THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

# THE EFFECTS OF SELECTED PHYSICAL AND CULTURAL VARIABLES ON THE POPULATION, LAND USE, AND VEGETATION PATTERNS OF TWO PACIFIC ISLAND ECOSYSTEMS

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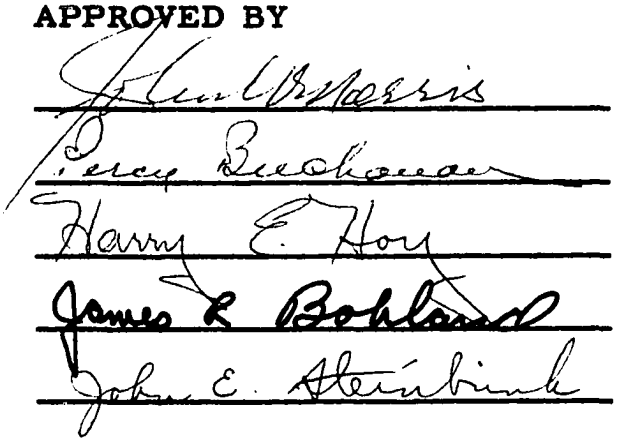
APPROVED BY



DISSERTATION COMMITTEE

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# THE EFFECTS OF SELECTED PHYSICAL AND CULTURAL VARIABLES ON THE POPULATION, LAND USE AND VEGETATION PATTERNS OF TWO PACIFIC ISLAND ECOSYSTEMS

## CHAPTER I

## INTRODUCTION

Since the advent of Western man in the Pacific islands, there have been numerous changes in the physical and cultural environments of many islands. Among the more obvious and significant changes are those which have occurred in the land use, vegetation, and population patterns. Many explanations are possible for these changes, but cultural factors are among the most important causes for the initiation of change. This study is concerned with the impact of selected cultural and physical variables on the land use, vegetation, and population patterns of two Pacific islands. The specific problem is to analyze the functional relationship between the independent variables (soil patterns, location, water resources, economic systems, political systems, land tenure systems) and selected dependent variables (population, land use, vegetation), on the islands of Niue in the South Pacific

and Lanai of the Hawaiian Islands.

## Research Hypotheses

It is assumed, for the purpose of this study, that islands are functioning ecosystems, of which aboriginal inhabitants are integral components. On the basis of this assumption, the following research hypotheses are posed:

1. The initiation of changes in land use, vegetation, and population patterns on islands are primarily the result of external cultural influences.
2. The types of changes which have occurred in an island's land use, vegetation, and population patterns are dependent upon certain inherent physical components of the island ecosystem.

## Definition of Terms

Land use, as employed in this study, is the pattern of occupance and utilization of the land by aboriginal and contemporary man. As such, the analysis of land use is concerned with both settlement patterns and agricultural patterns, as well as with the specified purposes which have been assigned by island inhabitants to currently unoccupied lands.

The analysis of vegetation is concerned with a macro-scale analysis of vegetation found on unoccupied and unused lands. The high

degree of human influence on the island ecosystem results in vegetation patterns which are functionally related to land use, and are not a completely independent physical-biotic factor. Therefore, the analysis of vegetation patterns is closely related to land use analysis.

The population variable has many aspects, but this study is concerned with only three population characteristics: numbers, distribution, and ethnic composition.

For this study three independent cultural, or man-made, variables are of primary concern: economic systems, political systems, and land tenure systems. Economic systems are those forms of economic activity which account for the livelihood of the inhabitants of the islands. The discussion of this variable is concerned with the major attributes and controlling factors of each island's economic system.

In the context of this study the term political systems refers to the administrative power which exercises political control over each respective island. The analysis of political systems is concerned with the manner in which political control has interacted with the other two independent variables in order to have an effect on the land use, vegetation, and population patterns.

Land tenure systems are those systems under which land is owned and transferred. The analysis of land tenure systems is concerned with the traditional and contemporary standards for legal own-

ership and transfer of ownership of land.

The three physical variables analyzed are: location, soil patterns, and water resources. Location is employed as both absolute location on the earth grid, and relative location. Of the two, relative location is most important because the analysis of the location of each island is concerned with both accessibility and the effects of other islands.

Soil and water resources are both self-explanatory. The analysis of soil is concerned with the distributional characteristics and suitability of soils for agriculture. The analysis of water resources is concerned with the availability and development capacity of ground water reserves.

The term "ecosystem," which is used throughout this study to indicate the system of physical-biological-cultural interaction that exists on the islands of Lanai and Niue, is generally understood to mean any interacting system of living organisms and their effective environment, physical, biological, and cultural. The use of the term "ecosystem" in this study is intended only for the conceptualization of the relatedness of human and physical-biological components of the island landscape, which has resulted in the present patterns of population, land use, and vegetation.

## Research Design

One of the well-established traditions in geographic research is the Man-Land tradition.[1] This study is in that tradition. In recent years one of the methodological trends in geographic research in the Man-Land tradition has been the ecological approach.

The science of ecology, which is the study of the relationship between organisms and their environment, came into being in 1869 when Ernst Haeckel first coined the term.[2]

The use of the ecology concept in geography was first suggested by H. H. Barrows in 1922 in an address before the Association of American Geographers. At that time Barrows attempted to define the entire field of geography as human ecology.[3] The immediate impact of Barrows' address was apparently quite minimal. In 1939 Hartshorne treated human ecology as being merely a modification of environmentalism.[4] Subsequently, in 1959, with the publication of Perspective

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[1] William D. Pattison, "The Four Traditions of Geography," Journal of Geography, LXIII, (May, 1964), 211-216.

[2] Eugene P. Odum, Fundamentals of Ecology, (Philadelphia: W. B. Saunders Company, 1959), 3.

[3] H. H. Barrows, "Geography as Human Ecology," Annals of the Association of American Geographers, XIII (Jan. 1923), 1-14.

[4] Richard Hartshorne, The Nature of Geography, (Lancaster, Pennsylvania: Association of American Geographers, 1939).

on the Nature of Geography, neither Barrows nor the subject of human ecology were mentioned.[5]

The weakness in Barrows' philosophy was not so much that it was environmentalist, but that it lacked the proper biological terminology to express adequately a holistic viewpoint. The holistic concept in biology was finally given clearer expression in 1935 by A. G. Tansley when he coined the term "ecosystem."[6] This term, which refers to the entire system of relationships between organisms and their environments is currently a basic concept in ecology.

The first volume to employ specifically the ecosystem concept in the study of man resulted from the Tenth Pacific Science Congress in 1961, and is entitled Man's Place in the Island Ecosystem.[7] The importance of this volume, although it deals with only one kind of human ecosystem is that it gives clearer expression to the ecosystem concept as it applies to the study of human communities. It also deals with man as an environmental agent and therefore an active participant in and integral component of the island ecosystem.

Although the ecological philosophy of Barrows did not immedi-

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[5]Richard Hartshorne, Perspective on the Nature of Geography, (Chicago: Rand-McNally, 1959).

[6]A. G. Tansley, "The Use and Abuse of Vegetational Concepts and Terms," Ecology, XVI (1935), 284-307.

[7]F. R. Fosberg (ed.), Man's Place in the Island Ecosystem, (Honolulu: Bishop Museum Press, 1963).

ately flourish, it is now apparent that the ecological perspective, and particularly the ecosystem concept, are well-established geographic research paradigms. This is indicated by the writings of such geographers as D. R. Stoddart,[8] R. P. Moss and W. B. Morgan,[9] R. E. Dickinson,[10] and James D. Clarkson.[11]

The ecological perspective in geographic research covers a broad spectrum of research problems. This study is done within the framework of cultural ecology, in that it is concerned with the analysis of certain cultural patterns which result from the man-milieu relationship. Although the concept of any system comprised of the total physical environment and complete cultural make-up of any given area is beyond the grasp of any one individual, it is possible to ana-

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[8]D. R. Stoddart, "Geography and the Ecological Approach: The Ecosystem as a Geographic Principle and Method," Geography, L (1965), 242-251: D. R. Stoddart, "Organism and Ecosystem as Geographic Models," in R. J. Chorley, and P. Hagget, (eds), Models in Geography, (London: Methuen and Col. Ltd., (1967), 511-547.

[9]R. P. Moss and W. B. Morgan, "Geography and Ecology: The Concept of Community and its Relationship to Environment," Annals of the Association of American Geographers, LV (1965), 339-350; R. P. Moss and W. B. Morgan, "The Concept of Community: Some Applications to Geographical Research," Transactions, Institute of British Geographers, No. 41, (June, 1967), 21-32.

[10]R. E. Dickinson, Regional Ecology: The Study of Man's Environment, (New York: John Wiley & Sons, Inc., 1970).

[11]James D. Clarkson, "Ecology and Spatial Analysis," Annals of the Association of American Geographers, LX (December, 1970), 700-716.

lyze the functional links between certain components of the system.[12] That is the purpose of the present study.

This study, which deals with man as a culture-bearing organism in a Pacific island setting, has a precedent in a work by James D. Clarkson dealing with the cultural ecology of a Chinese village in the Cameron Highlands of Malaysia.[13] Clarkson employed the methods of historical analysis within the framework of cultural ecology.

Similarly, this study employs the methodology of historical geography and the perspective of cultural ecology. The purpose of the study is to examine and analyze the historical development of the population, land use, and vegetation patterns of Niue Island and Lanai, concentrating on the functional links between the dependent variables and the independent variables (Figure 1).

Since historical analysis is the primary methodology employed in this study, the bulk of data for the study is from documents gathered from various sources. The primary sources for this data were the Sinclair Library of the University of Hawaii, the Land Study Bureau of the University of Hawaii, the Bishop Museum of Honolulu,

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[12]Marvin W. Mikesell, "Cultural Ecology," in Phillip Bacon (ed.), Focus on Geography, (Washington, D.C.: National Council for the Social Studies, 1970), p. 42.

[13]James D. Clarkson, The Cultural Ecology of a Chinese Village, (Chicago: The University of Chicago, 1968).

the Alexander Turnbull Museum of Wellington, New Zealand, the Department of Island Territories, Wellington, New Zealand, the Office of the Resident Commissioner, Alofi, Niue Island, the Department of Agriculture, Alofi, Niue Island, and the Dole Company, Honolulu, Hawaii. In addition, field research was carried out on both Niue Island and Lanai.[14]

Since the approach to this study is basically historical, Chapter II is concerned with a history of the population, land use, and vegetation patterns of the two islands, with an emphasis on three different periods of time. The first is the period of aboriginal occupance; the second is the period of early Western occupance or influence; and the third is the present era of occupance.

The third chapter analyzes the functional relationships between the physical components of the ecosystem and the population, land use, and the vegetation patterns. Chapter IV discusses the functional relationships that exist between the dependent variables and the cultural components of the ecosystem.

Chapter V summarizes and concludes by designating those variables which have had the greatest continuing impact on the various

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[14]The author's initial field experience on Niue Island occurred between January, 1959 and July, 1961, during which time he was a resident on the island. Subsequent field research was carried out in July and August, 1964. The initial field research on Lanai was in December, 1963. Subsequent research was carried out in July, 1970.

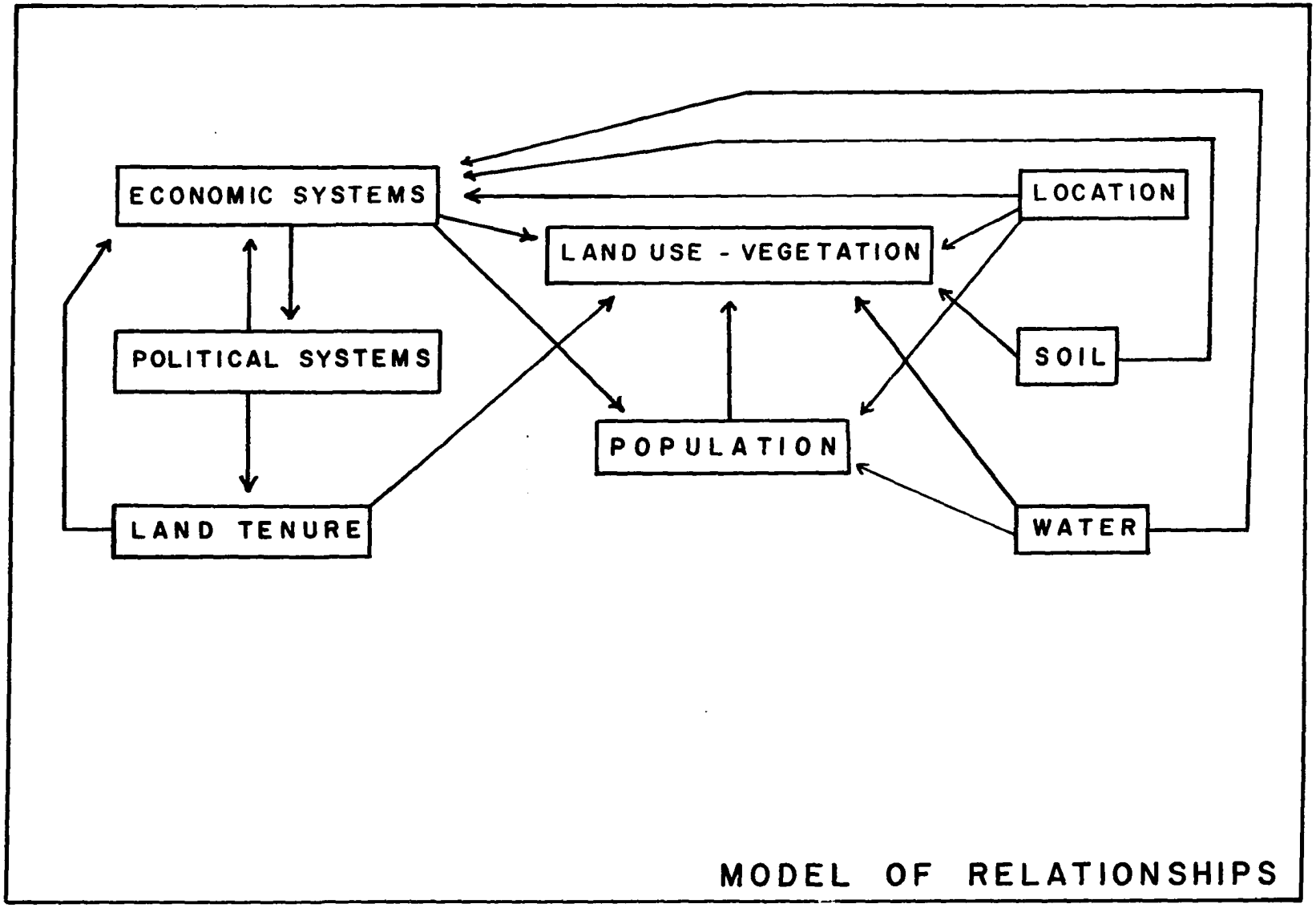
ECONOMIC SYSTEMS
LOCATION
LAND USE - VEGETATION
POLITICAL SYSTEMS
SOIL
POPULATION
LAND TENURE
WATER
MODEL OF RELATIONSHIPS

Figure 1

patterns of the island ecosystem. The chapter also attempts to project the possible future patterns of population, land use, and vegetation.

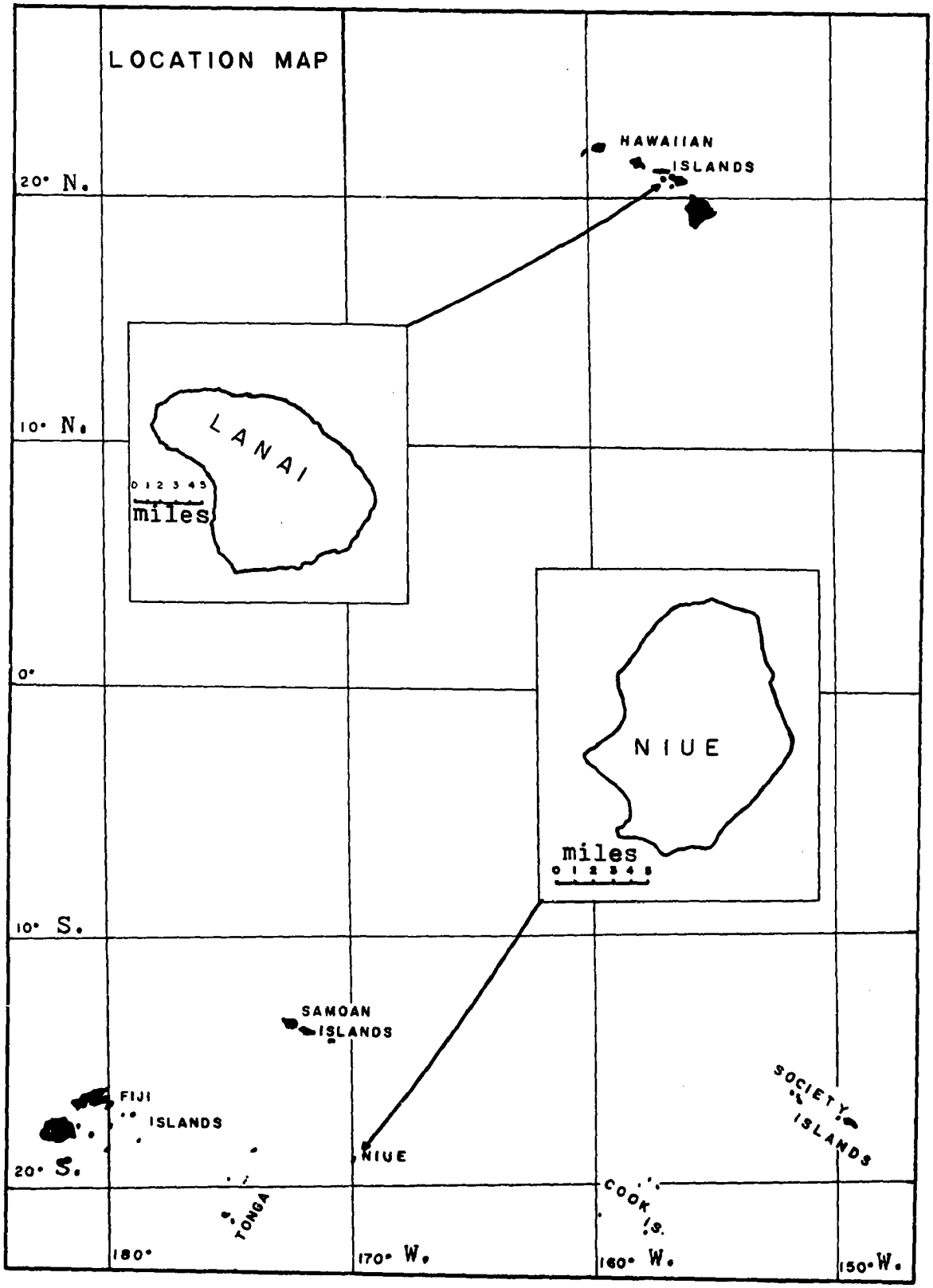
LOCATION MAP
HAWAIIAN ISLANDS
20° N.
10° N.
LANAI
0 1 2 3 4 5
miles
0°
NIUE
miles
0 1 2 3 4 5
10° S.
SAMOAN ISLANDS
FIJI ISLANDS
NIUE
SOCIETY ISLANDS
20° S.
COOK IS.
TONGA
180°
170° W.
160° W.
150° W.

