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Vegetation as an Element in the Management of the Coastal Zone

by

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VEGETATION AS AN ELEMENT IN THE MANAGEMENT OF THE COASTAL ZONE

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Introduction

The purpose of this paper is to give an overview of the role of the vegetation as an element which must be considered when management plans are created and implemented in coastal zone areas. The various management purposes will be discussed as they relate to the vegetation followed by highlights of the various aspects of the vegetation which must be considered in an analysis of any plans. A brief introductory discussion of what vegetation data are available and what are the major unmet data and anlysis needs will be given.

Since there are several governmental and university groups interested and active in the various data collection and management aspects, some information relative to their roles will be presented.

Management Purposes

The vegetation of the earth is the basis of the support of animal life. Such support ranges from the use of plants as food through their use as structural habitat. Plants are important components of watersheds and are used as manageable, renewable resources for many industries. Thus, plants are intimately involved in many very important aspects of our lives. We often overlook the many and varied roles when we focus on the more obvious agricultural uses of plants. For discussion purposes here, four major roles will be highlighted.

Natural Areas

The identification and preservation of areas of natural vegetation is an important aspect of any comprehensive management plan. These areas serve as important refuges for both plant and animal species away from the competition resulting from man's presence. In a region such as Hawaii, with such a high occurence of rare and endangered species, this is a very important general management concern.

Vegetation as a Harvestable Resource

Some areas, such as cultivated croplands, forests, and ranges, serve as places where the vegetation is harvested and used. This is done directly as in the case of food crops and timber, or it is used indirectly as in our harvesting of rangeland animals. The management practices appropriate to such types of systems have been the subject of study for many years.

The Role of Managed, but Non-harvested, Vegetation

The use of vegetation for its structural properties is an important management concern. In this way, vegetation serves to enhance the watershed characteristics of an area, protects against various sorts of erosion, stabilizes loose soils (such as beach sand), modifies stream flow characteristics, and other similar relationships. Various management practices are applied to most fully utilize these properties of the vegetation.

Vegetation as Habitat

In an ecosystem context, vegetation serves in a complex series of interactions to provide habitat for animals (and other plants). It may provide food resources, trap water, modify the climate, had have appropriate structures and materials for nests. To a certain extent, some of these aspects can be managed by various forms of direct modification to the vegetation or by making changes to the environment (such as with the application of fertilizers). In addition, the animal populations may be managed directly (such as with pesticides or by some harvesting scheme).

The separation of the various management needs is an important step in providing focus on the various management problems and techniques. It is also important to be able to integrate the various management activities into a larger view. Only in this way will some balance between the various needs be achieved. It is with this latter area that this discussion is primarily concerned. Several of the apparent types of questions which much be resolved are the subject of the next section.

Coordinated Management Concerns

Since land area is limited, it is unavoidable that alternative land use pressures will require that priorities be established so that the most appropriate apportionment of uses is achieved. The discussion in this section will highlight some of the factors which should be considered in the relative apportionment of land to these different uses.

Categories and Sizes of Different Vegetation Types

The types of areas which should be incorporated into a land use management plan will depend on the various uses, categorization will be required to identify what particular subdivisions are appropriate for each use type. Some of the categorizations schemes which have been proposed for the natural ecosystems in Hawaii will be presented later.

Associated with each type of area will have to be some evaluation of the aggregate area required for each type of use. This assumes that there is an interest in maintaining some mixture of uses, a goal which relates to the yet larger set of objectives in the management of the area. While required area estimates are often very difficult to obtain, there should be some serious considerations of this matter, including the procedures and assumptions underlying the estimates.

The list resulting from these two exercises would be a classification into some categories and a desired area which should be devoted to each use category.

The Number of Areas and their Distribution

The spatial assortment of the types of land use areas will be an additional important consideration in the formulation of plans for management. Some types of arrangements are expected to cause problems, such as locating natural areas within appropriate environments and with ample buffer zones. The minimum size of some areas must also be considered; patches which are too small may not allow that part of the system to function even though the aggregate area is adequate.

The number and distribution of areas must also be viewed in the perspective of the global distribution of ecosystems. While a type of ecosystem may not be particularly unique in Hawaii, it may be exceptionally rare when viewed from a world-wide perspective, which should cause greater concern for its appropriate management.

Stability

The maintenance of the various ecosystems as types which persist is an important management concern. Examples are particularly evident in Hawaii where there have been dramatic changes from one type of system to another, often due to man's interference. Kaneohe Bay is just one such area.

The management concerns must be particularly sensitive so that they will allow an analysis of ecosystem to ecosystem impacts. Appropriate protection, and possibly reestablishment procedures, will have to be carefully evaluated and utilized.

What Do We Already Know About Hawaiian Ecosystems

What Ecosystems are there?

