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THE TRANSFORMATION OF THE LANDSCAPE IN WAIMEA, HAWAII:  
PRE-HUMAN ERA TO 1860

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## **ABSTRACT**

Waimea's landscape underwent three major transformations from pre-human times to the mid-1800s: native species were replaced by alien ones; agricultural terraces were built by the growing population; and cattle became a dominant presence. Upon arrival, Polynesians introduced their transported landscapes. The population grew, cleared vegetation, and established an intricate agricultural system by the 1300s. Waimea was an attractive draw, with a water supply, ideal climate and soils, and moderate distance to the ocean. Captain Cook's arrival introduced a commercial economy resulting in further transformations. The sandalwood trade denuded Waimea's forests by the 1830s while the cattle industry grew. As the cattle increased, introduced diseases caused Waimea's native population to decrease from thousands to a few hundred by the 1860s. From the time of its first settlers to 1860, Waimea was transformed from a landscape of highly endemic flora and fauna to a paniolo landscape dominated by alien species.

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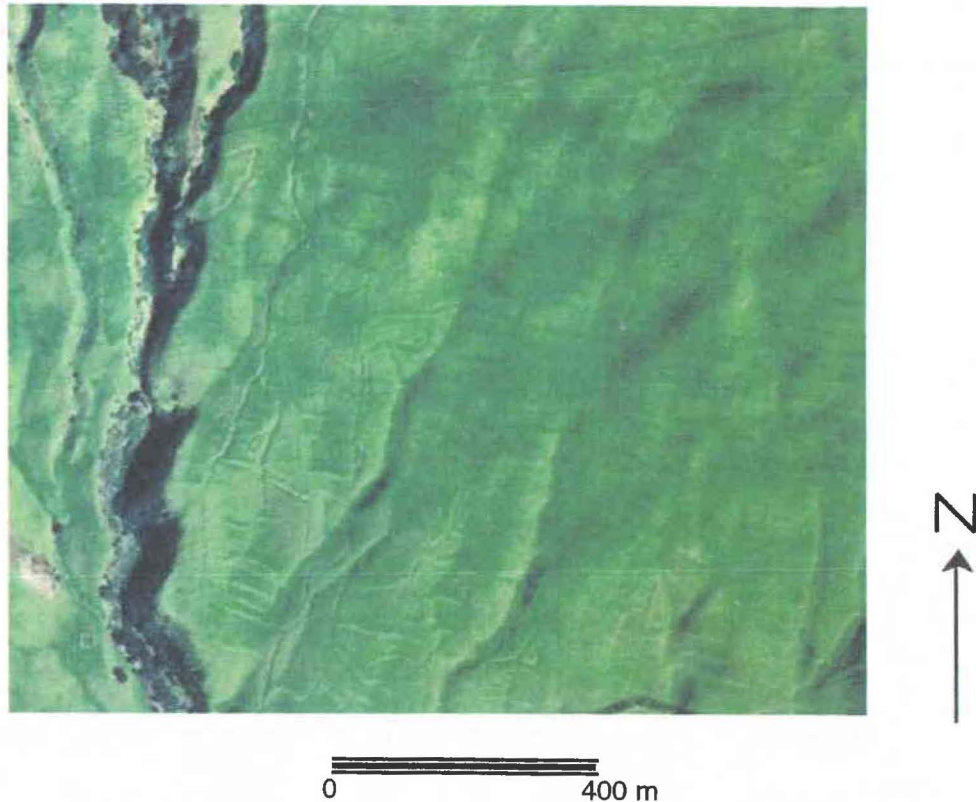
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## CHAPTER 1

### INTRODUCTION

#### 1.1 Introduction

Today the landscape of Waimea on the island of Hawai'i shows signs of past modifications. Trees are conspicuously absent on the green slopes where the hillsides indicate agricultural terracing in the past (Figure 1.1). The landscape suggests a history of human adaptation to a cultural system that evolved from an agrarian society to a commercial one.



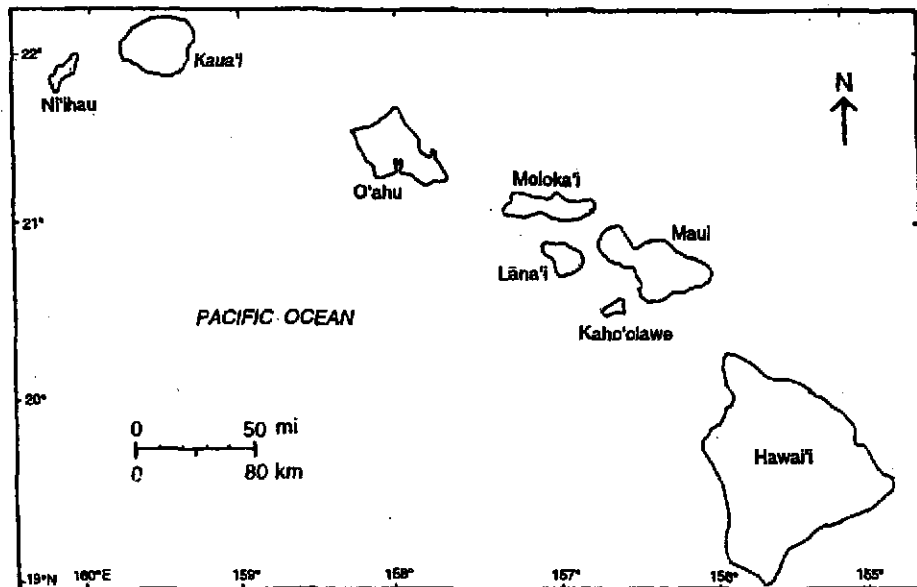
**Figure 1.1. Aerial View of an Upslope Area of Waimea**  
(modified from Morriss 2001)