Figure 2

# CHAPTER II

## ABORIGINAL, TRANSITIONAL, AND CONTEMPORARY PERIODS OF OCCUPANCE

In practically all Pacific islands three periods of occupance can be recognized: (1) the period of purely aboriginal occupance before the arrival of Western Man: (2) the period of transition, during which time aboriginal occupance patterns either disappeared or were altered by Western influence; and (3) the present period, during which occupance patterns have become a reflection of current economic influences in the islands. These three periods can be recognized on both Lanai and Niue, although the manner and degree to which each island has responded to the changing times is somewhat different.

To explain the present patterns of population, land use, and vegetation in the islands it is necessary to depict these three variables as they existed in the past, during the aboriginal and transitional periods, and as they exist at present. A portrayal of the dependent variables in each of these three periods will illustrate the nature and degree of change that has taken place.

## Aboriginal Period

### Lanai

Some of the Hawaiian Islands have been continuously inhabited for the last 1,000 to 1,500 years by members of the Polynesian race.[1] The island of Lanai, however, was apparently not occupied until relatively recently. According to Hawaiian oral tradition the island was first occupied about 1400 A. D.[2] This late date of occupance is understandable in light of the fact that the other islands of the Hawaiian chain have much more desirable physical environments. There is some indication that within recent times both Lanai and Kahoolawe were used as points of exile, and it is altogether probable that the first inhabitants of Lanai were in fact exiles from other islands in the Hawaiian group.[3] It is certain that Lanai never achieved much prominence in ancient Hawaii. Throughout the known portion of Hawaiian history Lanai was ruled from Maui, and never produced a prominent native chief.[4] The population of Lanai, at its peak, about 1779 has

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[1]Robert C. Suggs, The Island Civilizations of Polynesia, (New York: New American Library, 1960), p. 152.

[2]K. P. Emory, The Island of Lanai, (Honolulu: Bernice P. Bishop Museum, Bulletin 12, 1924), p. 12.

[3]"Kahoolawe and Lanai: Tiny Isles wer Homes of Exiles Less Than a Century Ago," Paradise of the Pacific, XXVI, (November, 1923), 27-28.

[4]Emory, The Island of Lanai, p. 21.

been estimated as high as 20,400, however Emory's estimate of 3,500 is more realistic.[5]

Because of the physical nature of the island, there could not have been any large concentrations of population on Lanai. This has been illustrated by Emory's reconstruction of aboriginal settlement on the island. He estimated that there were about eighty villages at one time or another. Sixty of these villages were on the coast, the remainder inland. Few of the villages had more than ten houses.[6] There is no evidence to indicate that all were populated simultaneously: however, since only ten of the village sites contain a heiau, a traditional ceremonial center, it is probable that most of the villages were temporary in nature[7] (Figure 3).

Since eight of the heiau sites and most of the village sites are on the coast, some in areas of insufficient soil for agriculture, it may be assumed that fishing was the main activity of many of the people who inhabited Lanai during the aboriginal period. This is consistent with the type of settlement that existed on the now-uninhabited island of Kahoolawe, which has many of the same environmental char-

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[5]Robert C. Schmitt, Demographic Statistics of Hawaii, 1778-1965, (Honolulu: University of Hawaii Press, 1968), p. 42.

[6]Emory, The Island of Lanai, p. 51.

[7]Ibid.

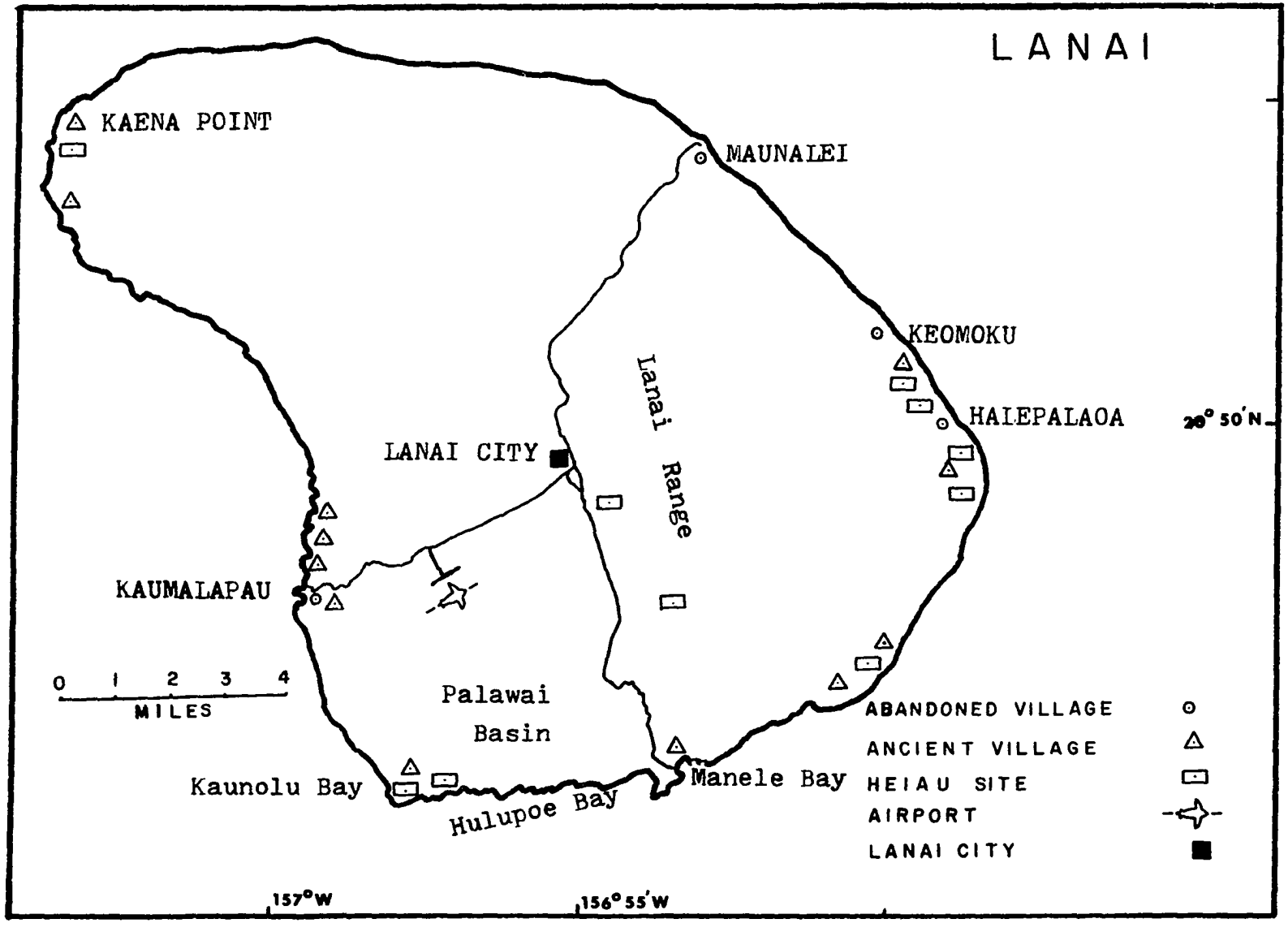
LANAI
KAENA POINT
MAUNALEI
KEOMOKU
HAIEPALAOA
20° 50'N
LANAI CITY
Lanai Range
KAUMALAPAU
0 1 2 3 4
MILES
Palawai
Basin
Kaunolu Bay
Hulupoe Bay
Manele Bay
ABANDONED VILLAGE
ANCIENT VILLAGE
HEIAU SITE
AIRPORT
LANAI CITY
157°W
156°55'W

Figure 3

acteristics as Lanai.[8] Fishing, however was not the only source of food for the aboriginal inhabitants of Lanai. Around some of the coastal village sites traces of ancient rock terraces have been found, indicating some cultivation of food crops in these areas.[9] The ancient gardens, usually only a few square yards in area, are now almost completely eroded away.

It has been reported by an early resident of Lanai that the people of the coastal lowlands were somewhat dependent upon the people living in the highland villages for their taro and sweet potatoes, bartering fish in exchange.[10] There are two main heiau sites on the plateau, both of which are located in an area with suitable soil for subsistence agriculture. Since the agricultural land near these sites is currently under extensive pineapple cultivation, it is impossible to determine the exact extent of cultivation during the aboriginal period. It is possible, however, to make a reasonable assumption about aboriginal land use on Lanai based not only on the few archaeological remnants which still exist, but also on the physical nature of the is-

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[8]J. Gilbert McAllister, Archaeology of Kahoolawe, (Honolulu: B. P. Bishop Museum, Bulletin 115, 1933), pp. 58-60.

[9]H. T. Stearns, Geology and Ground-Water Resources of Lanai and Kahoolawe, Hawaii, (Honolulu: U. S. Geological Survey, 1940), p. 5.

[10]Lawrence K. Gay, True Stories of the Island of Lanai, (Honolulu: Mission Press, 1965), 1. 61.

land, and ancient Hawaiin agricultural practices as developed on the other islands in the chain.

Studies of other Hawaiian islands have shown that taro and sweet potatoes were the principal food crops grown by the ancient Hawaiians.[11] On the island of Kauai most cultivation was done in irrigated taro beds which were built up and surrounded by stone walls.[12] The same type of cultivation was practiced on Oahu.[13] In the case of taro production, patches ranged in size from a few square yards to about one-half acre.[14] Sweet potato and dry-land taro cultivation was carried on in upland areas where irrigation was impossible. This is the type of cultivation which would have been practiced on Lanai. There is no area on Lanai with sufficient surface water for irrigation of wet land taro.

Emory's reconstruction of ancient settlements on Lanai indicates that many of the house sites were accompanied by small enclosures or

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[11] Richard Pearson, "Some Bases for Ecological Inference About Aboriginal Population of the Hanapepe Valley, Kauai," Journal of the Polynesian Society, LXXXI, (December 1962), 379-385.

[12] W. C. Bennett, Archaeology of Kauai, (Bernice P. Bishop Museum, Bulletin 80, 1931), p. 19

[13] J. B. McAllister, Archaeology of Oahu, (Bernice P. Bishop Museum, Bulletin 104, 1933), p. 27

[14] Ibid.

terraces for gardens.[15] This would indicate that most of the cultivated land on the island was limited to those areas where settlement occurred. Where terraces and gardens have been identified, they covered only small areas. The average size of each garden appears to have been about 300 square feet.[16] Since there are about 630 house sites on the island, and many of those sites are associated with fishing villages, it is probable that there was never more than about ten acres of land on the entire island under cultivation at any given time during the aboriginal period.

Although there was some shifting of garden sites through the several centuries of aboriginal occupance of Lanai, the fact that native land utilization was limited to the areas of settlement indicates that most of the land remained relatively unaffected by human occupance. As a result, the native vegetation remained mostly undisturbed during the aboriginal period.[17] During this period, native forest covered the windward slopes and higher elevations of the island. The dominant species of vegetation in the native forest was the kukui tree (Aleurites moluccana), with wiliwili (Erythrina monosperma), and ha'la (Pandanus) also important at the lower elevations. The dominant

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[15]Emory, The Island of Lanai, p. 48.

[16]Ibid.

[17]Gay, True Stories, p. 51.

forms of vegetation on the higher slopes were koa trees (Acacia koa) and ohia lehua (Metrosideros polymorpha). The leeward slopes and much of the semi-arid central plateau were covered with pili grass (Heteropogon), cactus (Opuntia megacantha), and other xerophytic shrubs.[18]

## Niue

During the aboriginal period of occupance on Niue, the general pattern of land utilization bore many similarities to that of Lanai. Niue, like Lanai, was originally settled by Polynesians. Apparently two groups of Polynesians settled on Niue, the first coming from Samoa over 1,000 years ago, with subsequent migrations from Tonga.[19] In fact, even today, there are discernible physical and speech differences between the people of the southern part of the island and those of the northern part. Early population figures are difficult to estimate, but there is no evidence that the population of Niue had ever been larger than that found by the early missionaries. The first accurate population count, in 1849, gave the figure 4,700.[20]

There has never been an archaelogical reconstruction of abo-

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[18]Ibid. pp. 65-74.

[19]E. M. Loeb, History and Traditions of Niue, (Honolulu: Bernice P. Bishop Museum, Bulletin 32, 1926), pp. 24.

[20]London Missionary Society, "Niue (Savage Island)", Niue Island, 1964, (Mimeographed), p. 4.

riginal settlement on Niue. It is almost certain, however, that there were no large concentrations of population during ancient times. The physical nature of the island, and the nearly continual state of warfare which existed, would have served as limiting factors on nucleated settlement. According to tradition, there were a few small settlements during the aboriginal period, some of these being on the sites of the present villages of Alofi, Tuapa, Mutalau, Liku, and Hakupu. Others were located inland at Fetuna, Tafolomahina, Paluki, and Havaka (Figure 4).

The aboriginal inhabitants of Niue, like many of those on Lanai, were primitive subsistence cultivators, working small plots of land; thus, it appears likely that a substantial portion of the aboriginal population lived in the bush near their agricultural plots. Considering the tools available to them, and the nature of their crops (taro, sweet potatoes, yams), the garden plots of Niue were probably similar in size to those of Lanai. Present-day garden plots on Niue are rarely more than 400 square feet in area, and there is little reason to believe that they would have been different in ancient times.

One major difference between Niue and Lanai is the condition of the soil. Although cultivation is possible over much of the surface of the island, the soils of Niue will not support subsistence agriculture for more than two successive years without losing their fertility. On Niue, garden sites had to be moved periodically and the land left fal-

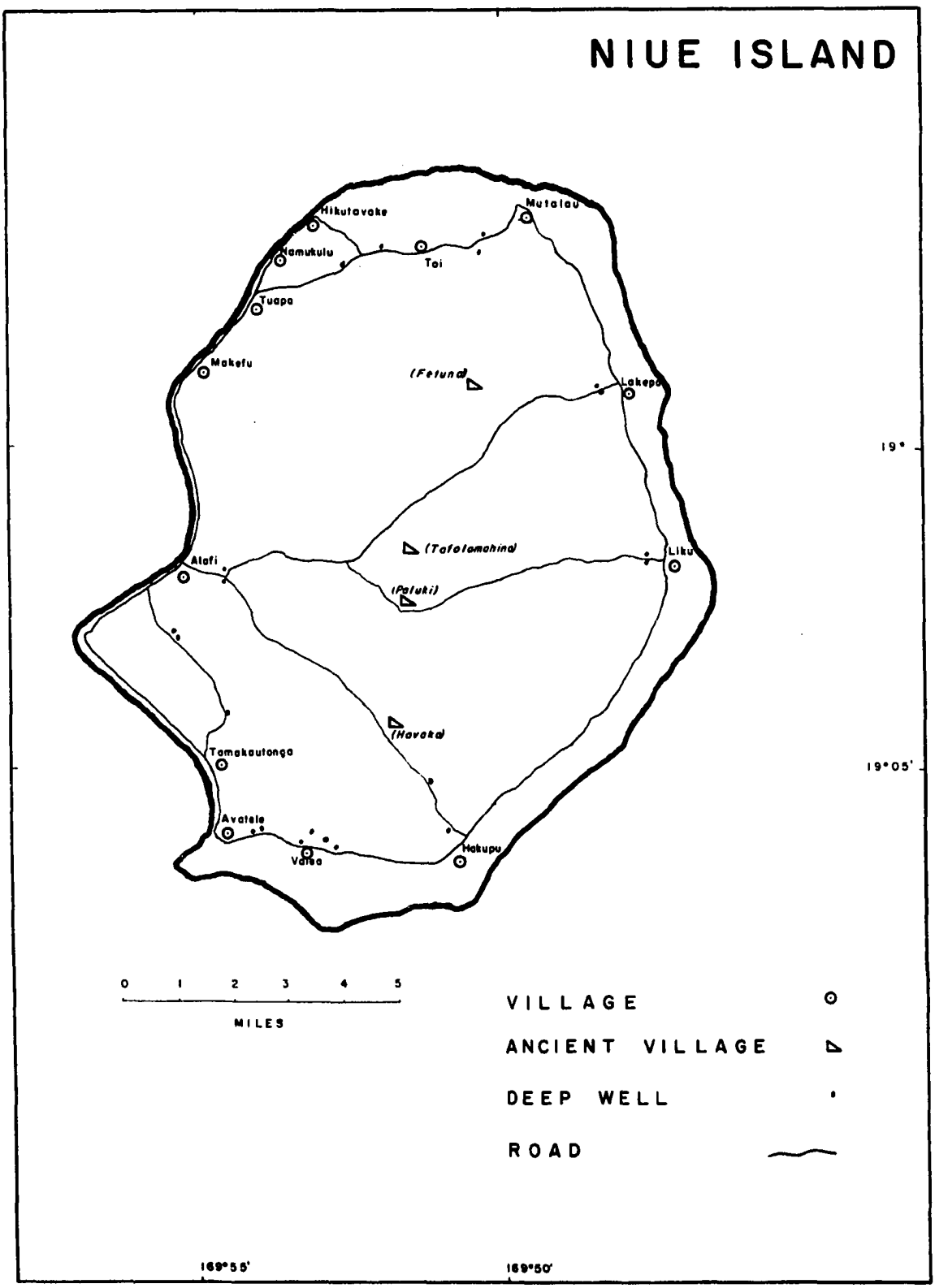
NIUE ISLAND
Hikutavake
Mutalau
Namukulu
Toi
Tuapa
Makefu
(Fetuna)
Lakepa
19°
(Tafolomahina)
Liku
Alofi
(Paluki)
(Havaka)
Tamakautonga
19°05'
Avatele
Hakupu
Vaiea
0 1 2 3 4 5
MILES
VILLAGE
ANCIENT VILLAGE
DEEP WELL
ROAD
169°55'
169°50'

Figure 4

low for seven to ten years before any given site could be cultivated again. Over a period of years this would have resulted in a much larger area of land coming under human influence on Niue than on Lanai. In any given year, however, there was still probably less than 1 per cent of the land under ultivation.

The primeval vegetation which covered most of Niue was almost certainly dense broadleaf evergreen forest. This forest was composed of mixed stants of several tropical species, including kafika (Eugenia inophylloides), kolivao (Eugenia richii), tavahi (Rhus taitensis), and other varieties.[21]

Gradually, over the centuries, the aboriginal inhabitants cleared much of this primeval forest in order to use the land for food crops. The areas in which the most extensive deforestation occurred were those in which the soils were best suited for agriculture. Those which remained under forest cover were rocky and less suitable for subsistence cultivation methods. Considering the land needs of the pre-European population of Niue, and the length of time the island had been occupied, it is probably that over one-half of the original forest cover of Niue was destroyed by the aboriginal inhabitants of the island.