There have been several ecological zonation schemes applied to Hawaii. Viewed from the perspective of the entire State (not limited to a narrow definition of the coastal zone), these have been presented at different levels of generality. These schemes are compared in Appendix I. The principal natural terrestrial ecosystems have been listed in this appendix.

Rare and Endangered Species

The identification of rare and endangered species of plants generally has not been investigated to the same extent as animals. While some plants certainly qualify in this category and deserve similar protection, our efforts have not been systematic at identifying the appropriate species or their known distributions. This awaits further work for the solution of the general problem.

Some specific plants have been identified, such as the silversword, which now receives protection in the Hawaii National Parks.

Unmet Information Needs

Additional, Specific Vegetation Mapping

While the various zonation schemes exist, there have been few systematic attempts to classify the vegetation at the more detailed levels of generality. Vegetation maps exist for some localities (see Appendix II), but these represent only a small fraction of the area of the State which should be surveyed. The techniques and analytical capabilities exist to undertake the classification and mapping of new areas; lacking is the financial support for such an enterprise.

Coordinated Map-based Information System

Data are being collected on the vegetation by numerous investigators. For the marine vegetation, some coordination for the storage and retrieval of these data with the use of the Hawaii Coastal Zone Data Bank. Terrestrial Data are not as systematically stored, except for particular areas (for example, vegetation data for the Hawaii Volcanoes National Park is maintained in the US/IBP data bank).

One of the prime requisites for enhancing our ability to coordinate the use of the vegetation data is the availability of a map-based information system. Such a system is being developed as part of the Coastal Zone activities; close coordination is being maintained with this group so that the needs of the vegetation data handling will be met.

Analysis of Ecosystem Relationships

The collection of data is not the end step in the effort to rationally use vegetation data for management decisions. An understanding of the ecosystems, including their dynamics and stability, is particularly important. Hawaii has witnessed many perturbations to its vegetation through the intended or accidental management of parts of the ecosystems. We have only the most fragmentary understanding of Hawaiian ecosystems on which we may base our recommendations for management. Considerably more basic research is required on these ecosystems.

APPENDIX ***

PRINCIPAL NATURAL TERRESTRIAL ECOSYSTEMS IN THE HAWAIIAN ISLANDS

(Outline of types of described natural areas
within six mapped ecological zones)*

I Coastal zone (not on Knapp's 1965 small-scale maps, refers to only a narrow fringe usually within 100 m from the shore; 13 ecosystem types)

II Hot dry to moderately dry lowland zone (Knapp: zone 3, 4, 5; 12 ecosystem types)

III Moderately moist submontane zone (Knapp: zone 1; 10 ecosystem types)

IV Montane rain forest zone (Knapp: zone 2; 10 ecosystem types)

** V Subalpine zone (Knapp: zone 6; 6 ecosystem types)

**VI Alpine zone (Knapp: zone 7; 3 ecosystem types)

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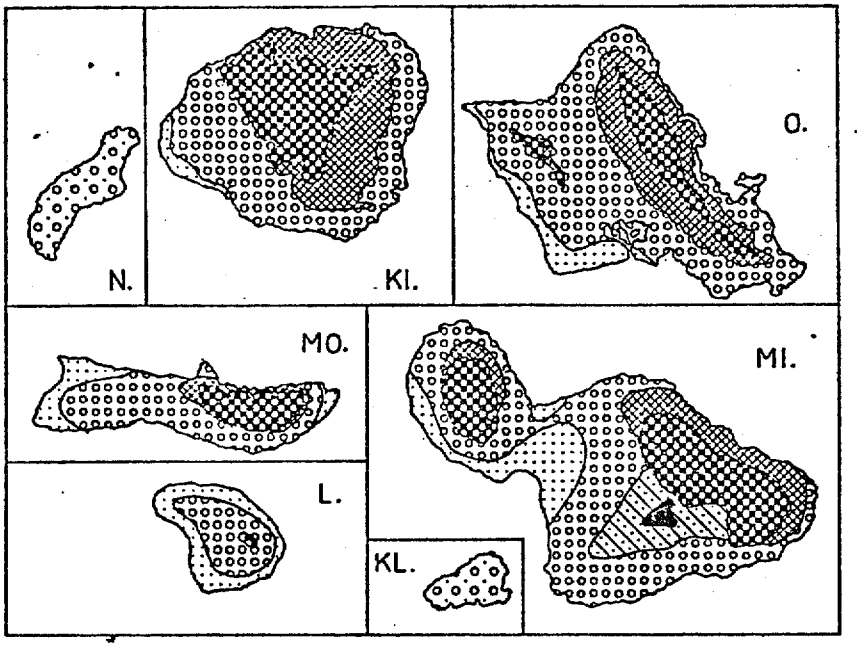
* prepared as an initial guide to mapping ecosystems through vegetation on 1:50,000 - 1:200,000 base maps, D. Mueller-Dombois, July 12, 1973

