to relate forest bird distribution to vegetation types, and to provide a framework on which to study the dynamics of the 'ohi'a rain forest. I expect, however, that the map series will be useful to other persons and agencies whose work involves the native forests, particularly in such areas as ecological and geological research, and land use planning, most notably connected with preservation of our natural areas.

The major reason for this paper, therefore, is to make more people aware of this project, and to solicit additional suggestions which may increase the overall applicability of the maps to other types of studies.

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TABLE 1. Summary of ranges of map scales and the types of vegetation information which they can display. (Adapted from Mueller-Dombois and Ellenberg 1974).

MAP SCALE TYPE	SCALE RANGE	TYPES OF INFORMATION DISPLAYED	(approx.) MINIMUM UNIT SIZE
1. Small scale	1: > million* (*1 cm = > 10 km)	Generalized potential vegetation	> 2500 ha
2. Intermediate	1:1 mill to 1:100,000* (*1 cm = 1 km)	Regional maps, potential vegetation associations	2500-25 ha
3. Large	1:100,000 to 1:10,000* (*1 cm = 100 m)	Generalized actual plant associations	25-.25 ha
4. Very large	1:10,000 to 1:100* (*1 cm = 1 m)	Detailed plant associations, Individual trees	2500 m^2-1 m^2
5. Chart maps	1:<100* (*1 cm = <1 m)	Individual plant cover for shrubs and herbaceous species	< 1 m^2

TABLE 2. Components for the tree layer which are used in the vegetation map symbols.

TREE CANOPY CROWN COVER

d = Dense; >85% cover

c = Closed; >60-85% cover

o = Open; > 20-60% cover

s = Scattered trees; <20% cover

TREE CANOPY HEIGHT

1 = Short-stature trees; 3-5 m tall

2 = Moderate-stature trees; 5-10 m tall

3 = Tall-stature trees; > 10 m tall

TREE SPECIES COMPOSITION FORMAT

A	Only sp. A present; comprises all of the crown cover indicated for this layer
A, B	Species A dominant comprising >60% of indicated cover; species B present but comprising 20-40% of indicated cover
A-B	Species A and B codominant, each comprising 40-60% of indicated cover
A-B, C	Species A and B codominant, with species C present, comprising 20-40% of indicated cover.
Other possible forms	A-B-C; A, B, C

TREE SPECIES NAME ABBREVIATIONS

Ac = Acacia koa

Ch = Cheirodendron trigynum

Eu = Euphorbia sp.

Is = Introduced species

Me = Metrosideros collina

Mr = Myrsine lessertiana

My = Myoporum sandwicense

So = Sophora chrysophylla

TABLE 3. Components for the ground cover which are used in the vegetation map.

FORMAT

1. The format for listing ground cover is the same as for listing tree species composition
2. Unless otherwise noted, the ground cover is assumed to cover > 60%
3. If the ground cover is < 60%, it is indicated by the symbol "o:" placed before the ground cover symbol(s); (e.g., "o:ds-mg").

INDIVIDUAL SPECIES

An = Andropogon spp.

De = Deschampsia australis

Pa = Paspalum conjugatum

Ps = Psidium cattleianum

Se = Setaria palmaefolia

Sp = Sphagnum sp.

SPECIES GROUPS

bg = sedges, rushes, grasses, and herbs in boggy situations

ds = native alpine or subalpine shrubs, (Styphelia, Vaccinium, Dodonaea, Geranium, Dubautia, etc.)

il = introduced lianas (primarily Passiflora spp.)

is = introduced shrubs (Rubus, Buddleja, Pluchea, Eupatorium)

mf = matted ferns (Dicranopteris spp., Sticherous, Hicriopteris)

mg = mixed grass complex (both native and introduced species)

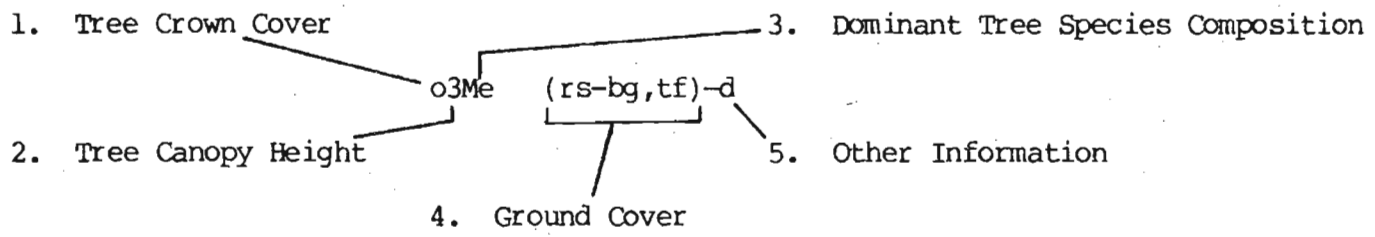
ng = native grass complex (Deschampsia, Trisetum, Panicum)

rs = native rain forest shrubs (Broussaisia, Vaccinium, Clermontia, Pelea spp., etc.)

pg = pasture grasses

tf = tree ferns (Cibotium spp.)