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[21] T. G. Yuncker, The Flora of Niue Island, (Honolulu: Bernice P. Bishop Museum, Bulletin 178, 1943).

## Transitional Period

### Lanai

During the several centuries of occupance of Lanai, the native Hawaiians achieved a rather stable relationship with the land. It appears that they did not destroy any of the meager resources which the island had to offer, and made good use of all that was available to them. Although they did not achieve a high level of technology or material culture, they were able not only to survive, but to maintain a consistent and steady growth of population. Within a few years, following the arrival of the first Europeans on the island, the native population was decimated, the aboriginal pattern of land use disappeared, and much of the original natural vegetation destroyed.

The first European contact with the island of Lanai occurred February 25, 1779, when the island was sighted by two British ships in an expedition led by Captain James Cook. The first visitors of consequence, however, did not arrive on Lanai until 1835, when the first Christian missionaries landed. These missionaries were Americans, sent to the Hawaiian Islands by the American Board of Commissioners for Foreign Missions, a Protestant missionary group in New England. Within a very short period of time after the arrival of the missionaries, the population of the island began to decline. The population in 1832 was estimated by the Hawaiian government to be 1,600. By 1838 the official census showed 1,200. In 1846 the popu-

lation of the island had declined to only 616 people.[22] The population seemed to stabilize at about that level for a number of years, so it is probable that the marked decrease between 1838 and 1846 was primarily due to emigration to other islands. Following the collapse of an attempted Mormon colony in the Palawai basin in 1864, the population of Lanai began to decline again. At the height of interest in the colony the population of the island had been as much as 646, but following the demise of the colony the population decreased to 395, and continued to decline. By 1896, there were only 105 people remaining on Lanai.[23]

During the period following 1835, when the population was declining, the pattern of land utilization was also undergoing change. Most settlements along the coast disappeared, the only ones remaining being at Maunalei, Halepalaoa, and Koele, plus isolated houses around the Palawai basin. With the abandonment of the old villages came an abandonment of much of the formerly cultivated land. It is probable that the people remaining on Lanai continued to practice subsistence agriculture in much the same manner as their aboriginal ancestors. There is no indication, however, of any commercial crops being grown on the island prior to 1890.

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[22]Emory, The Island of Lanai, p. 8.

[23]Schmitt, Demographic Statistics, p. 70.

A turning point, in terms of land use on Lanai, occurred in 1861, with the arrival of Walter Murry Gibson. He came to supervise the Mormon colony which was being established in the Palawai basin. Some of the land for this colony had been acquired in 1855. The colony was to be populated by Hawaiian Mormons from the other islands in the Hawaiian group. Gibson managed to enlarge the holdings of the colony until they encompassed the best agricultural land on Lanai. This was the first land on the island to be transferred from native control into alien hands. In 1864 the Church excommunicated Gibson and withdrew support for the colony when it was discovered that Gibson held title to the land on Lanai in his own name. Within two years the colony failed. There are now no traces remaining of this former settlement.

Gibson retained title to the lands on Lanai, and upon his death in California in 1888 the title passed to his daughter, Mrs. Talula Lucy Hayselden.[24] Her husband, Frederick H. Hayselden, introduced commercial agriculture to the island when he organized a sugar company. This company tried to develop its operations on the windward side of Lanai, where it was felt the soils and availability of water were best for growing sugar. They built a wharf at Halepalaoa, and laid a railroad bed from the wharf to the new settlement at Keomoku.

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[24]Emory, The Island of Lanai, p. 48.

Unfortunately, there was insufficient water for sugar cultivation. In 1901 the company failed and Keomoku soon became a ghost town.

Between 1901 and 1917 there were at least two ranching operations on the island. By 1917 most of the island was under the control of the Lanai Ranch Company. This ranching operation, and the operation of Charles Gay, occupied all but about five hundred acres of the island, which remained under native ownership.[25] Finally, in 1922, the entire island was acquired by the Hawaiian Pineapple Company, now known as the Dole Company. This corporation developed the highland plateau for commercial plantation cultivation of pineapple, but continued grazing cattle on the lower slopes.

Sometime during the nineteenth century goats were introduced to the island. This was one of the more disastrous events to occur on Lanai. The goats ran wild, and before they were finally exterminated by the Dole Company, sometime in the 1920's, they had virtually denuded practically all of the island. The native forest was almost completely destroyed, and the slopes of the island became so bare that they suffered from extensive wind erosion.

## Niue

Niue Island had its first contact with the outside world on June 20, 1774, when it was first sighted by Captain James Cook, al-

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[25]Ibid.

most five years prior to his first contact with Lanai. Due to a rather hostile reception by the Niuean people, Cook named the island "Savage Island." Apparently this rather unfortunate name discouraged further landings by Europeans, as the next verified landing did not occur until 1830. At that time the London Missionary Society unsuccessfully attempted to land native teachers from Aitutaki.

In 1846, a native Niuean named Peniamina, who had been converted to Christianity in Samoa, was sent to Niue by the London Missionary Society. Although not particularly successful as a missionary, Peniamina did manage to lay the foundation for further missionary efforts. Samoan teachers were sent to Niue in 1849. By the time the first European missionaries arrived in 1861, the entire population had been converted to Christianity.

The population of Niue, which stood at 4,700 in 1861, continued to increase until 1884, when it peaked at 5,070. After that date the population declined, until it reached its lowest level of 3,747 in 1928.[26] Part of this decline was due to disease, but a significant part was also due to the removal of male Niueans from the island by "blackbirders."[27] It should be noted that Niue suffered significant-

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[26]Judy Tudor (ed.), Pacific Islands Year Book and Who's Who, (Sydney: Pacific Publications, 1968), p. 157.

[27]The term "blackbirder" refers to the men who roamed the Pacific islands during the nineteenth century recruiting, sometimes forceably, native islanders as workers for sugar plantations in Australia and guano deposits in Peru.

ly less depopulation than many other islands of the Pacific.

Under the influence of the missionaries, the people of Niue made some slight changes in their land use patterns. The former settlements in the middle of the island were abandoned in favor of the present-day village system.

The arrival of foreign trading agents on Niue in 1866 also gave impetus to some slight changes in land use. Whereas the Niueans had always been primitive subsistence cultivators and fishermen, they then began to grow a few cash crops. Some sweet potatoes and bananas were exported, but the principal cash crop was copra. This resulted in an extension of coconut tree planting, until coconuts formed a wide belt along the northern and eastern perimeter of the island (Figure 5).

There were no major changes in native land use patterns, like those which occurred on Lanai. The forest area was still being diminished, but very slowly. Except for changes in settlement patterns, the land use pattern of the transitional period was not markedly different from that of the aboriginal period. It is significant that practically no land passed from native ownership into alien hands during this period.

In making a comparison between Lanai and Niue for the transitional period, it is immediately obvious that the island of Niue experienced much less change than did Lanai. Whereas Lanai experienced almost total depopulation and deforestation during this period, and also

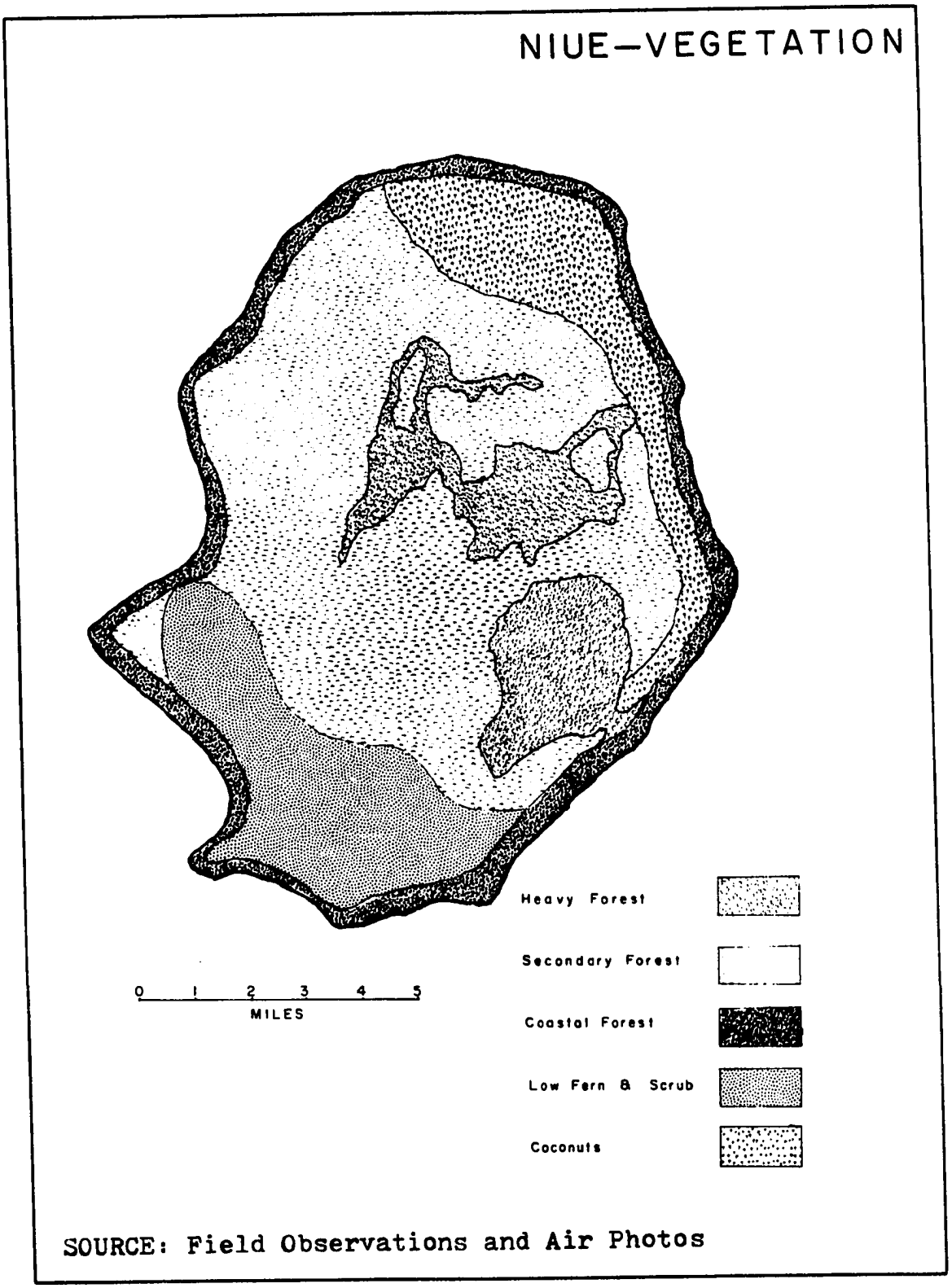
NIUE—VEGETATION
0 1 2 3 4 5
MILES
Heavy Forest
Secondary Forest
Coastal Forest
Low Fern & Scrub
Coconuts
SOURCE: Field Observations and Air Photos

Figure 5

experienced a complete changeover in land use patterns from subsistence cultivation to ranching, and eventually to commercial plantation agriculture. Niue Island patterns of population, land use, and vegetation remained virtually the same as during the aboriginal period.

## Contemporary Period

### Lanai

One of the more dramatic changes which have occurred on Lanai is that of population. The aboriginal population was completely Polynesian, living in scattered settlements and numbering about 3,500 people at the time of peak population. During the transitional period the population decreased to as low as 105. The population increased slightly to 185 by 1920, but only about one hundred of these people were native Hawaiian. The importation of labor by the Dole Company brought the population to 2,356, most of whom were of Japanese or Filipino ancestry, at the time of the 1930 census. By 1960 the population of the island was 2,115, none of whom were native Hawaiian. The entire population of the island at present is either directly or indirectly dependent upon the Dole Company for their income. Therefore, with the exception of a few fishermen living on the windward coast, and a few Dole employees living near the harbor at Kaumalapau, the entire population of Lanai lives in Lanai City, which was constructed by the Dole Company as a company town for its employees. As

The Dole Company owns and operates the entire island, it is difficult for settlement to occur outside of Lanai City.

TABLE 1

POPULATION OF LANAI 1910-1970[a]

| 1910 | 1920 | 1930 | 1940 | 1950 | 1960 | 1970[b] |
|---|---|---|---|---|---|---|
| 131 | 185 | 2,346 | 3,720 | 3,136 | 2,115 | 2,204 |

[a]Source: Robert C. Schmitt, Demographic Statistics of Hawaii, 1778-1965, (Honolulu: University of Hawaii Press, 1968), p. 116.

[b]United States Department of Commerce, Bureau of the Census, 1970 Census of Population, Hawaii.

Unlike the aboriginal and transitional periods of occupance of Lanai, during which the land use pattern was largely unplanned and uncoordinated, the present land use pattern is very orderly. The principal purpose of the Dole Company on Lanai is to grow pineapple, and to this end every bit of land that can be economically developed for pineapple cultivation has been so developed (Figure 6). Over 16000 acres of land on Lanai are now under pineapple cultivation.

The remainder of the island has not been developed in the same manner as the pineapple land, but it has been assigned to various auxiliary purposes. Most of the mountainous area has been set aside as a water shed. Some parts of the island have been designated strictly for recreational uses, such as picnic areas, swimming beaches, boat

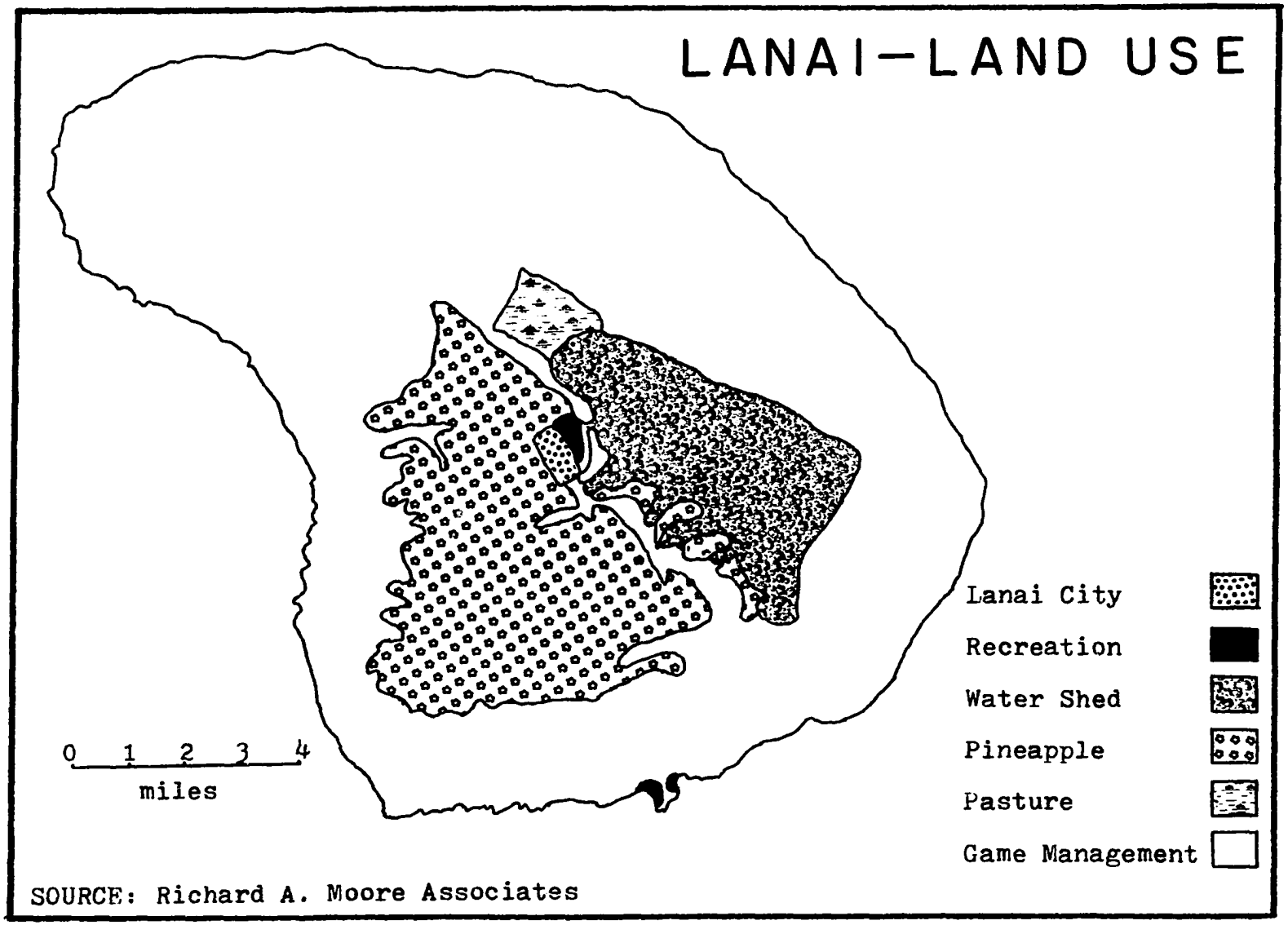
LANAI—LAND USE
0 1 2 3 4
miles
Lanai City
Recreation
Water Shed
Pineapple
Pasture
Game Management
SOURCE: Richard A. Moore Associates

Figure 6

harbor, and golf course. The vast majority of the island, however, has been designated as a game management area (Table 2). Game animals have been imported for this purpose, and cattle grazing is no longer practiced on Lanai.

The Land Study Bureau of the University of Hawaii has assigned six classifications of land use on Lanai: urban, recreation, pasture, water shed, pineapple, and game management. The acreage used for pasture is included in the figure for water shed acreage (Table 2), as the pasture, which is used for horses owned by residents of the island, is in the part of the island which is best suited for water shed. That part is higher, and a somewhat mountainous region which forms the backbone of the island. The pineapple acreage is located in the central plateau portion, and represents one large semi-contiguous block of land. All of the urban acreage is in Lanai City. There are three pieces of recreational land: the golf course, near Lanai City, the boat harbor at Manele Bay, and the swimming beach and park at Hulopoe Bay.

Since goats and cattle decimated most of the native vegetation, the largest portion of the island, particularly the slopes and coastal areas, is of little economic value to the Dole Company. Because of its lack of suitability, this area has been designated as a game management area. Three species of game animals, mouflon, axis deer, and pronghorn antelope, and four species of game birds, quail, par-

tridge, wild turkey, and ring-necked pheasant, have been established in the Lanai game management area, and hunting is permitted the year around in this area.