** only on Maui and Hawaii

*** This appendix was prepared by Dr. D. Mueller-Dombois, Department of Botany, University of Hawaii.

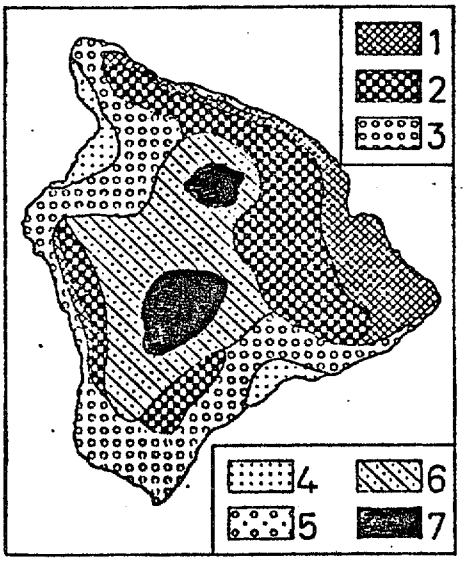
Vegetation zones as mapped in

Knapp, R. 1965. Die Vegetation von Nord-und Mittelamerika und der Hawaii-Inseln. Gustav Fischer Verlag. Stuttgart, page 320.



Legend to Knapp's ecological zones, mapped at 1:1.7 million (1 cm=17 km)

1 Submontane rain forest zone
2 Montane rain forest zone
3 Moderately dry lowland zone
4 Very dry lowland zone
5 Zones 3 and 4 not separated
6 Upper montane or subalpine zone
7 Alpine zone or cold desert zone
N = Niihau; KI = Kauai; O = Oahu;
MO = Molokai; L = Lanai; MI = Maui;
KH = Kahoolawe; below Hawaii at
1:2.5 million



Ecological zones in the Hawaiian Islands: a summary comparison of three zonation schemes

F. Egler (1939)	R. Knapp (1965)*	V.J. Krajina (1963)
Xero-tropical	I. Hot dry zone	Important key species
Makai zone (seaward)	4. Very dry	1. *Prosopis* (kiawe) zone
Middle zone	3. Moderately dry	2. *Leucaena* (koa haole) 3. *Psidium* (guava) - *Lantana*
Mauka zone (inland towards the mountains)	5. Zones 3 and 4 mixed; Niihau and Kahoolawe	
Pluvio-tropical	II. Rain forest zone	
guava zone koa zone	1. Submontane	4. *Acacia koa* - *Psidium* - *Styphelia* (koa - guava - pukiawe) 5. *Acacia koa* - *Nephrolepis* - *Paspalum* (koa - Boston fern - Basket grass)
ohia zone cloud zone	2. Montane	6. *Metrosideros* - *Cibotium* (ohia - tree fern) 7. *Cheirodendron trigynum* - *Cibotium* (olapa-tree fern) 8. *Cheirodendron dominii* - *Clermontia* - *Gunnera* (lapalapa-oha-wai-ape'ape) 9. *Oerobulus* - bog zone (Alakai swamp and others)
Only on Maui & Hawaii	III. Cool dry-forest and heath zone	
	6. Upper montane or subalpine	10. *Metrosideros* - *Sadleria* (ohia - amaumau fern) 11. Koa - Boston fern - *Dryopteris paleacea* 12. Koa - *Sophora* (mamane) - *Styphelia* (pukiawe) 13. *Sophora* - *Styphelia* - *Vaccinium* (ohelo)
	IV. Alpine	
	7. Cold desert, from about 3000 m up	14. Lichens, mosses, (*Argyroxiphium*)

* Number sequence relates to vegetation zone map in Knapp (1965: 320).

Note: In addition a strand zone is present on all islands. It covers most of the leeward islands in their entirety.

A preliminary outline of kinds of described natural areas within six ecological zones in the Hawaiian Islands

I. Coastal zone (not shown on Knapp's map)

1. Hibiscus ecosystem on beach flat
*2. Scaevola ecosystem on dunes
*3. Scaevola ecosystem on raised coral rock
*4. Scaevola ecosystem on rocky basalt coast
*5. Scaevola ecosystem on talus and alluvium
6. Chloris-Sida ecosystem on talus
7. Prosopis ecosystem on talus and alluvium
8. Prosopis ecosystem on tuffaceous headland
9. Prosopis ecosystem on dunes
10. Chloris-Prosopis ecosystem on dune and clay flat complexes
11. Batis ecosystem on mud flat
12. Mangrove (Rhizophora) ecosystem on tidal flat
*13. Pandanus ecosystem on coastal flats

(1 - 12 described for Oahu by Richmond and Mueller-Dombois 1972)