TABLE 4. Example of a vegetation type symbol showing the interpretation of the different symbol components.



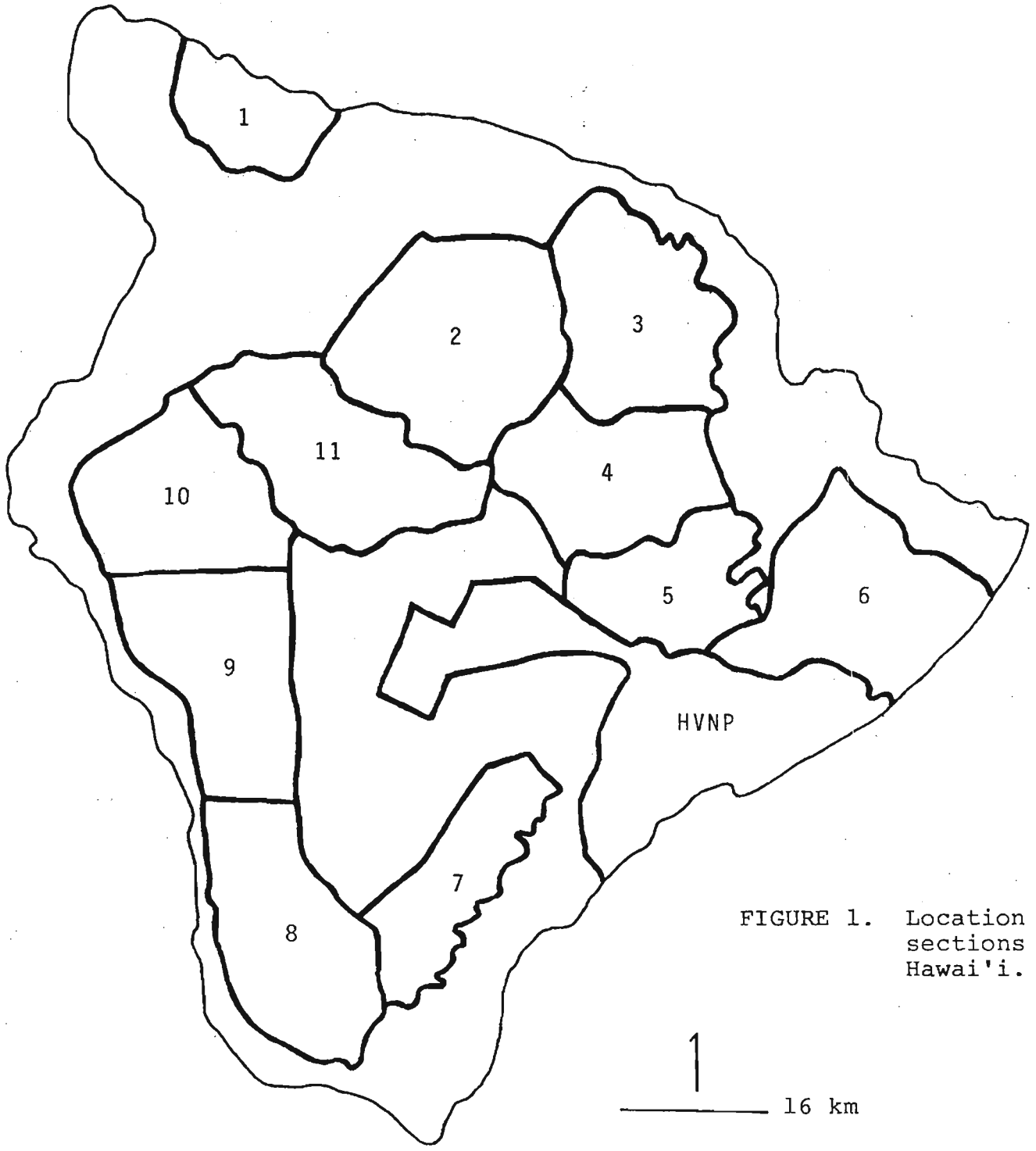
1. Tree crown cover >20-60%.

2, Canopy height >10 m.