TABLE 2

LAND USE--LANAI[a]

| LAND USE | ACRES | PER CENT OF TOTAL |
|---|---|---|
| Pineapple growing | 16,141 | 18.18 |
| Water shed | 5,989 | 6.64 |
| Game management | 67,293 | 74.57 |
| Recreation | 107 | 0.12 |
| Urban | 440 | 0.49 |
| TOTAL | 90,240 | 100.0 |

[a]Detailed Land Classification-Island of Lanai, (Honolulu: Land Study Bureau, University of Hawaii, Bulletin No. 8, May, 1967), p. 17.

The contemporary pattern of vegetation of Lanai is different, in terms of individual species, from that of the aboriginal period. There are, however, some broad similarities in the general pattern of vegetation. That part of the island reserved as a game management area is now covered with cactus, xerophytic shrubs, and grasses. This same general pattern probably existed in the aboriginal period. The water shed area, and the area immediately around Lanai City, have been planted in Norfolk pine. During the aboriginal period this same area was covered with native forest. This native forest, how-

ever, was probably much more extensive in area. Most of the island today is entirely devoid of tree cover, (Figure 7).

## Niue

On Niue, the population decline leveled off in 1928, and after a short time the population began to rise. By 1966 there were 5,199 people on Niue, all but 134 being native Niueans of Polynesian descent (Table 3). The small European community on the island consists almost entirely of government employees, their families, and missionary personnel. There are virtually no non-Polynesians permanent inhabitants.

One contemporary aspect of population is that there is substantial emigration from the island. Each year about 150 people leave Niue for New Zealand, where they settle permanently. As a result there is a substantial community of Niueans living in New Zealand, very few of whom ever return to live on Niue.

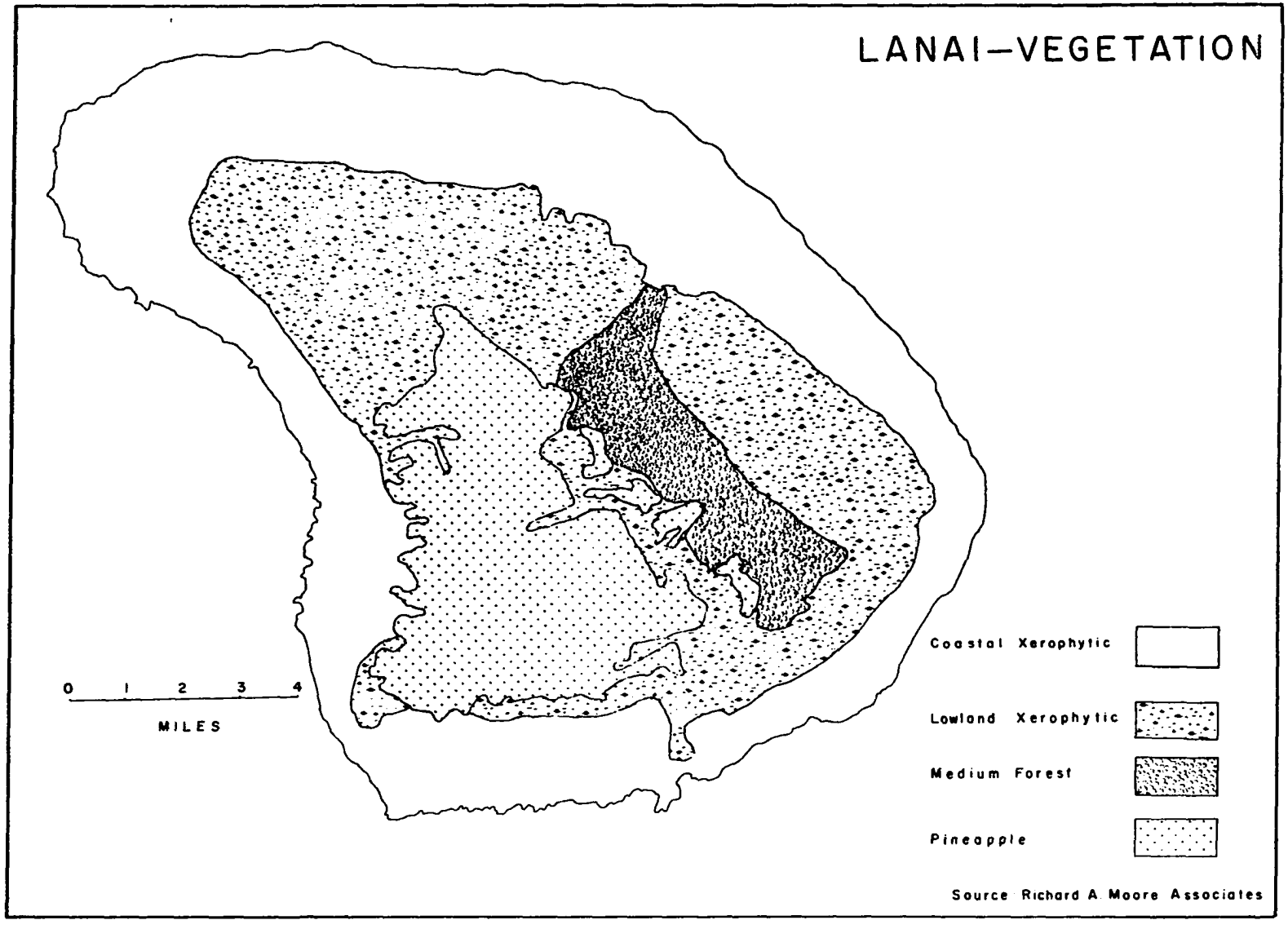
LANAI—VEGETATION
0 1 2 3 4
MILES
Coastal Xerophytic
Lowland Xerophytic
Medium Forest
Pineapple
Source Richard A. Moore Associates

Figure 7

TABLE 3

POPULATION OF NIUE 1900-1969[a]

| 1900 | 1928 | 1939 | 1951 | 1961 | 1966 | 1969[b] |
|---|---|---|---|---|---|---|
| 4,200 | 3,747 | 4,281 | 4,634 | 4,864 | 5,065 | 5,343 |

[a]Judy Tudor (ed.), Pacific Islands Year Book and Who's Who, (Sydney: Pacific Publications, 1968).

[b]Office of the Resident Commissioner, Government of Niue, February 24, 1971.

One of the results of emigration has been to retard the rate at which land use patterns change. Semi-subsistence agriculture is still the dominant form of cultivation. The principal export crops remain copra, bananas, and kumaras (sweet potatoes). Copra exports have fluctuated in recent years as a result of hurricane damage to the coconut trees. Kumara exports have also fluctuated due to the occurrence of black rot in the Niue crop. Of the poeple who emigrate, apparently many are the more successful as cash crop cultivators, since one of the residual effects of emigration is that the amount of land under cultivation for cash crops does not increase significantly from year to year. Field observations have shown that at any given time there is only about 1 per cent or less of the land surface in crop cultivation other than copra.

Despite the efforts of the Agriculture Department of the Govern-

ment of Niue, most cultivation is still carried on in small plots which are shifted from year to year. The major exceptions to shifting cultivation are the coconut groves and banana plantations.[28] Unfortunately, there is little attention given by most Niueans to the judicious development of their copra or banana plantations. Copra plantations on Niue are not neat, orderly rows of trees, but are rather haphazard groves, with the trees growing wherever nuts fall and germinate. Weeds and undergrowth beneath the coconut trees are not cleared away. Banana plantations are usually somewhat more orderly than are the copra plantations, but are nonetheless not as productive as they could be. Most banana growers fail to fertilize and properly cultivate the groves and, as a result, get a smaller crop than is possible. There has been very little enthusiasm on the part of the Niueans for commercial banana cultivation, and less than three hundred acres is devoted to the growing of bananas.

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[28]On Niue the term "plantation" refers to any agricultural plot, regardless of its size. Most "plantations" are only a few square yards in area.

TABLE 4

LAND USE--NIUE[a]

| LAND USE | ACRES | PER CENT OF TOTAL |
|---|---|---|
| Land not available for agriculture (roads, buildings, etc.) | 400 | 0.6 |
| Land which has never been used | 8,000 | 12.5 |
| Rocky soils unsuited at present for most crops | 27,050 | 42.3 |
| Soils suited for crops but not presently used | 7,490 | 11.7 |
| Land under ten-year cycle of shifting cultivation | 7,545 | 11.8 |
| Land under permanent plantations (mainly coconuts) | 5,320 | 8.4 |
| Land formerly cultivated but now abandoned | 8,095 | 12.7 |
| Total | 63,900 | 100.0 |

[a]A. C. S. Wright and R. J. van Westerndorp, Soils and Agriculture of Niue Island, (Wellington: New Zealand Soil Bureau, Bulletin 17, 1965), p. 70.

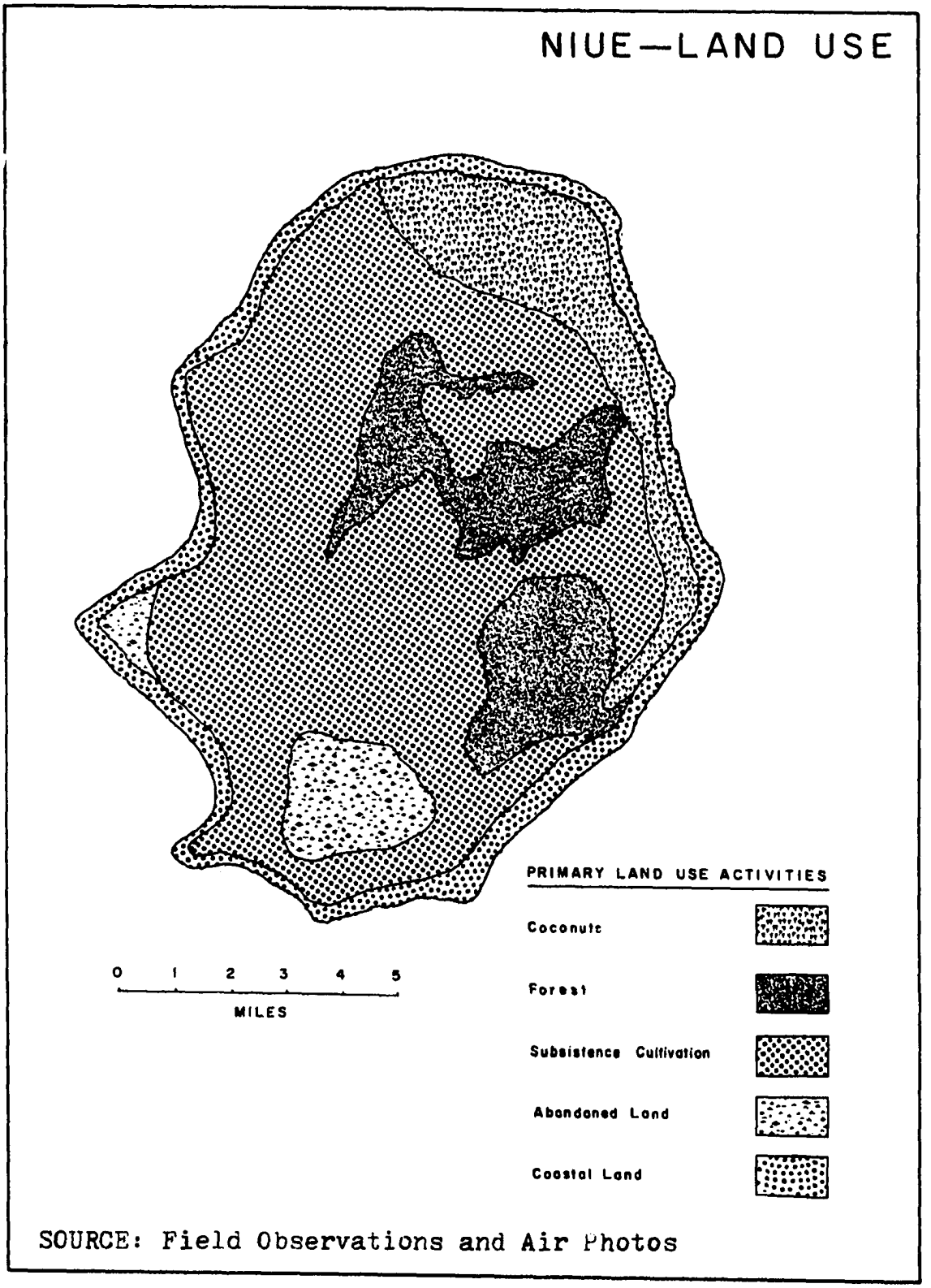
NIUE—LAND USE
0 1 2 3 4 5
MILES
PRIMARY LAND USE ACTIVITIES
Coconuts
Forest
Subsistence Cultivation
Abandoned Land
Coastal Land
SOURCE: Field Observations and Air Photos

Figure 8

Pastoral farming, a new type of land use for Niue, is being introduced, but it is still in the experimental stage. Such might prove to be the best form of land use for the more than 8,000 acres which have been depleted by over-cultivation. Much of this land is now useless for other types of export and food crops, but is suitable for the growth of forage crops.

The only other commercially potential land use on the island is lumbering. There are about 6,000 acres of hardwood forest, in which some lumbering is now being done for local use. The potential of this resource has yet to be realized or fully assessed.

## Summary of Changes

### Lanai

The island of Lanai has undergone very marked changes in its population-land use-vegetation complex from the aboriginal era to the present. In many respects it is almost like a completely different island. The major changes which can be identified are:

1. The aboriginal Polynesian population, which once numbered over 3,000 persons, gradually declined in the nineteenth century, and eventually disappeared altogether in the twentieth century. The current population of the island, which varies according to the employment policies of the Dole Company, is predominantly of Japanese and Filipino ancestry.

2. The subsistence agricultural land use patterns of the aboriginal era were replaced with commercial ranching in the transitional era, which was in turn succeeded by extensive commercial pineapple cultivation in the contemporary period.

3. The aboriginal vegetation pattern of the island was completely altered during the transitional era by introduced sheep, goats, and cattle. The current vegetational characteristics are largely dependent upon the reforestation policies of the Dole Company. Current vegetation patterns are a reflection of land use policies.

## Niue

The population-land use-vegetation complex of Niue Island has undergone very little marked change, as compared to that of Lanai. Many aboriginal characteristics have been retained, and Western influence has had much less impact on the nature of the Niue Island ecosystem. This is indicated by the following:

1. The population of Niue is currently overwhelmingly Polynesian, still speaking the Niuean language, and preserving many traditional customs.

2. The current population is at the highest numerical level of any time in history.

3. The prevailing system of agriculture on Niue is still sub-

sistence agriculture. Therefore, the general pattern of land use is the same as that of the aboriginal era.

4. There has been no large-scale deforestation or destruction of species on Niue. The contemporary pattern of vegetation is not significantly different from that of the aboriginal era of occupance.

It is obvious, therefore, that Lanai has undergone very marked, and perhaps catastrophic changes in the nature of its ecosystem, while Niue has remained rather stable in its general characteristics. This would indicate that Lanai has been subject to external influences which, for some reason, have not been attracted to Niue Island.

## CHAPTER III

## THE EFFECTS OF LOCATION, SOIL, AND WATER

Although the physical environmental complex of any island is composed of several variable elements, not all of these elements play decisive roles in determining the patterns of population, land use, and vegetation which are found on that island. In the case of the islands of Lanai and Niue, three physical variables are of paramount importance; location, soil, and water. Even though other physical elements are involved in the environmental complex, and all are important to some degree, these three are the ones which are the most decisive in influencing the current patterns of land use, vegetation, and population.

As employed in this study, the term "location" refers to both absolute location on the earth grid, and to relative location. Relative location, that is location in relation to other specific places, is the most important aspect of this variable, and the analysis of relative location will be concerned mainly with accessibility.

The discussion about soil is concerned primarily with the suitability of the soils of each island for agriculture, and the distributional characteristics of soil types. The analysis of the water situation

for each island is concerned not only with precipitation characteristics, but also with the availability and development capacity of ground water reserves.

## Location

### Lanai

Lanai, located at 156°55' west longitude, 20°50' north latitude, is one of four islands forming a small cluster in the center of the Hawaiian archipelago. The other three islands are the smaller island of Kahoolawe, some fifteen miles to the southeast, and the larger islands of Maui, eight miles east of Lanai, and Molokai lying seven miles to the north. It is significant that Maui and Molokai both lie windward of Lanai; therefore, Lanai is in a rain shadow created by these two larger islands.

Being part of a group of islands Lanai is located relatively near larger centers of population and transportation. The city of Honolulu, the largest city in the Hawaiian Islands and a major transportation and distribution center of the Pacific islands, is approximately sixty miles northwest of Lanai, and is readily accessible both by sea and air.

Effects on population. According to the postulated model of relationships between the dependent and independent variables, there is a relationship between location and the population characteristics of numbers, distribution, and ethnic composition. This relationship,

however, is a secondary rather than a primary relationship.

First, it is obvious that during the aboriginal era the island of Lanai was more isolated and inaccessible than it is today. This was due, of course, to the markedly lower level of transportation technology which existed at that time. Therefore, the Hawaiian Islands generally, and the island of Lanai in particular, were not inhabited until several centuries after the beginning of the Christian era.[1] Thus, there was insufficient time for the population level of the island to exceed the island's carrying capacity during the aboriginal era.

A second effect of the relative inaccessibility of Lanai was a result of the fact that the island is located in the North Pacific Ocean. This location was considerable removed from the trade and exploration routes of the technologically advanced nations of Western Europe during the fifteenth, sixteenth, and seventeenth centuries. Therefore, the island remained unknown to the Western world until the aboriginal Polynesian inhabitants, who had their roots in Southeast Asia,[2] had established their integral relationship with the island's resources. The relative inaccessibility of Lanai, therefore, did have an effect on the ethnic composition of the island's population.

During the transitional period the relative isolation of Lanai

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[1]Robert C. Suggs, The Island Civilizations of Polynesia, (New York: New American Library, 1960), p. 152.

[2]Ibid. p. 72.

was not as pronounced as during the aboriginal period. The Western world "discovered" the Hawaiian Islands, and technological advances in shipbuilding and navigation made the islands considerably more accessible than previously. Not only Honolulu, but also Lahaina, on the nearby island of Maui, became major ports-of-call during the nineteenth century. During the transitional period many Europeans, including planters, whalers, merchants, and missionaries established residence in the Hawaiian Islands. This induced a break-down in aboriginal native customs as the Hawaiian people abandoned their traditional culture in favor of the seemingly more attractive Western ways. Despite the fact that Lanai had somewhat less contact with the outside world than the other inhabited islands of the Hawaiian chain, due at least partially to the lack of good docking facilities, the changes that were occurring on the other islands inevitable spread to Lanai. The primary effect of these changes is indicated by the population decline that occurred between first European contact in 1832 and the official census of 1846. During that time the population went from 1,600 to only 616.[3]

During the contemporary period Lanai cannot be considered as either isolated or inaccessible. It is served by regular boat service,

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[3]K. P. Emory, The Island of Lanai, (Honolulu: Bernice P. Bishop Museum, Bulletin 12, 1924), p. 8.

and by passenger and freight air service. This accessibility, however, has had no apparent effect on population numbers, distribution, or ethnic composition during the contemporary period of occupance.