II. Hot dry to moderately dry lowland zone (xerotropical)
(Knapp zones: 3 circles, 4 dots, 5 circles + dots)

*1. Dryland sclerophyll forest (Fosberg 1972:32, Mueller-Dombois 1966:429)
*2. Mixed lowland forest (Fosberg 1972:31, Hatheway 1952, Wirawan 1972)
3. Prosopis forest (Fosberg 1972:33, Mueller-Dombois and Spatz 1972)
4. Leucaena scrub (Fosberg 1972:27, Mueller-Dombois and Spatz 1972)
5. Acacia farnesiana scrub (Mueller-Dombois and Spatz 1972)
6. Opuntia scrub (Fosberg 1972:34)

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* predominantly native vegetation

**7. Heteropogon-(Rhynchelytrum) grassland (Fosberg 1972:34, Mueller-Dombois 1966:411, Kartawinata and Mueller-Dombois 1972:387)

*8. Eragrostis variabilis grassland (Kartawinata and Mueller-Dombois 1972:388)

9. Chloris barbata grassland (Kartawinata and Mueller-Dombois 1972:389)

10. Dichantium aristatum grassland (Kartawinata and Mueller-Dombois 1972:391)

11. Panicum maximum grassland (Kartawinata and Mueller-Dombois 1972:391)

12. Trichachne insularis grassland (Kartawinata and Mueller-Dombois 1972:392)

III. Moderately moist submontane zone (Knapp zone 1 cross-hatched)

**1. Aleurites forest (Fosberg 1972:26)

2. Eugenia cuminii forest

*3. Koa forest (Fosberg 1972:24)

4. Psidium guajava forest and scrub (Fosberg 1972:24)

5. Lantana scrub (Fosberg 1972:27)

*6. Dry cliffs (Fosberg 1972:35)

7. Rhynchelytrum grassland (Kartawinata and Mueller-Dombois 1972:394)

8. Andropogon virginicus grassland (Mueller-Dombois 1966:414, Kartawinata and Mueller-Dombois 1972:392)

9. Melinis minutiflora grassland (Kartawinata and Mueller-Dombois 1972:396)

*10. Metrosideros-Andropogon open forest with native shrubs (Mueller-Dombois 1966:422)

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* predominantly native vegetation
** introduced by Hawaiians and then naturalized

IV. Montane rain forest zone (Knapp zone 2, checkered)

*1. Metrosideros-Cibotium forest (Fosberg 1972:19, Mueller-Dombois 1966:409)

*2. Metrosideros-Dicranopteris open forest (Fosberg 1972:23, Mueller-Dombois 1966:409)

*3. Cibotium forest (Mueller-Dombois 1966:426)

*4. Koa-Metrosideros-Cibotium forest (Mueller-Dombois 1966:418)

*5. Cloud forest (Fosberg 1972:20, Krajina 1963:zones 7 and 8)

*6. Bog ecosystems (Fosberg 1972:21, Krajina 1963:zone 9)

*7. Metrosideros-Sadleria forest (Krajina 1963:zone 10)

*8. Metrosideros scrub-forest with only little Cibotium but associated small tree species (most of the native rain forest on older islands; Gay 1966)

*9. Wet Cliffs (Fosberg 1972:34)

10. Psidium cattleianum forest (Fosberg 1972:26)

V. Subalpine zone (only on Maui and Hawaii) (Knapp zone 6, angle hatch and dots)

*1. Koa-Dryopteris paleacea forest (Krajina 1963:zone 11, Mueller-Dombois and Krajina 1968:segment 7 on Mauna Kea, Fosberg 1972:24)

*2. Koa-Sophora-Styphelia-Deschampsia Mountain parkland ecosystem (Mueller-Dombois 1967:segment 7, Fosberg 1972:38)

*3. Metrosideros-scrub forest (Mueller-Dombois 1967:segment 6)

*4. Sophora-Myoporum parkland (Fosberg 1972:38, Mueller-Dombois and Krajina 1968:segment 4 on Mauna Kea)

*5. Chenopodium oahuense scrub (Fosberg 1972:45)

*6. Tussock grassland (Fosberg 1972:46)

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* predominantly native vegetation

VI. Alpine zone (only on Maui and Hawaii) (Knapp zone 7 cold desert from 3000 m upwards)

*1. High-altitude microphyllous scrub (Fosberg 1972:44, Mueller-Dombois and Krajina 1968:segments 3 and 4 on Mauna Loa and Mauna Kea)

*2. Rhacomitrium stone desert (Mueller-Dombois and Krajina 1968: segment 2 on Mauna Loa)

*3. Sparse moss, lichen and grass stone desert (Mueller-Dombois and Krajina 1968:segment 2 on Mauna Kea)

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* predominantly native vegetation

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