3. Tree canopy dominated by Metrosideros collina.

4. Ground cover codominated by native rain forest shrub species and herbaceous plants growing in boggy situation with some tree ferns.

5. Canopy trees in "dieback" condition at time of mapping (i.e., with many standing dead or defoliated trees).



1 KOHALA
2 MAUNA KEA*
3 HAMAKUA*
4 WAIAKEA*
5 OLAA*
6 PUNA
7 KAU*
8 KONA - SOUTH
9 KONA - NORTH
10 HUALALAI
11 POHAKULOA

* mapping completed

FIGURE 1. Location of the vegetation map sections for the island of Hawai'i.

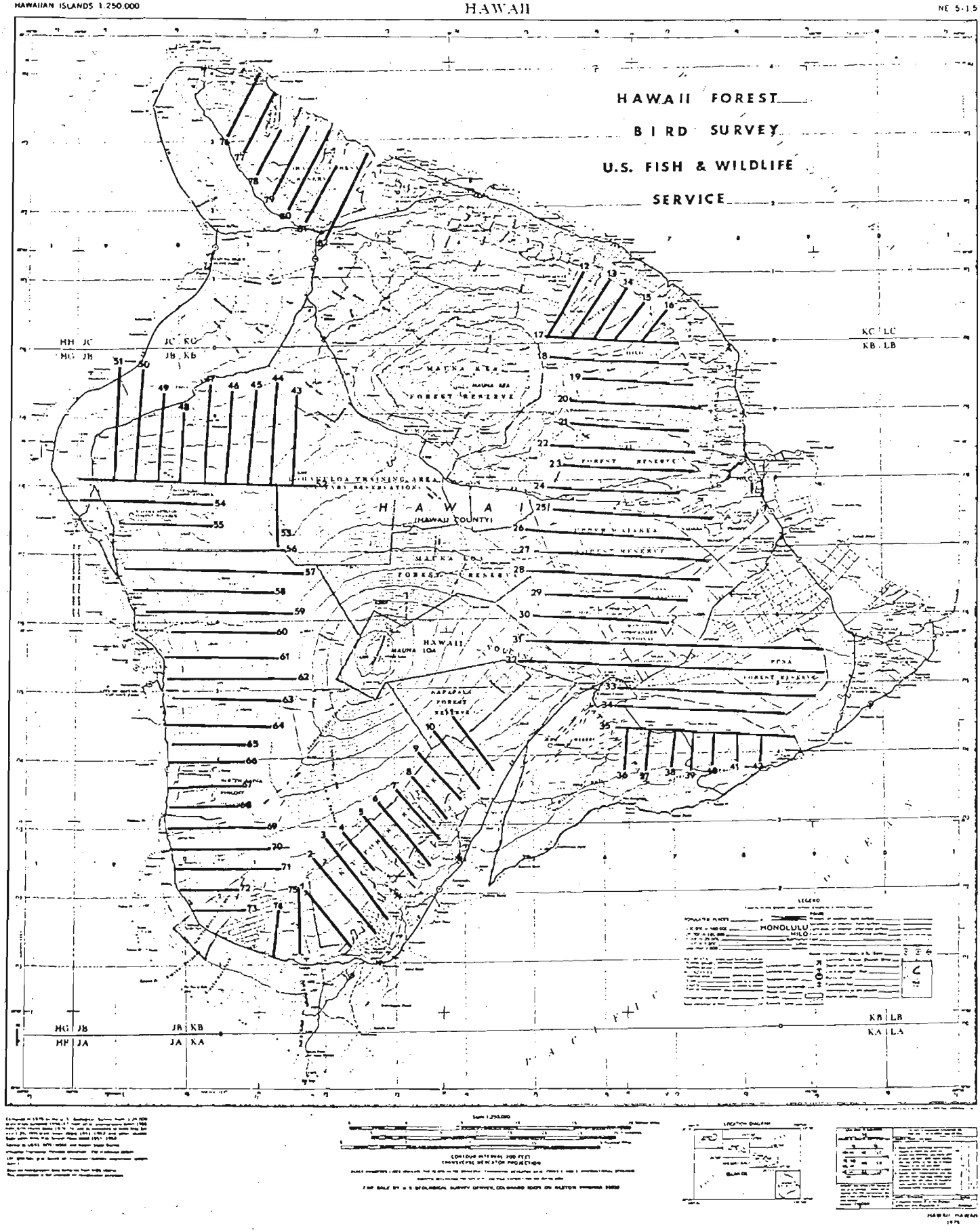


FIGURE 2. Location of the U. S. Fish and Wildlife Service's Forest Bird Survey transects on the island of Hawai'i.