Effects on land use and vegetation. There is also a relationship between location and the patterns of land use and vegetation on Lanai. This relationship, however, is also a secondary relationship and not a direct cause-effect relationship. Two major qualities of location, relative inaccessibility and location within a tropical climatic regime, impose certain limitations on the type of land use and vegetation which can occur on Lanai.

Inaccessibility, of course, had its greatest impact in the pre-aboriginal era, prior to any human occupance of the Hawaiian Islands. During this era, when the native vegetation of the island was established, the only types of vegetation which could exist were those which could be transported by wind, waves, or birds.[4]

Even during the aboriginal era of occupance, when some new species of vegetation were introduced, the inaccessibility factor limited the new species to those which could be transported over great distances in open canoes. Thus, in all probability, the new species introduced during the aboriginal period were food species.

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[4]Elwood C. Zimmerman, "Nature of the Land Biota", in F. R. Fosberg, Man's Place in the Island Ecosystem, (Honolulu: Bishop Museum Press, 1963), pp. 57-58.

The effect of location on land use during the aboriginal era was, therefore, twofold: not only were the aboriginal inhabitants limited to cultivation those species which they could transport to the island under their limited technology, but they were also limited to those which could successfully compete in the climatic environment of the island. In this respect, both native and introduced species were under the same limitations.

During the transitional and contemporary periods of occupance the two limiting factors of inaccessibility and climate were largely overcome. Increased technology has not only made the island more accessible, due to improved transportation facilities, but it has also enabled the island residents to overcome climatic aridity through the development of ground water resources.

The most marked effect of improved accessibility has been on the land use pattern. The present pinapple plantation on Lanai is possible because the pineapple can be transported economically to the processing facilities in Honolulu. Thus, location has a secondary effect on land use patterns as well as a primary effect on economic systems.

## Niue

Niue Island, located at 169°17' west longitude, and 19°10 south latitude, is a solitary island and not part of any larger group. The nearest island, Vava'u in the Tongan Islands, lies 240 miles to the

west; the nearest major airport is located in American Samoa, on the island of Tutuila, some 350 miles northwest of Niue; and the nearest major port facility is in Suva, Fiji, which is over 650 miles west of Niue.

Effects on population. Niue Island displays many of the same locational effects on population as on Lanai. Here, again, there is a relationship, as indicated on the model, but the relationship tends to be secondary in its effects rather than primary.

Niue Island, like Lanai, was not occupied until well into the Christian era.[5] The reason for this was the same as that of Lanai; isolation and inaccessibility. Similarly, the result of this somewhat late date of occupance was that Niue did not experience a population growth during the aboriginal period of occupance that was in excess of the island's carrying capacity.

During the transitional period of occupance, differences between the two islands began to appear. Some of these differences were a result of location. Although both islands were "discovered" by the Western world at about the same period of time, changes occurred much more rapidly on Lanai than on Niue, and with much more drastic end results in terms of the native populations. One reason for this was that Niue was not close to any other island which would at-

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[5]Edwin M. Loeb, History and Traditions of Niue, (Honolulu: Bernice P. Bishop Museum, Bulletin 32, 1926), p. 24.

tract Western interests, and they had very little in and of itself to attract merchants, whalers, planters, or even missionaries. Therefore, the native population of Niue Island actually continued to increase long after first contact with Europeans. It finally peaked in 1884, several years after the first European missionaries arrived. There were, in fact, no detrimental effects on the population of Niue during the nineteenth century as a result of location.

During the contemporary period the situation for Niue changed only slightly from its past status of isolation and inaccessibility. The island is regularly served by only one boat every four weeks. An air strip was completed on the island late in 1970, but there is no regular air service at the present time. The most noticeable effect of continued isolation on the population of Niue is that the island has retained its aboriginal ethnic composition. Although there has been some racial mixing on the island, the population remains overwhelmingly Polynesian.

Effects on land use and vegetation. The same two limiting qualities of location which exist on Lanai, inaccessibility and location within a tropical climatic regime, also exist on Niue, and with much the same results. There was on Niue during the pre-aboriginal era the same general paucity of varieties of plants, and during the aboriginal era the same limitation on cultivated organisms.

The marked differences between the two islands is a result of

the transitional and contemporary periods of occupance. During those two periods fewer exotic species were imported into Niue. The major factor, however, is the result of the effect of location on the economic systems of the island, with its resultant effect on the land use patterns. Because of Niue's continuing isolation and relative inaccessibility, it has not been economically feasible to grow many crops other than those which are cultivated under the traditional methods. Therefore, there has been very little change in the overall land use pattern of the island. Therefore, the relationship which is shown in Figure 1 between location and land use is a secondary relationship rather than a primary one.

## Soil

### Lanai

The soils of Lanai are the result of weathering of residual materials, none of the parent material having been transported to the island, as is the case of some Pacific islands. Six great soil groups are represented on Lanai; Alluvial, Low Humic Latosol, Humic Ferruginous Latosol, Humic Latosol, Lithosol, and Regosol.[6] Since most of the soil forming processes are similar throughout the island, slope is the dominant factor in the formation of the different soil groups.

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[6]Detailed Land Classification--Island of Lanai, Honolulu: Land Study Bureau, University of Hawaii, Bulletin No. 8, May 1967), p. 2.

Only three of these soils, the Low Humic Latosols, Humic Ferruginous Latosols, and Alluvial soils, are suitable for agriculture.[7] All are deep, well drained, and free of stones. The most extensive of these three soil groups are the Low Humic Latosols, which occupy most of the central part of the island (Figure 9).

Effects on population. The soils of Lanai are an important component of the island ecosystem. They reflect, in part, the dominant climatic and vegetative characteristics of the island, but more importantly, they enter into the man-land relationship through agriculture. The importance of the soils to this relationship has changed, however, with technological and economic changes.

It does not appear that population numbers, distribution, or ethnic composition have been affected by the quality of the soils of Lanai in either the aboriginal or the transitional eras of occupance. In neither period of time were the occupance of the island totally dependent upon the soil for their livelihood.

During the contemporary period, however, the quality of the island's soils have been of greater importance, and have had an indirect impact, through their effects on the economic system of the island, on the island population. The contemporary population of Lanai is almost totally dependent upon the operation of the pineapple plantation

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[7] Ibid.

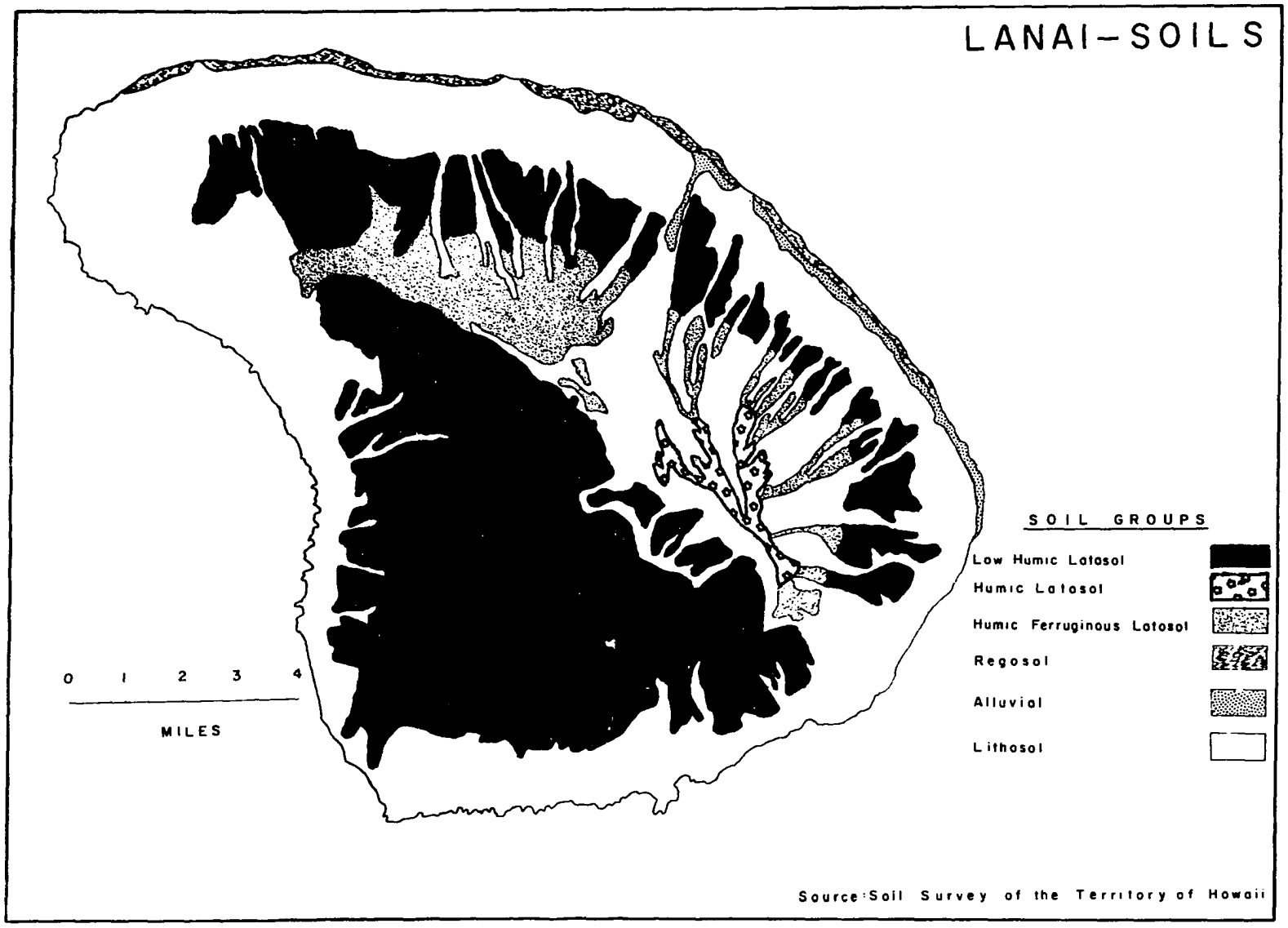
LANAI-SOILS
SOIL GROUPS
Low Humic Latosol
Humic Latosol
Humic Ferruginous Latosol
Regosol
Alluvial
Lithosol
0 1 2 3 4
MILES
Source: Soil Survey of the Territory of Hawaii

Figure 9

for their livelihood. This operation is possible primarily because of the extensive area of Low Humic Latosols, which are eminently well-suited for pineapple cultivation. Therefore, there has been an indirect effect on the size of the island's population by the soils of Lanai.

Effects on land use and vegetation. Land use patterns, as indicated in Chapter II have varied through time, and have been directly affected by the soil patterns of Lanai. This is consistent with the postulated model of relationships for the island as illustrated in Figure 1.

The primary effect of soil has been in its suitability for agriculture under prevailing economic and technological conditions. During the aboriginal period very little of the total land area of the island was under cultivation at any given time. The area of greatest settlement, however, and therefore the area of most concentrated cultivation during the aboriginal period, was in the portion of the island where Alluvial soils are found. Therefore, soil quality did have an effect on land use during the aboriginal period.

Since the primary form of land use during the transitional period was stock-raising, it appears as though soils were of less consequence to the man-land relationship during this era.

The contemporary period is the one in which soils are of greatest importance. Most of the area which contains soils which are suitable for pineapple cultivation are devoted to that purpose. Those

areas of the island which are covered with soils not suitable for pineapple cultivation have been set aside as game management areas. No other extensive type of land use is practiced on Lanai.

Although a precise reconstruction of aboriginal vegetational patterns is impossible, it does not appear that soil quality was the predominant factor in controlling the vegetational pattern of the island. The availability of water is more important than soil; therefore, the vegetation of Lanai is not affected primarily by soil, but rather is affected by soil indirectly through man's use of the land.

## Niue

The soils of Niue are of an uncertain origin, as the parent materials have not yet been identified.[8] The results of the first soil survey indicated that volcanic ash might possibly have been the parent material.[9] Subsequent investigations, however, have indicated that the parent material might possibly be a combination of coral reef materials and submarine sediments.[10]

Four soil series have been identified on Niue: the Hikutavake,

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[8]A. C. S. Wright, and R. J. van Westerndorp, Soils and Agriculture of Niue Island, New Zealand Soil Bureau Bulletin 17, (Wellington: Department of Scientific and Industrial Research, 1965), p. 28.

[9]A. C. S. Wright, "Soil Reconnaisance of Niue Island," (Unpublished New Zealand Soil Bureau Bulletin, 1949), pp. 1-2.

[10]Wright, Soils and Agriculture, p. 28.

Hakupu, Fonuakula, and Palai series. The Hikutavake series, which occupies the lower terrace, is a Tropical Rendzina. Since about 90 per cent of the area of the Hikutavake series is covered with coral limestone outcrops, it is an unsuitable soil for agriculture.[11] The other three series have been tentatively classified as Latosolic Soils of High Base Status.[12] These three series, which occupy the upper terrace of the island, are differentiated largely on the basis of weathering increases toward the center of the island[13] (Figure 10).

All of the soils of Niue are shallow and rocky; only in a few places are they more than eighteen inches in depth, and in nearly all places they are underlain by compacted coral sand or partially decomposed limestone. Approximately 48 per cent of the surface of the island is covered with limestone outcrops. In fact, there are relatively few areas of any magnitude which are free of rock outcrops.

[11] Ibid.

[12] Ibid.

[13] Wright, "Soil Reconnaisance", pp. 12-14.

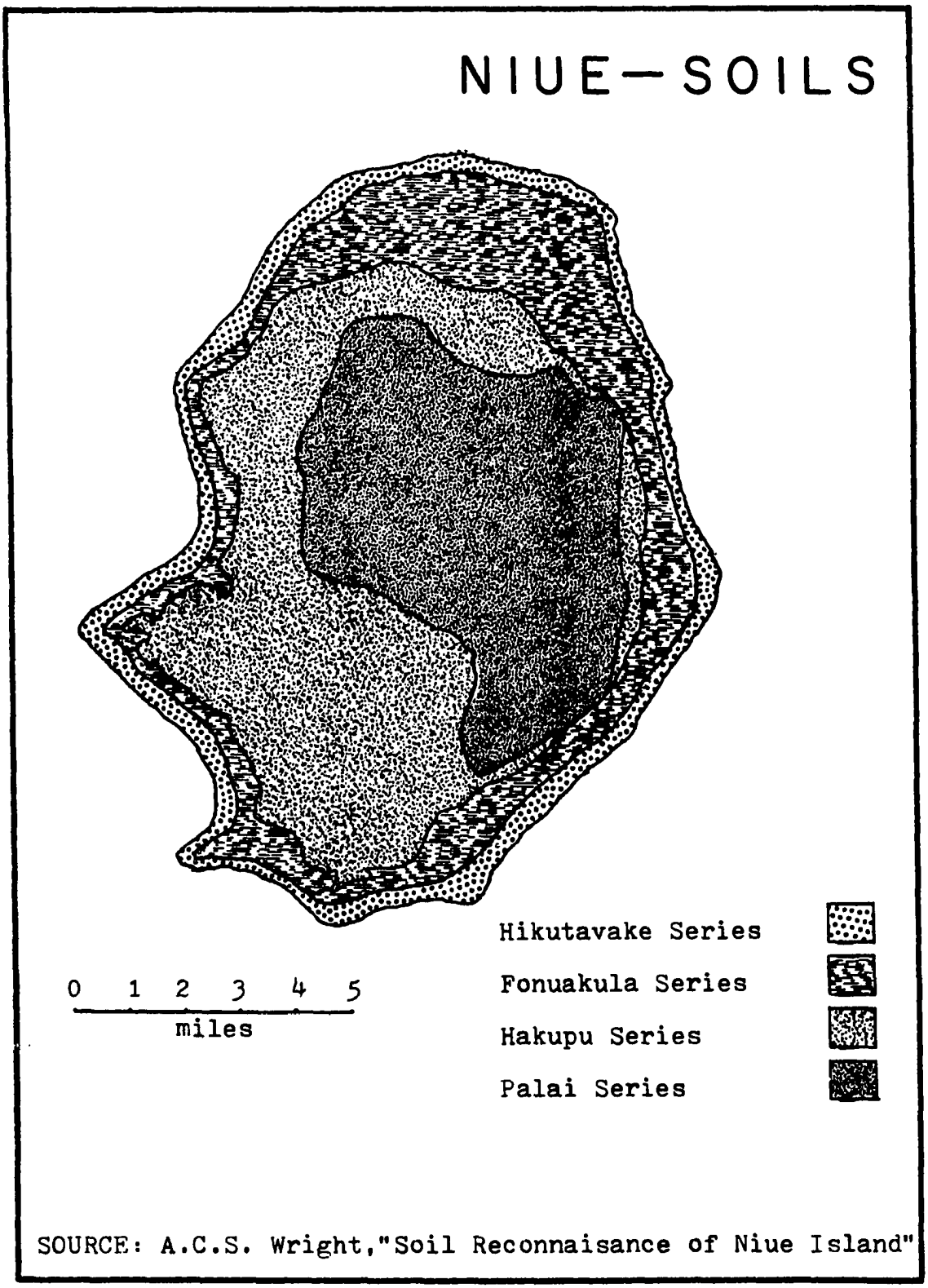
NIUE—SOILS
0 1 2 3 4 5
miles
Hikutavake Series
Fonuakula Series
Hakupu Series
Palai Series
SOURCE: A.C.S. Wright,"Soil Reconnaisance of Niue Island"

Figure 10

TABLE 5

AREAL EXTENT OF NIUEAN SOIL SERIES*

| SERIES | TOTAL ACRES | SOIL | ROCK | PER CENT ROCK |
|---|---|---|---|---|
| Hikutavake | 6,785 | 1,090 | 5,695 | 83.9 |
| Hakupu | 16,410 | 7,810 | 8,600 | 52.4 |
| Fonuakula | 21,780 | 14,090 | 7,690 | 35.3 |
| Palai | 19,930 | 10,500 | 9,430 | 47.4 |
| Total | 64,905 | 33,490 | 31,415 | 48.4 |

*A. C. S. Wright and F. J. van Westerdorp, Soils and Agriculture of Niue Island, New Zealand Soil Bureau Bulletin 17, Wellington: Department of Scientific and Industrial Research, 1965), p. 28.

Effects on population. According to the model of relationships (Figure 1) there is no direct relationship between population and soils on Niue Island. There is, however, an indirect relationship. The soils of Niue are of such a nature that extensive agricultural practices are virtually impossible.[14] Because of this, very few Niuean farmers can make more than a subsistence living from the soil. Since there are virtually no other resources on the island from which Niueans may earn a living, economic progress is retarded. Therefore, many Niueans, not satisfied with a mere subsistence income, emigrate to New Zealand. This is, however, a problem that is a direct result of economic systems, and related indirectly to soils, and is therefore consistent

[14]Another factor which inhibits extensive cultivation is land tenure. This factor will be discussed in Chapter IV.

with the model.

