VEGETATION MAPPING

Vegetation mapping should be an integral part of ongoing research and management efforts in Hawaiian ecosystems.

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Vegetation maps are used to present information on the composition and structure (height, canopy cover, and life form classes) of plant communities in a two-dimensional format. Such maps provide a regional framework upon which ecological investigations of individual species or biological communities (for either wilderness or other land use) can be based. Generally, the vegetation of an area is mapped on aerial photographs, with the mapped units verified during field surveys. In some cases, however, the mapping is done completely from ground reconnaissance.

Vegetation maps may be produced at various scales and for a great diversity of purposes (Küchler 1967). The degree of detail that can be expressed in a vegetation map is a function of both the mapping objective (that is, what components are to be displayed), and the scale at which the map is to be prepared.

Mapping objectives may be quite variable for any one particular area, resulting in very different maps, depending on what components of the vegetation are emphasized. For example, a forester may focus on species composition and diameter class for a stand of trees, while a map produced for pasture management may ignore the trees altogether but display the grassland cover in great detail. The most complex vegetation maps are those which describe both the structural and floristic composition of a plant community and may additionally include information on other ecological variables, such as rainfall, substrate characteristics, temperature regime, and so forth.

Scale-related limitations of maps pertain primarily to the size of units that can be visually resolved in a two-dimensional presentation (Table 1). A small-scale map is limited to units that are fairly large and generalized, and may include a great deal of heterogeneity in the delineated units. A large-scale map, on the other hand, can theoretically display units that are quite small and detailed in the field, and may be relatively homogeneous. Most vegetation maps at the scale of 1:5,000,000 (1 cm on the map = 5 km on the ground) or smaller are limited to displaying potential or climax vegetation (see climax community) as interpreted from regional climates, soils, geology, and topographic information. Maps at larger scales (for example, 1:10,000 [1 cm on the map = 100 m on the ground]) show actual vegetation units with boundaries that can realistically be identified in the field.
One of the biggest problems with vegetation maps is accuracy. Map accuracy has two components: first, accuracy must be considered in terms of the content of the interpreted units themselves. In other words, how real are the units that have been mapped. Second, there is the mechanical problem of accurately drawing a unit boundary onto the base map. Map accuracy is a crucial point, as it determines the actual use potential of the map. Accuracy is less of a problem with small-scale maps, as they are extremely generalized to begin with. However, with large-scale maps, the map units displayed can actually be determined and visited in the field. Many users attempt to relate field results to the vegetation maps they are using. If maps are inaccurate, their utility is limited, and the conclusions may be compromised.

### SOME PREVIOUS VEGETATION MAPS FOR HAWAI'I

Over 35 different maps have been prepared to show the distribution of aspects of the vegetation of the Hawaiian Islands. These maps include small-scale maps (> 1:1 million) through very large-scale maps (< 1:10,000) and depict units ranging from generalized potential vegetation zones (see

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**Table 1. Summary of the types of vegetation information that can be displayed on maps at various scales. (Adapted from Mueller-Dombois and Ellenberg 1974.)**

<table>
<thead>
<tr>
<th>MAP SCALE</th>
<th>SCALE RANGE</th>
<th>TYPES OF INFORMATION THAT CAN BE DISPLAYED</th>
<th>MINIMUM UNIT SIZE (approximate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Scale</td>
<td>&gt; 1:1 million</td>
<td>Generalized potential vegetation</td>
<td>&gt; 2500 ha</td>
</tr>
<tr>
<td>Intermediate</td>
<td>1:1 million to 1:100,000</td>
<td>Regional maps, potential vegetation</td>
<td>2500 - 25 ha</td>
</tr>
<tr>
<td>Large</td>
<td>1:100,000 to 1:10,000</td>
<td>Generalized actual plant associations</td>
<td>25 - 0.25 ha</td>
</tr>
<tr>
<td>Very Large</td>
<td>1:10,000 to 1:100</td>
<td>Detailed plant associations, individual trees</td>
<td>2500 m² - 1 m²</td>
</tr>
<tr>
<td>Chart Maps</td>
<td>&lt; 1:100</td>
<td>Foliage cover for individual shrubs and herbaceous plants</td>
<td>&lt; 1 m²</td>
</tr>
</tbody>
</table>
ecological zones; Cuddihy, this volume) on all of the Islands to very detailed displays of actual plant communities on a portion of one of the Islands. The most frequently cited vegetation map is Ripperton and Hosaka's (1942) 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 1:500,000. (The island of Hawai'i was mapped at the scale of 1:1.5 million.) Ripperton and Hosaka's map provides a good, but very generalized, overview of potential vegetation zones for all major Islands, based on a combination of existing vegetation, climatic patterns, and topography.