Effects on land use and vegetation. As was indicated in the previous chapter, most of the agricultural land on Niue is either under coconut plantations or is under a ten-year cycle of shifting cultivation. The pattern of shifting cultivation, which has existed since the earliest times of human occupance of the island, is a direct response to the shallow, rocky, and relatively infertile soils of Niue. These soils cannot be continuously cultivated for more than two or three growing seasons without a drastic loss in fertility. Therefore, shifting cultivation is necessary unless artificial fertilization is practiced.

During the aboriginal and transitional periods, artificial fertilization was impossible due primarily to the lack of technology. During the contemporary period chemical fertilizers are available, but Niuean farmers have so far been reluctant to use them extensively. Part of their reluctance is due to the cost of fertilization, and part is due to their lack of previous experience with this type of agricultural practice. There are, however, a few parcels of land, including the government experimental farm, that are being brought into production on a permanent, non-shifting basis through the use of chemical fertilizers.

Vegetation on Niue seems to be more a response to human influences than to soil. The major perceptible direct relationship be-

tween soils and vegetation is in the different types of forest found on the Hikutavake soils of the lower terrace, and that found on the soils of the upper terrace (Figure 5). Even in this relationship, however, there are other factors (salt spray, human activities, wind action) which are also important in determining the nature of the vegetation found on the two terraces.

## Water

### Lanai

Lanai is a dry island. The average annual precipitation at Koele, near Lanai City, is 35.83 inches.[15] Evaporation, however, for the island is so high that a general condition of aridity exists. There are only four months of the year, December through March, during which actual precipitation totals exceed potential evapotranspiration. According to the Thornthwaite system of climatic classification, the island of Lanai has a yearly mositure index of -4.96. One of the major reasons for this aridity is that Lanai lies in a rain shadow created by the islands of Maui and Molokai. Some areas of Lanai actually receive less than ten inches of rain a year (Figure 11).

As a result of this aridity, Lanai has no perennial streams and very few springs. Despite the absence of surface water, however, Lanai does have a very large reserve of ground water. It is estimat-

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[15]D. I. Blumenstock and S. Price, Climates of the States, Hawaii, (Washington, D. C.: U. S. Department of Commerce, 1967).

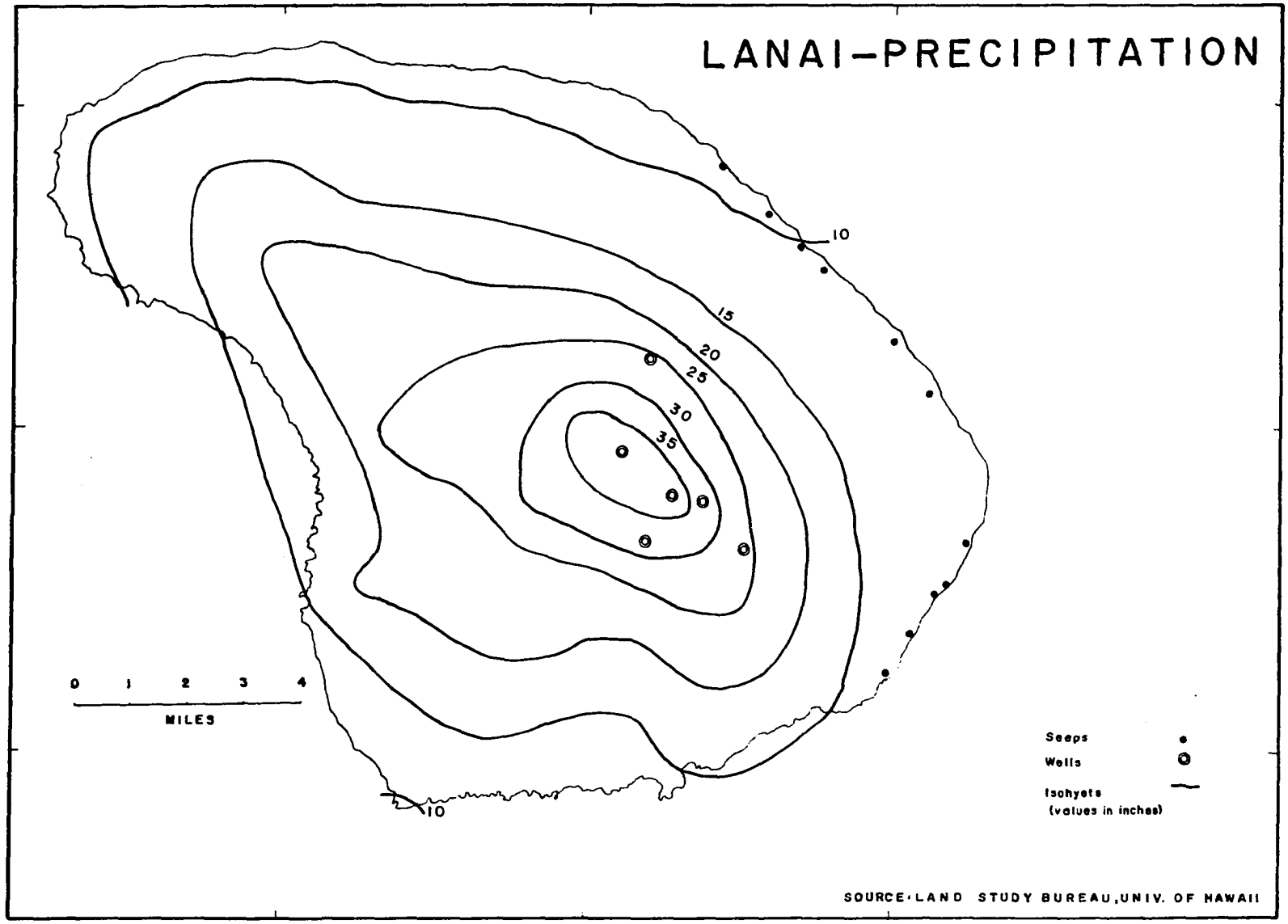
LANAI-PRECIPITATION
10
15
20
25
30
35
10
0 1 2 3 4
MILES
Seeps
Wells
Isohyets
(values in inches)
SOURCE: LAND STUDY BUREAU, UNIV. OF HAWAII

Figure 11

ed that Lanai has enough ground water, if properly developed, to supply more than 1,325,000,000 gallons of water per year.[16] The major source of this ground water is the high recharge area of the Lanai Range.

The original inhabitant of Lanai no doubt found the island to be as dry as it is today. They would have found several seeps and springs along the windward coast, all of which would have dried up in most summers. The only stream that existed was in the upper reaches of Maunalei Gulch, and in most years this stream disappeared into its bed before it reached the sea.[17] In the upper part of the island the only source of fresh water was dew which was shaken from the bushes.[18]

The first actual development of water on Lanai occurred during the transitional period of occupance. Around 1890 the Hayseldens built a 400,000 gallon reservoir in Kaiholena gulch, near the present-day site of Lanai City. This reservoir did not always supply their water needs.[19]

The Maunalei Sugar Company, which was formed in the 1890's

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[16] Lanai Land Management and Development Study, (Honolulu: Richard A. Moore Associates, 1969), p. 18.

[17] J. T. Munro, "A Record of Water Supply on Lanai", (Honolulu: The Dole Company, December 1957, Typewritten), p. 1.

[18] Ibid.

[19] Ibid.

drilled several wells on the windward side of the island near the coast. Subsequently, when the island passed into the hands of Charles Gay, several other wells were also dug along the windward side. All of these wells have since been abandoned.[20]

Charles Gay was also the first to make use of the water in Maunalei Gulch. He dammed the stream and installed a pump and water line through which the water was pumped over the ridges and into the Kaiholena reservoir. Portions of the original water intake lines are still in use.[21]

Water development on the island was advanced somewhat in 1911, after the island had been acquired by the Lanai Company. A tunnel was dug some 1,000 feet into the side of Maunalei Gulch, and the water flow was increased to around 250,000 gallons per day.[22] This entire system was subsequently enlarged and improved by the Lanai Company.

Following the purchase of Lanai by the Hawaiian Pineapple Company in 1922, extensive development of existing ground-water facilities occurred. The Hawaiian Pineapple Company, (now the Dole Company) has spent a great deal of time and money in developing the

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[20] Ibid. p. 2.

[21] Ibid.

[22] Ibid. p. 3.

ground water resources of Lanai in order to improve their pineapple operation on the island. Without the proper development of water the operation would not be possible. The present system of five wells and the Maunalei tunnel are capable of yielding over 635,000,000 gallons of water per year.[23]

Effects on population. One of the reasons for the late date of occupance on Lanai was the aridity of the island. Since water was obtained only with great difficulty, it is not likely that Lanai presented a very hospitable environment for the earliest settlers. Availability of water was also a prime locational factor in terms of aboriginal settlement. In the aboriginal era the numbers and distribution of population were directly related to the availability of water.

During the transitional and contemporary periods, however, the relationship between population and water has changed somewhat. No doubt the development of ground water resources would not have occurred without the economic necessity to do so during these two periods of occupance, however, the economic system of the island could not have been developed without the availability of ground water resources. The population of the island, therefore, is directly affected by the economic systems. but secondarily also to the water resources.

Effects on land use and vegetation. The obivous effect of the availability and development of the ground water resources of Lanai

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[23]Ibid. p. 9.

on the land use pattern is the very existence of the pineapple plantation. Despite the fertility of the soils of Lanai, this extensive plantation could not exist without the ground water resources of the island.

The vegetation pattern of Lanai is also directly related to the water characteristics of the island. The vegetation, aside from pineapple, is however, dependent upon precipitation rather than the ground water resource. Since Lanai exhibits a general quality of water deficiency in regard to precipitation, it is logical that the predominance of xerophytic shrubs and grasses outside of the cultivated area is indicative of this aridity. The Lanai Range is the only place on the island where there is sufficient moisture to support ferns and other heavy vegetation. The vegetative pattern of many parts of the island is reminiscent of a mainland desert landscape, similar to that found in Nevada.

## Niue

Niue Island has considerably greater precipitation totals than Lanai, the average annual precipitation being 80.66 inches. Precipitation totals have ranged from annual extremes of 41.94 inches to 125.41 inches.[24] There is no month on Niue during which there is a moisture deficit, on the average, and only one month, July, during which potential evapotranspiration exceeds precipitation totals on the

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[24]Wright, Soils and Agriculture, p. 28.

average. Even then, the amount of excess is only .81 centimeters. The Thornthwate moisture index for Niue Island is 43.09.

Like Lanai, however, there are no perennial streams on Niue. In the case of Niue Island the lack of streams is due to the configuration and structure of the island, which allows all precipitation not held by the soil to percolate through the subsurface rocks. As a result, Niue is underlain by a fresh-water lens under the entire island[25] (Figure 12).

Until 1964 nearly all culinary water on Niue was obtained from rain-water catchments. There are some brackish springs along the coast which have rarely been used, and one deep well near the government prison farm at Fonuakula. Beginning in 1964 several wells were bored by a professional well-driller from New Zealand, tapping the fresh-water lens. A total of twenty-two wells are now is use.

Effects on population. The major effect of water on population on Niue is that there has always been sufficient water to support the population of the island. Although water has been difficult to obtain in the past, this has not served as a limiting factor in population growth or distribution. The effects of the recently-developed ground water resource cannot yet be assessed.

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[25] J. C. Schofield, The Geology and Hydrology of Niue Island, South Pacific, (Wellington: New Zealand Geological Survey, Bulletin n. s. 62, 1959), p. 20.

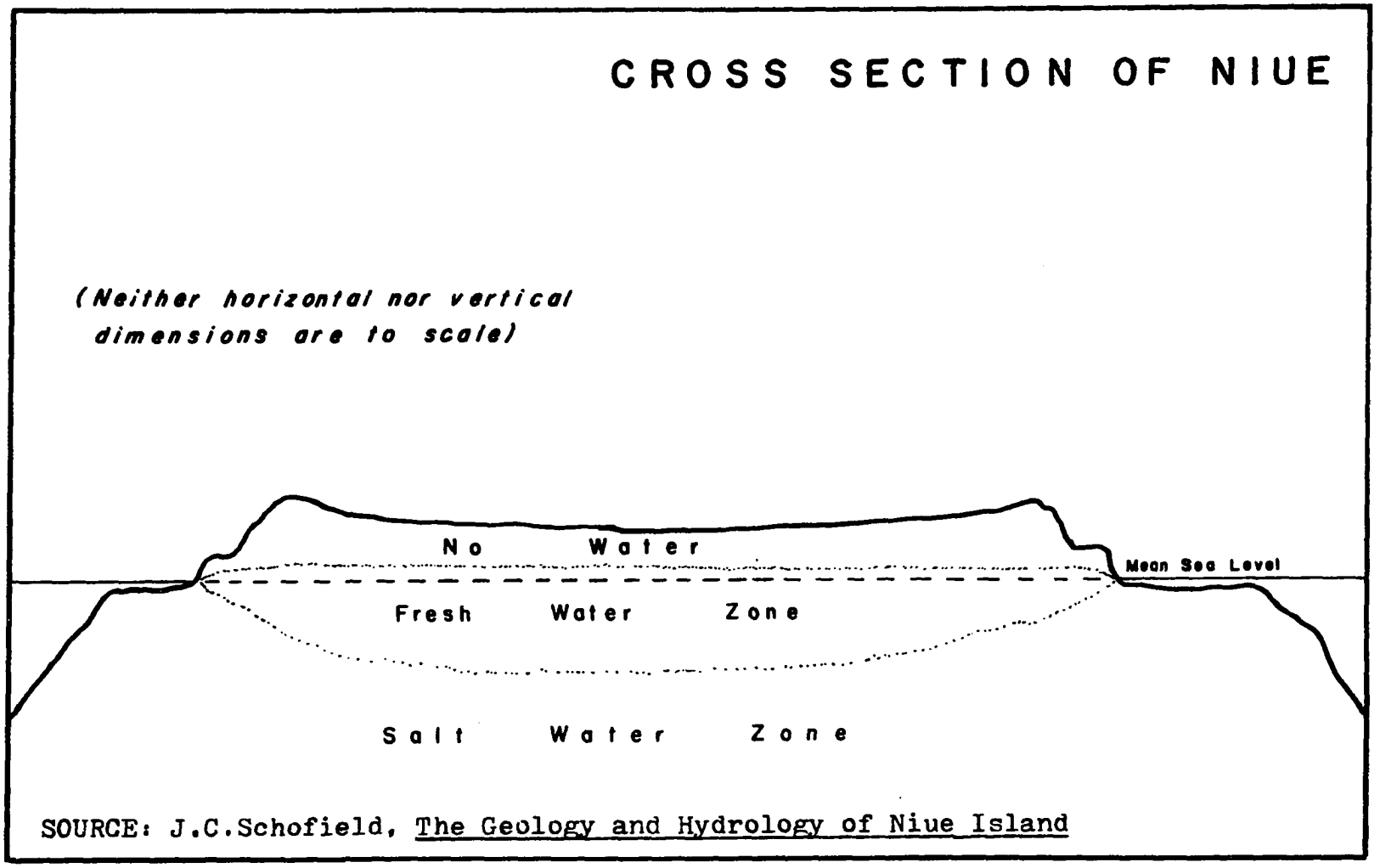
CROSS SECTION OF NIUE
(Neither horizontal nor vertical dimensions are to scale)
No Water
Mean Sea Level
Fresh Water Zone
Salt Water Zone
SOURCE: J.C.Schofield, The Geology and Hydrology of Niue Island

Figure 12

Effects on land use and vegetation. Although occasional droughts do occur on Niue Island which might affect land use patterns in any given year, on the average there is sufficient moisture to support the traditional system of semi-subsistence agriculture. This is consistent with the relationship between land use and water as indicated on the model. The recent development of ground water resources might change the pattern of land use on the island, but it is still too early to determine whether or not this will be the case. In any event, the direct relationship between water and land use will remain.

Natural vegetation, like cultivated crops, has been and continues to be dependent for moisture on the abundant precipitation which occurs on Niue. Therefore, there is also a direct relationship between general vegetation patterns and precipitation, as indicated in Figure 1.

## Summary

### Lanai

The effects of location, soil, and water on the patterns of population, land use, and vegetation on Lanai have varied through time. Some of the major effects are:

1. The relative isolation of Lanai during the aboriginal period of occupance resulted in occupation by Polynesian people who developed a life-style that was consistent with the physical environment of the island.

2. The decreased isolation of the transitional era resulted in a break-down of aboriginal patterns, and the eventual disappearance of the aboriginal population.

3. During the contemporary period the improved accessibility of the island has made possible a commercial agricultural operation.

4. The soil quality of Lanai, which was of minimal importance during the aboriginal and transitional periods, has also aided in the development of a commercial plantation on the island.

5. The arid nature of Lanai inhibited settlement during the aboriginal and transitional periods.

6. Development of Lanai's ground water reserves has been another key factor in the establishment of a commercial pineapple plantation on the island.

## Niue

Although the same model of relationships applies to both islands, different physical factors on Niue have resulted in different population, land use, and vegetation patterns. Some of the major effects are:

1. As in the case of Lanai, the isolation of Niue resulted in occupation by Polynesians who developed a culture that was compatible with the physical environment of the island.

2. The isolation of Niue did not decrease in the transitional and contemporary periods of occupance, and as a result the ethnic character of the island, as well as the population attributes of numbers and distribution were not markedly altered.

3. The continued inaccessibility of the island has served to preserve the aboriginal nature of the land use patterns.

4. The soils of Niue do not lend themselves to extensive commercial agriculture, and as a result land use patterns have not changed from the semi-subsistence configurations of the aboriginal era.

5. Because land use patterns have not adjusted to commercial conditions, some Niueans are migrating from the island to seek better economic conditions in New Zealand.

6. There is sufficient precipitation on Niue to maintain agriculture throughout the island under subsistence conditions. The natural vegetation of the island is also dependent upon rainfall.

7. The development of ground water resources has occurred too recently to have shown a noticeable effect on land use or population patterns.

It is obvious that some of the changes in land use patterns which have occurred on Lanai could not possibly occur on Niue due to the differences in location, soil quality, and water reserves. It is equally as obvious, that one of the results of Lanai's changing land use patterns

# CHAPTER IV

# THE EFFECTS OF POLITICAL SYSTEMS, LAND TENURE, AND ECONOMIC SYSTEMS

Given the same set of physical variables, varied population and landscape patterns can emerge in different places, or in any one place at different periods of history. Cultural variables, those variables which are mainly the product of man's imaginative response to his environment, are as important as physical variables in shaping the character of the landscape.

Only three cultural variables are considered in this study: political systems, land tenure systems and economic systems. These three interdependent variables have been the most decisive in molding the present patterns of land use, vegetation, and population on the islands of Niue and Lanai.

The discussion of political systems is concerned with the historical development of those systems of the two islands as far as it pertains to which extra-insular power has gained and maintained political control. Attention is also given to the relationship between political control and land tenure systems.

The analysis of land tenure systems is concerned with the historical development of the legal systems of land ownership on the two islands, also giving attention to the relationship between land tenure and economic systems.

Since the historical development of economic activity on the two islands has already been treated in Chapter II, the analysis of the economic variable is concerned primarily with the contemporary economic systems of Niue and Lanae. The discussion of this variable emphasizes the controlling factors of each island's economic system, particularly the relationship to land use patterns.

## Political Systems

### Lanai

The Hawaiian Islands have gone through five different periods of political rule. The first period, the ancient era, was the one in which the various islands and districts of the Hawaiian chain were ruled individually by various chieftains. This period lasted from earliest settlement until 1795. During this early era Lanai was ruled from Maui.

In 1795 the entire chain was conquered by Kamehameha I, who became the first ruler of the unified Kingdom of Hawaii. The royal family which he founded lasted through eight monarchs. In 1893 the monarchy ended in a bloodless coup when Queen Liliuokalani was

deposed. At that time a republic was founded, largely through the efforts of local white planters and merchants.

The republic came to an end when the Hawaiian Islands were annexed by the United States in 1898. The Territory of Hawaii was formally constituted June 14, 1900. In June, 1959 a plebiscite formally endorsed United States senatorial legislation, and Hawaii became the fiftieth state of the Union.

The chain of events which eventually led to statehood for Hawaii actually began in 1820, with the arrival of the first American Protestant missionaries. Although there had been some British interest in the islands prior to that time, after the missionaries arrived American interests were dominant and largely unchallenged.

American interests in the Hawaiian Islands, which began as an altruistic missionary venture, shifted in the early years of the nineteenth century to more worldly pursuits. Gradually, white planters and merchants became the dominant persons in both the Hawaiian economy and Hawaiian politics. Most of the advisors to the royal family were Americans, and they logically pushed American interests. Under the influence of American advisors, the decision was made during the reign of Kamehameha III (1825-1854) to redistribute all of the land of the Hawaiian Islands into a system of fee simple land tenure.[1]

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[1]Robert H. Horwitz and Norman Meller, Land and Politics in Hawaii, (East Lansing: Michigan State University, 1963), p. 3.

As part of this distribution, it was decided, in 1850, to allow aliens to acquire, through purchase, title to lands in Hawaii.[2]

Once aliens, particularly Americans who had economic interests in the islands, were able to gain land, political control gradually shifted from the Hawaiians to the Americans. Eventually, the overthrow of Queen Liliuokalani came about largely because she was opposed to the dominant American power in the islands and wished to re-establish the power of the monarchy.[3]

The political system which presently exists in the Hawaiian Islands came about, therefore, largely because of the emerging nature of the economic systems of the islands. One of the major results of changing political control in the islands was a new system of land tenure. Therefore, the effect which the political system of the Hawaiian Islands has on the population-land use-vegetation complex of the islands, including Lanai, is indirect, as indicated in Figure 1. The land tenure system, and particularly the economic system, are the major cultural factors which determine the nature of the population-land use-vegetation complex, but these two variables could not exist in their present form were it not for the nature of the dominant

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[2]Jean Hobbs, Hawaii, A Pageant of the Soil, (Stanford: Stanford University Press, 1935), p. 1.

[3]Gavan Daws, Shoal of Time, (New York: The Macmillan Company, 1968), 11. 258-279.

political system of the islands. Therefore, political systems are an important component of the model of relationships, despite the fact that they do not directly influence the patterns of population, land use, or vegetation on Lanai.

## Niue

The history of political control of Niue was determined largely by the origin of the first missionaries. Prior to the arrival of missionaries, the ruling power of the island had been in the hands of various chiefs and warriors, although none had very extensive powers. Occasionally, a head chief was chosen from among the local chiefs, and he was given the title patuiki. This title literally translates as "elder-lord," but in current usage it means "king". The powers and authority of these ancient "kings" were usually quite limited.

After the Christianization of Niue, the missionaries were in nearly complete control of government on the island. There was a council of representatives from each of the island's mission stations, but the European missionary was obviously in charge. Many of the laws passed by the council were distinctly ecclesiastical.

The missionaries, however, had little power of enforcement over non-Niueans, and were able to do little to prevent occasional raids by "blackbirders" upon the people of Niue. Partially because of the lack of effective control on the island, the people of Niue began to

petition for a British Protectorate as early as 1859.

In 1876 the people of Niue, with missionary sanction, re-established the position of patuiki. The position was mainly ceremonial and had little actual power or authority. Mataio Tuitonga, the man appointed as patuiki, died in 1887. He was succeeded by two more "kings," until the British finally accepted jurisdiction in 1900. The first Resident Agent arrived in 1901, and in that same year Niue came under the control of New Zealand, which still retains control of Niue as an Island Territory. The people of Niue are New Zealand citizens and British subjects.

It is apparent that the British, and subsequently the New Zealanders, came to power in Niue primarily as benefactors of the Niuean people. No white British subjects profited financially by the assumption of British jurisdiction over Niue Island. More importantly, however, was the fact that no traditional Niuean customs were abrogated by the assumption of this jurisdiction.

As in the case of Lanai, the nature of political control in Niue has had very little direct effect on the nature of the population-land use-vegetation complex. It has, however, had a great deal of effect on the preservation of the traditional system of land tenure, which in turn has had an effect on the economic systems and the landscape patterns of the island. Therefore, as indicated in Figure 1, political systems are an important component of the systems of relation-

ships which exists on Niue Island.

## Land Tenure

### Lanai

The ancient system of land tenure that existed prior to Kamehameha's conquest of the Hawaiian Islands is not well understood. Apparently it was a feudalistic system, with each chief holding such land as he could defend, and populating it with lesser chiefs and commoners that were loyal to him.[4]

After Kamehameha I conquered the islands, all of the land belonged to the king, but was held and used by the various chiefs who were granted stewardship over the land by the king.[5] There was no concept of private ownership of land, as all of the land belonged to the king, and only he could divide it for use among the nobles who could, in turn, further subdivide their land among their followers.

There were several types of subdivisions of land for both administrative and stewardship purposes, two of which accounted for the actual control and occupance of land throughout the entire Kingdom of Hawaii. The basic unit was the ahupua'a which comprised the estate of the chief. This unit, which was of indefinite size, consisted in many instances of a strip of land extending from the mountain crest

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[4]Hobbs, Hawaii, p. 1.

[5]Ibid.

to the sea so as to contain every type of land found on any particular island. Each island, including Lanai, was divided into several ahupua'a, each of which was under the control of stewardship of a chief as his personal estate. Some chiefs controlled more than one of these units. There were thirteen ahupua'a on the island of Lanai[6] (Figure 13). Each ahupua'a was divided into smaller administrative units known as ili and ili kupono. The chief of the ahupua'a generally controlled the use and revenue of the ili, while the ili kupono were controlled by lesser chiefs and nobles.[7]

The unit of land that was actually occupied, cultivated, and improved by the common people was known as the kuleana. Like the ahupua'a, the kuleana was of no standard size, did not belong to the occupant, and was occupied only at the will of a higher chief.[8] The number of kuleana on Lanai during the aboriginal period is unknown, but the space resource of the island was adequate so supply all of the kuleana necessary for the peak aboriginal population.

This basic system, with all its faults and attendant abuses, continued until the time of Kamehameha III. During his reign, and under Western influence, the land of the Kingdom was redistributed

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[6]K. P. Emory, The Island of Lanai, (Honolulu: Bernice P. Bishop Museum, Bulletin 12, 1924), p. 45.

[7]Hobbs, Hawaii, pp. 13-14.

[8]Ibid. p. 16.

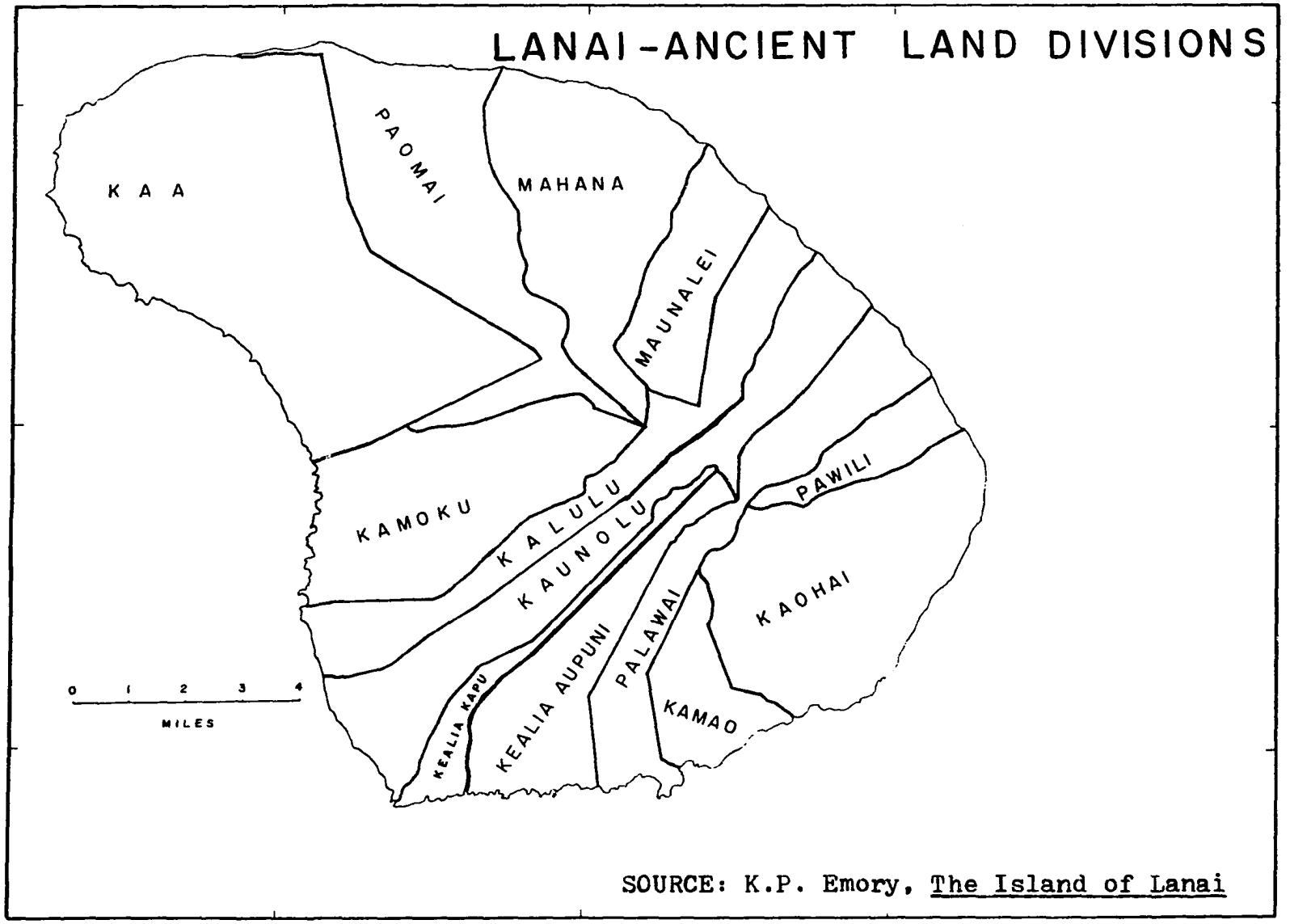
LANAI-ANCIENT LAND DIVISIONS
K A A
PAOMAI
MAHANA
MAUNALEI
KAMOKU
KALULU
KAUNOLU
PAWILI
KAOHAI
PALAWAI
KEALIA AUPUNI
KEALIA KAPU
KAMAO
0 1 2 3 4
MILES
SOURCE: K.P. Emory, The Island of Lanai

Figure 13

in a system of fee simple land tenure, under which titles were issued for each and every parcel of land. This redistribution, known as the Great Mahele, gave some 30,000 acres to the commoners, approximately 1,600,000 acres to the chiefs and nobles, and around 1,000,000 acres were reserved as "crown lands" for the support of the royal family. About 1,500,000 acres were set aside as state lands for support of the government.[9]

To effect this redistribution, the Board of Commissioners to Quiet Land Titles was established. The function of the board was to determine the titles to the various plots of land which had been occupied over the centuries. Although this commission was in session for over ten years, many Hawaiians neglected to come before it to establish their claims. Eventually much land reverted to the state. The unfortunate decision, from the Hawaiian point-of-view, was the one made in 1850 which allowed aliens to purchase land and acquire title to it.[10] The effect of this decision was to permit the alienation of land from the native Hawaiians.

The present status of land tenure in Hawaii is much the same as that in the rest of the United States. Land can be bought and sold, and titles shifted from one owner to another, completely without re-

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[9]Horwitz and Meller, Land and Politics, p. 3.

[10]Hobbs, Hawaii, pp. 39-47.

gard to race or national origin. The island of Lanai is indicative of this type of land tenure. The entire island is owned by Castle and Cooke, the parent company of the Dole Company. The title to the island was acquired through purchase, and if the company so decided, the title to the entire island, or any portion of it, could be sold, without regard to any traditional system of land tenure.

Effect on population. The primary effects of land tenure, as indicated in Figure 1, are upon economic systems and land use patterns. However, these two variables, in turn, have a very marked effect on the population of Lanai. Therefore, although the effect of land tenure on population is indirect, it is nonetheless important. This indirect relationship is discussed below under the section on economic systems.

Effect on land use and vegetation. There is a direct relationship between land tenure systems and land use-vegetation patterns which has existed from the aboriginal era to the present. During the aboriginal period, at which time the inhabitants of Lanai were largely dependent upon the land for their food resources, the traditional system of land tenure allowed the land to be effectively occupied and tilled by the island's inhavitants. Despite the fact that the actual control of the various ahupua'a of the island was in the hands of chiefs and noblemen, the system did not deprive the commoners access to and use of the land.

In the transitional era, during which time the system of land tenure changed and allowed the alienation of land from the native Hawaiians, various parcels of the island began to pass into the hands of Westerners. Walter Murry Gibson's colony, Frederick Hayselden's sugar plantation, and the ranching operations of Charles Gay and others were able to occur primarily because the land tenure system which evolved during the transitional era allowed them to acquire the necessary land on which they operated.

The current land use pattern of Lanai is possible primarily because the Dole Company is able to control the resources of the entire island. The major factor which enables them to control these resources is that they have been able to acquire title to the entire island. Without complete and unrestricted ownership it would be difficult, if not impossible for the company to make the improvements necessary to carry on a profitable operation. The Dole plantation could not have developed under the traditional system of land tenure.

The vegetation pattern of the island is also directly affected by the land tenure system. Under the traditional system there was minimal disturbance of the native vegetation. During the transitional period, however, when cattle, sheep, and goats were introduced and allowed to graze extensively over the island, the entire vegetation pattern was changed, with many native species being reduced in areal extent.

The contemporary pattern of vegetation, like the contemporary land use pattern, is largely dependent upon the policies of the Dole Company. The vegetation pattern that finally emerges on Lanai will be determined by the land use policies of the company.

## Niue

The traditional system of land tenure in Niue, as with the traditional systems of Hawaii and virtually all of Polynesia, did not have the idea of private ownership of land. The basic unit of land ownership in Niue was not the individual, but the family, or mangofaoa. This unit consisted of all individual over three or four generations descended from a single person. The mangafaoa also included all adopted children, a common feature in most traditional Polynesian families.

Anciently, the entire island of Niue was divided by its inhabitants, by some unknown process, into individual blocks of land of varying and inconsistent size. These blocks are known as fonua, and in most instances are under five acres in extent. Each mangafaoa holds a certain number of fonua, each of which has a name and supposedly fixed boundaries. There is no land on the island which is not under the fonua system.

The recognized head of each mangafaoa was generally, but not always, the oldest male descendant of the original ancestor, and he

was known as the pule mangafaoa. This term translates as the "family authority." The main function of the pule mangafaoa was to oversee the distribution of the land held by the mangafaoa to its various members.[11]

The mangafaoa was usually made up of several smaller family units, each of which was headed by a patu. The tiele patu was generally given to all married men. It was to these men that the land was assigned to be used and occupied by their immediate families. The land was always distributed to each family, or in some cases to an individual, on the basis of the fonua. The fonua were apparently never subdivided, but were always allotted in their entirety.

Once amember of a family received a definite allocation of land, it would be his permanently, and his descendants would have perpetual rights to that portion of land. Occasionally a fonua would revert to the mangafaoa should the person who held it die without heirs. Some land could be held jointly by a mangafaoa for mutual use, or for future allocation.[12]

This traditional system was very well-wuited to Niue in several respects; it divided the land into definite units with recognized boundaries, it provided for a single family head who had the authority to

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[11] J. M. McEwen, "Unpublished draft of report on land tenure in Niue," (Wellington: Department of Island Territories, 1956).

[12] Ibid.

distribute land and settle family disputes, and it gave individual landholders undisturbed rights of occupance. Under the system all land would be held by somebody, yet none of it would be divided among too many persons to be effectively occupied under traditional methods of cultivation. The system also provided that rights to the land might be lost by any individual who did not occupy and use the land.

The New Zealand Government accepted the customary Niuean system of land tenure, and it has remained fairly stable, changing only slightly with the changes that have occurred in Niuean family traditions. The family has remained as the most important unit of Niuean society, although it has lost some of its cohesiveness. Whereas the old mangafaoa included all of the descendants of a common ancestor over as many as five generations, the modern mangafaoa today rarely consists of more than three generations. The term pule mangafaoa is not used anymore. Nearly all of the land presently held by Niueans is land they received from their parents, foster parents, or from aunts and uncles. The customary system of land division is still effective, for the traditional fonua continue to exist.

Recently increased emigration has somewhat confused the land ownership situation. Many people who have migrated to New Zealand have insisted on retaining title to their lands on Niue, and passing this title on to their descendants. Partially in response to this problem, the Niue Island Assembly, the elected representatives of the

Niuean people, spent several years considering land legislation. In October 1969 they passed a land ordinance that formally legalized a system of land tenure.

This land ordinance closely adheres to the traditional system in numerous ways. It provides for the definition and surveying of boundaries for all parcels of land, and for the issuance of title for all of those parcels. The traditional position of pule mangafaoa has been replaced by a leveki mangafaoa, which means "family protector." The duties of this new position are very similar to those of the traditional position, but are now defined by law.