Two other intermediate-scale maps were prepared by Lamoureux (1983) and Knapp (1965). Lamoureux's map is very similar to Ripperton and Hosaka's (1942) and also displays generalized vegetation zones for all of the Islands. This map is readily available in the popular Atlas of Hawai'i (Armstrong 1983). Knapp's map delineates major vegetation zones, primarily based on moisture and temperature regimes.

In the mid 1960s, the U.S. Forest Service and the Hawaii State Division of Forestry produced the "Hawai'i Forest Type Maps" at the scale of 1:52,500, based on aerial photographs taken between 1950 and 1954 (Nelson 1967). These maps were prepared for all forested areas except National Park Service lands on all the major Hawaiian Islands. The Hawai'i Forest Type Map units provide information on 1) land use class, 2) forest type (that is, tree species composition), 3) density of tree cover, and 4) tree stand size class in terms of sawtimber (marketable trees) classes. Despite the greater level of mapping detail at this large scale, the Hawai'i Forest Type maps were prepared at the reconnaissance level, with only a limited amount of unit verification in the field.

Several other detailed vegetation maps have been prepared for smaller areas on many of the Islands. A map by Mueller-Dombois and Fosberg (1974) displays vegetation types within and adjacent to Hawaii Volcanoes National Park on the island of Hawai'i. This map, at the scale of 1:52,000, presents a detailed as well as accurate description of the dominant trees and understory plant associations in the Park. Whiteaker (1983) prepared a similar map of the plant communities in Haleakala National Park on the island of Maui. Other recent vegetation maps of relatively small areas include those by Smathers (1967), Harrison (1972), Higashino and Mizuno (1976), Jacobi (1978), and McEldowney (1983).

A new set of vegetation maps, covering upland vegetation on the islands of Hawai'i, Maui, Moloka'i, and Lana'i, is currently in the final stages of production (Jacobi, in preparation). This map series was prepared to serve as a habitat base for the U.S. Fish and Wildlife Service's surveys of Hawaiian forest birds (Scott et al. 1981), and for studies of the dynamics of the ohia (Metrosideros polymorpha) forest conducted through the Botany Department of the University of Hawai'i (Mueller-Dombois 1985). The maps display the vegetation at two levels of generalization. The most detailed were produced at the scale of 1:24,000 and provide information on tree canopy cover, tree height, and plant species composition. The second set of maps is at the scale of 1:100,000, with the detailed vegetation units grouped into larger and more generalized units. The 1:24,000-scale maps provide detailed information that may be applicable to research or management programs of relatively small areas. The more general maps allow for a regional overview of the distribution of the major plant communities on an island-wide basis.
FUTURE NEEDS

Vegetation mapping should be an integral part of ongoing research and management efforts in Hawaiian ecosystems. Although the vegetation maps produced during the U.S. Fish and Wildlife Service surveys are quite detailed, they do not include all areas of native vegetation in the State. Additional maps need to be produced for areas not covered previously by the detailed mapping, and all of the maps need to be updated periodically to delineate communities that have been altered by land-use changes or natural phenomena (for example, new lava flows, plant invasion, ecological succession, and so forth).

Today, digital image processing of data gathered with multispectral sensors on earth-orbiting satellites, coupled with rapid computer data analysis capabilities, provide an additional set of mapping tools that could scarcely have been imagined by the scientists who produced the first maps of Hawaiian plant communities. We are quickly approaching the point where detailed vegetation maps can be easily and rapidly produced for even extremely remote areas of the earth. The application of new techniques to regularly update our knowledge of the composition, distribution, and changes in Hawaiian ecosystems will greatly enhance our conservation of these irreplaceable natural resources.

Important References

Cuddihy, L.W. [this volume] Vegetation zones of the Hawaiian Islands.
Jacobi, J.D. In prep. Vegetation maps of the upland plant communities on the islands of Hawai'i, Maui, Moloka'i, and Lanai. Files, U.S. Fish and Wildlife Service Hawaii Research Station.