The most important aspects of this land ordinance are that native land rights are protected. Alienation and partition of land are now carefully controlled by law, and are virtually impossible under normal circumstances, thus insuring perpetual rights to the land for native Niueans. The law also provides for the establishment of a land court and a land registrar to implement the provisions of the law and to settle all land disputes.[13]

Effect on population. Land tenure systems have not had a direct effect on the population characteristics of Niue. However, as in the case of Lanai, land tenure has had an effect on land use and economic patterns, thereby indirectly affecting population movement.

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[13]Niue Island Assembly, Land Ordinance 1969, No. 57.

Since this movement seems to be directly stimulated by economic systems it will be discussed in the section on these systems.

Effects on land use and vegetation. There is a direct relationship between land use patterns and land tenure systems. The relationship between these two variables, however, is not the same as is that of Lanai because the land tenure systems are so markedly different.

One of the major effects of the land tenure system of Niue is that practically no land has been alienated from the native Niueans. The only exceptions to this are some plots of land upon which churches have been built, and crown land, most of which is devoted to experimental agricultural plots. Another effect is that no one individual or mangafaoa has accumulated more land than can be worked under the traditional system.

Although land records on the amount of land held by any individual or mangafaoa are incomplete, due to the lack of land surveys and title issuance prior to 1969, field research indicates no individual land holder had more than three acres under cultivation. In 1964 one of the more active families on Niue, in terms of actual use and cultivation of land, was the Jackson family of Hakupu village.. Even though this family is probably the most aggressive on the island in establishing their land ownership and occupying their land, they cultivated only ten plots of kumara, each of which was bout one-half

acre in extent. These ten plots were held in the names of four patus, H. B. Jackson, F. Jackson, H. T. Jackson, and J. L. Jackson. No other individual or mangafaoa occupied this much land, even though there were 252 individual commercial kumara plots registered with the Department of Agriculture during that year.

Although the traditional system of land tenure on Niue has protected native land rights, it has virtually precluded any one individual from acquiring sufficient land to establish a large commercial operation. Therefore, the resultant pattern of land use on Niue is one of small, continually shifting plots of land devoted to semi-subsistence crops.

## Economic Systems

The economy of any place is determined in part by the types and quantities of goods and services which that particular place can provide. Services have so far been a negligible part of the economy on both Lanai and Niue, although this could conceivably change. Essentially, both islands have been limited in their economies to what they could produce from the soil.

### Lanai

As previously noted, Lanai has gone through three periods of agricultural activity; the subsistence farming of the aboriginal and early transitional periods, the stock raising of the late transitional

era, and the pineapple cultivation of the current period. Each type of agricultural system has left its mark on the island landscape, but only the pineapple production is important today.

The pineapple plantation on Lanai is the source of virtually all of the island's revenue. (The major exception to this is a small amount of tourist trade.) Pineapple is the raison d'etre for the continuing occupance of the island. The plantation employs around 430 people on a full-time basis, and an additional 964 people during the summer harvesting and planting season. The annual payroll on Lanai is well over $4,000,000.[14] The total value and amount of the annual pineapple crop of Lanai is known only to the Dole Company, which does not care to divulge these figures. Based on the fact that the Lanai operation comprises 24.27 per cent of the total pineapple acreage in the Hawaiian Islands, and that the estimated value of the pineapple crop for 1968 was around $127,500,000,[15] it is estimated that the value of the 1968 Lanai pineapple crop was around $30,944,000, after processing into the various pineapple products.

These figures are impressive for an island with a population the size of that of Lanai. It must be kept in mind, however, that the pineapple operation on Lanai is only one part of a much larger

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[14] Pineapple Fact Book/Hawaii, (Honolulu: The Pineapple Growers Association of Hawaii, 1969), p. 13.

[15] Ibid. pp. 2-3.

economic organization. The Dole Company is a subsidiary of the Honolulu firm of Castle and Cooke, Inc. This firm has extensive holdings, not only in the Hawaiian Islands, but also in Latin America, Asia, and the conterminous United States. It owns such operations as Standard Fruit and Steamship Company, Bumble Bee Seafoods, C and H Sugar Company, Royal Hawaiian Macadamia Nut Company, Oceanic Properties, Inc. (which actually holds the title to the island of Lanai), Ames Mercantile Company, and Hawaiian Equipment company, as well as majority ownership in several other firms. Revenues for Castle and Cooke for the year ending March 31, 1970 totaled $503,000,000, of which food products accounted for more than $358,320,000.[16]

The Dole Company, despite its vast holdings elsewhere, has a substantial investment on Lanai, and the operation is apparently profitable. Castle and Cooke, Inc., is in business to make money, therefore, the pineapple operation on Lanai will continue only as long as it continues to be the most profitable manner in which the island's resources can be used. This operation is subject to many external factors, including labor costs, machinery costs, shipping costs, and the continued demand for pineapple products. It is conceivable that unfavorable changes in any one of these external factors could cause the

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[16]Castle and Cooke, Inc. Annual Report for the year ended March 31, 1970, (Honolulu, 1970), p. 41.

Lanai operation to become unprofitable, in which case the cultivation of pineapple on the island would terminate, and some other form of land use operation begin. On the other hand, it is quite probable that the pineapple operation will continue to be profitable for many years to come, thus insuring a steady base for the island's economy.

Effects on population. That there is a direct relationship between the economic system of Lanai and population can be illustrated by referring to Table 1 (page 32). The population, which had dwindled to 185 in 1920, jumped to 2,356 in 1930. Since the entire island was purchased by the Hawaiian Pineapple Company in 1922, and the entire population of the island would have been economically dependent upon the company, it is obvious that this significant increase in population was entirely in response to the changing economic conditions brought about by the introduction of commercial pineapple cultivation to the island. It is also evident that the population of Lanai has not continued to increase since the beginning of the Dole operation, but has fluctuated from year to year. Because practically all of the economic opportunities on the island are associated with the pineapple plantation, and this operation can absorb only a limited number of people, it would seem that the natural increase of population has been off-set by emigration by those persons not able or willing to be absorbed into the plantation work force.

The distribution of population on Lanai has also been affected

by the prevailing economic system. Lanai City was constructed as a company town, and although many of the residents of this community own their own homes, it still remains a company town in which 96 per cent of the island's population lives.

A third population characteristic, ethnic composition, has also changed markedly since the Dole operation began. There are no longer any native Hawaiians living on Lanai. The population of the island is now composed predominantly of Japanese, Filipino, and Caucasian ancestry.

Effects on land use and vegetation. Since virtually every acre of land on Lanai that is economically and physically suited for pineapple cultivation is so used, it is apparent that the economic system of the island does have a direct effect on the land use pattern. Even that part of the island which is not devoted to pineapple is reflective of the dominant economic activity. Since the Dole Company runs Lanai for the purpose of making a financial profit, it does not invest its money in land use activities which do not promise a profitable return on their investment. With the exception of some recreational land development for the island's inhabitants, the land use pattern of Lanai is almost totally a reflection of the Dole Company's primary purpose on Lanai; raising pineapple.

Similarly, the vegetation pattern of the island is reflective of economic conditions. Because there is little monetary return in re-

forestation, even in the game preserve areas, very little has been done under Dole ownership. Such extensive reforestation might be highly desirable from an aesthetic or ecological viewpoint, but impractical from an economic viewpoint. Therefore the major areas of reforestation and tree planting have been around Lanai City and on the Lanaihale water recharge area, where Norfolk pine have been planted.

## Niue

Niue Island does not have the strong economic base that Lanai does. The economy of Niue is dependent upon two primary sources of income: export of agricultural products and expenditures of the Government of Niue, which is in turn largely dependent upon subsidies from the New Zealand government. The export of local products is the activity which has the greatest immediate impact on the people of Niue. The major exports over the years have been copra, bananas, plaited ware, and kumaras (sweet potatoes).

As an export producer, Niue Island is severely limited in the types and quantities of commodities that it can grow or produce. Agricultural products and by-products are the only goods which have so far been successful as income producers. A large segment of the population is wholly dependent upon agriculture for a living. Even those people who earn regular wages, either from the administration or from private traders, are partially dependent upon agriculture for

their own food needs, as well as for a supplement to their income.

The semi-subsistence agricultural practices of Niue, however, are not efficient in terms of production for production for export. The best year for exports from Niue was 1952, and in that year the total value of Niuean exports was $236,467. In 1969 the total value of Niuean exports was only $84,685.[17] Copra has traditionally been the most important export crop, followed by bananas and kumaras. In recent years the value of plaited ware, an agricultural by-product, has exceeded that of both bananas and kumaras.

A consistent feature of the Niue Island economy has been that the value of exports never exceeds the value of imports. Although the value of exports varies widely from year to year, and has been decreasing in the last five years (1966-70), the value of imports is steadily increasing. In 1969 the value of imports totaled $338,963.[18] Since many of these imports are vehicles, gasoline, parts, and building materials, they are paid for largely by the Government of Niue. It is unlikely that a favorable balance of trade could ever be developed on Niue.

Effects on population. The most obvious effect of the economic

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[17]Personal correspondence, Office of the Resident Commissioner, Niue Island, February 24, 1971.

[18]Ibid.

systems on the population of Niue has been to preserve the Polynesian nature of the population. Since the economy of the island has done very little to attract non-Niueans to the island, there has been very little immigration, and the aboriginal ethnic character of Niue has remained largely unchanged.

The primary effect of the nature of the economy of Niue has been the limiting effect it has had on the growth of population. During the period from 1955 to 1970, 5,263 people left Niue. During this same period 2,313 people returned to the island.[19] The accumulated deficit of 2,950 people represents more than 55 per cent of the resident population of Niue as of December 31, 1969. Nearly all of those who emigrated went to New Zealand.

Although a small percentage of emigrants from Niue leave the island for reasons of health, education, or recreation, interviews with emigrants both in Niue and New Zealand have indicated that the vast majority leave for economic reasons. The difficulty in earning a living from the Niue Island environment, coupled with an awareness of economic benefits available in New Zealand, serve as a potent force in encouraging emigration.

Effects on land use and vegetation. The economic dependence of Niue on small semi-subsistence plots and copra has resulted in

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[19] Ibid.

three distinct patterns on the Niue Island landscape. The first is the 5,320 acres of land under coconuts. This is the most extensive area of the island which shows the continuous impact of man on the landscape. The second pattern is indicated by the 7,545 acres which are under the ten-year cycle of shifting cultivation. This is the land that produces most of the kumara and bananas, as well as most of the food crops of Niue. The third pattern is the one of formerly cultivated but currently abandoned land. This land, which covers some 8,095 acres, has been depleted by cultivation over the years, but which could be brought back into production, given sufficient eco-mic impetus to do. However, it cannot be brought back into production under the traditional system of agriculture.

The Agriculture Department of Niue has consistently attempted to induce Niuean farmers to bring their land into permanent cultivation on a sedentary basis, but field research failed to find a single Niuean farmer that had been successful in doing so, despite the apparent success of the Agriculture Department's experimental farms.

Two types of agriculture, banana plantations and stock raising, lend themselves well to the Niue Island environment, particularly with the recent development of ground water reserves. There is, however, no evidence to indicate that either activity has gained a significant foothold on Niue.

## Summary

There is a definite chain of relationships between the three independent cultural variables and the population-land use-vegetation patterns of the two islands. The first step in the chain is the political variable. The nature of the political system of each island determined, to a large degree what the second step, the land tenure system, would be like. The nature of the land tenure system helped determine in turn the extent to which the land of either island could be used. The result of this is the characteristic economic system of each island, which is reflected in the land use, vegetation, and population patterns of the island.

### Lanai

Of the two islands the chain of relationships is the most obvious on Lanai. Some of the major effects of political system, land tenure systems, and economic systems on the landscape patterns of Lanai are:

1. Political control of the Hawaiian Islands, including Lanai, came into the hands of the Americans largely because of economic considerations. Thus, there is a tie between the political and the economic systems of the island.
2. Control of political power by the Americans resulted in a land tenure system that enabled the purchase of large blocks of land by aliens.

3. The loss of control of the land by Hawaiians resulted in a lessening of Hawaiian influence in the economy throughout the islands, and a complete disappearance of Hawaiian economic interest in Lanai.

4. The fee simple system of land tenure which currently exists in the Hawaiian Islands enabled the Dole Company to acquire the entire island of Lanai for its pineapple plantation.

5. Dole's control of the island of Lanai and the entire economy of the island has resulted in a jump in population since the transitional era. concentration of the population in Lanai City, and the total disappearance of the aboriginal Polynesian population.

6. The land use and vegetation patterns of Lanai are almost completely a reflection of the dominant economic system of the island.

## Niue

Niue Island has undergone considerably less change than Lanai in its population-land use-vegetation complex. Some of the reasons for this are due to the different set of cultural variables on Niue. Some of the major effects of these variables are:

1. Political jurisdiction over Niue by the New Zealand Government came about largely for humanitarian reasons. Therefore, no native rights were abrogated or changed by the assumption

of this jurisdiction.

2. Native land tenure systems provide for adequate usage rights to the land by all native Niueans. This system preserves the aboriginal system of land use and its resultant vegetation pattern. Therefore, the protection of the traditional system of land tenure on Niue has resulted in the preservation of the aboriginal system of land use.

3. Becuase the aboriginal system of land use does not provide for a growing export economy, the economic system of Niue Island is highly dependent upon subsidies from the New Zealand Government.

# CHAPTER V

# PROJECTION AND CONCLUSION

## Projection

It has been demonstrated that there are several characteristics of the independent variables of both islands which are unlikely to change in the immediate future. These characteristics are:

1. Soil quality,
2. Water reserves,
3. Political status,
4. Land tenure systems.

The economic variable is a constantly changing aspect of any island, and the location variable changes with increasing accessibility due to improved technology. Based on the reasonably safe assumption that the other variables will not change significantly, it is possible to make some projections concerning future land use, vegetation, and population patterns on Lanai and Niue.

### Lanai

The population of Lanai, although it is economically tied to the

Dole operation, is potentially mobile, and therefore not completely dependent upon future development of the island's resources. Should the pineapple operation become unprofitable in the future, it could be completely terminated and the entire population of Lanai could relocate on other islands in the Hawaiian chain, as has happened once before in the history of the island.

It is probable, however, that the current pineapple operation will not cease to be profitable. There is no other type of land use for Lanai that is obviously more profitable. Castle and Cooke, Inc., has considered the possibility of developing some of the land on Lanai for a resort and retirement community. This plan, however, has been rejected for the present. Although this type of land use could be developed on Lanai, without interferring significantly with the present pineapple operation, its possibility hinges almost entirely on executive decision. Therefore, if the pineapple operation remains as the only major economic activity on the island, as it probably will, the population numbers and distribution will maintain their present configuration, as will the land use and vegetation patterns. Only executive decision will change these patterns. Lanai has already passed through its period of greatest change.

## Niue

Niue Island may yet have to face another transitional period. The continuing rate of migration from the island, and the current trend

of decreasing value in exports both indicate that some changes must be made in the economic system of the island if the residual population is to enjoy a standard of living commensurate with their aspirations. Despite the fact that the physical environment of Niue imposes severe restrictions on the type of economic activity that can be developed, it is obvious that some changes must be made.

Increasing technology, and the recent development of new deep wells, may enable some changes to occur in the traditional agriculture systems. The major possibility for new development is stock raising, which can be developed with the introduction of tropical fodder crops, and sufficient judicious encouragement from the Government of Niue. Another tested, but largely untried commercial agricultural activity is extensive banana growing. Despite the fact that this crop has proven to be suitable for the Niue Island environment, most Niuean farmers have been reluctant to make the necessary commitment of time and money to make this crop a profitable commercial activity. Increased educational levels, and judicious government encouragement, might make some changes in traditional attitudes.

It is apparent that traditional methods of agriculture have not enabled the people of Niue to prosper. New agricultural methods must be adopted, within the framework of traditional land tenure customs, if there is to be an improvement in the standard of living of the residual population of the island.

## Conclusion

The first research hypothesis states: The initiation of changes in land use, vegetation, and population patterns on islands are primarily the result of external cultural influences. Based on the original assumption that the aboriginal inhabitants of the islands were integral components of a functioning island ecosystem, it has been shown that the first research hypothesis is correct for the following reasons:

1. Lanai has been, in the traditional and contemporary periods of occupance, the island with the most pronounced external cultural influences, and this island has experienced the greatest amount of change in its population, land use, and vegetation patterns.
2. The current land use, vegetation, and population patterns of Lanai have been influenced mainly by external factors.
3. The current land use, vegetation, and population characteristics of Niue Island, which are not significantly unlike those of the aboriginal period of occupance, are controlled predominantly by indigenous cultural factors.

The second research hypothesis stated: The types of changes which have occurred in an island's land use, vegetation, and population patterns are dependent upon certain inherent physical components of the island ecosystem. The validity of this hypothesis has been demonstrated by the following:

1. The nature of the soils, ground water reserves, and relative location of Lanai have been advantageous for the development of an extensive commercial agricultural operation on the island.

2. The soils, ground water reserves, and relative location of Niue Island have not been conducive to the development of extensive commercial agriculture.

It must also be concluded at this point that the predominant controlling factor in the type and amount of change which occurs in the population, land use, and vegetation patterns of an island is the land tenure system of that island. This has been demonstrated to be true in the cases of both Lanai and Niue. On Lanai, despite the favorable nature of the soils, and the availability of water under present-day technology, the existence of a large commercial plantation would not be possible were it not for the fact that the land tenure system has enabled the Dole Company to acquire the necessary land for an extensive plantation operation on a fee simple system of ownership. On Niue, the land tenure system, which precludes private personal ownership and transfer of land by sale, has made it virtually impossible for sufficient land to be obtained to encourage the development of extensive commercial agriculture.

With these conclusions in mind, it has been demonstrated that the diagramatic model of relationships illustrated in Figure 1 is valid

for the islands of Lanai and Niue. As the model indicates, the single most important independent variable from the standpoint of direct influence on dependent variables is that of economic systems. This is the one component of the model to which all other components are directly related. No single variable, however, can be the completely decisive one because of the set of inter-relationships that exists in an island ecosystem. On the islands of Lanai and Niue the land tenure variable has historically been the key which allows the economic variable to play its decisive role. The land tenure variable has been dependent to a large degree on the nature of the political system of the island. It can be concluded, therefore, that the three cultural variables are functionally inter-related in such a way that no one variable can exist as an integral component of an island ecosystem without the other two variables.

The method used to study these two islands is not new. It is that of historical analysis within the framework of cultural ecology. The advantage of this method is that it enables the researcher to isolate and examine those functional links within the man-land relationship which are the most decisive in giving character to the landscape of a region. This method, therefore, avoids the problem of encyclopedic description of each and every characteristic of a region, by isolating those qualities of the region which are most important as causal factors. The ecosystem concept has been used in this study

as a conceptual framework to describe the system of relationships which exists on the islands of Lanai and Niue. The ecological paradigm has proven to be useful in this role. Although this approach leaves many questions unanswered, it does provide a method, within the well-established man-land tradition of geography, whereby the broad implications of man's relationship to his environment may be better understood through studies of this kind.

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