Waimea's geographical history can be described as the transformation of a natural landscape to a cultural landscape. This research examines landscape modifications in Waimea. In particular, it focuses on the processes involved in the creation of the landscape up to 1860: the clearing of forests, the establishment of agricultural field systems, and the subsequent shift to a ranching environment.

## **1.2 The Setting**

J.T. Wilson (1963) was the first to propose the theory that the islands of Hawai'i (Figure 1.2) were formed as the Pacific plate moved slowly northwestward over a stationary hot spot beneath the earth's crust. This hot spot, which supplies magma to the moving Pacific plate, is the location for the formation of the Hawaiian Islands. The Pacific plate is moving towards the



**Figure 1.2. The Hawaiian Islands**

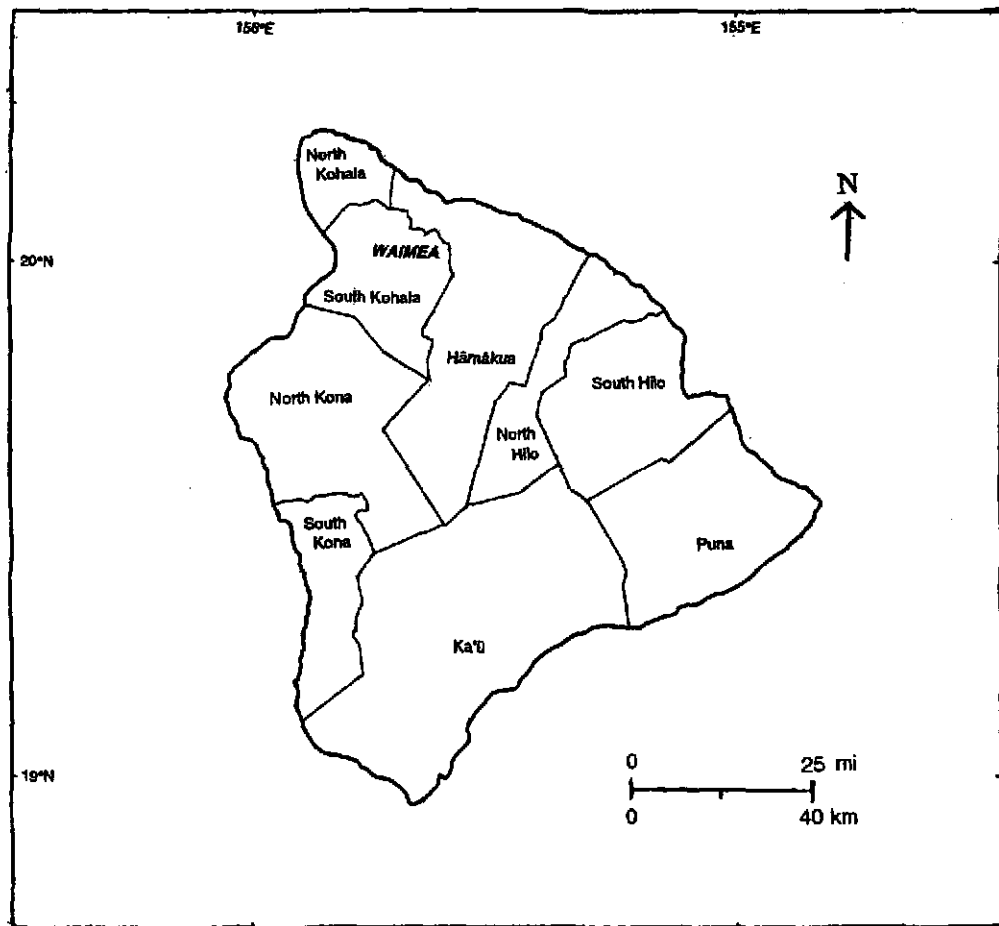
west-northwest at a rate of 9 cm per year (Clague 1998). Thus the Hawaiian Islands get progressively older as one moves northward up the archipelago. The island of Hawai'i, sitting atop the hot spot and lying furthest south, is the youngest of the islands and still growing.

Hawai'i Island is comprised of five volcanic mountains: Kohala, Mauna Kea, Hualālai, Mauna Loa, and Kīlauea. The extinct Kohala Volcano, with a maximum elevation of 1670 m, is the oldest of the five volcanoes and is comprised of lava from the Pololū series and the Hāwī series. Potassium argon dating has shown the Pololū series to be .33 to .45 million years old while the Hāwī series is .06 to .25 million years of age (Macdonald, Abbott, and Peterson 1983). The Kohala Volcano, after nearly reaching its maximum size, had its southern flank buried by lava flows of Mauna Kea (ibid.). Mauna Kea, at 4205 m, is the highest volcano in Hawai'i. It last erupted about 3600 years ago and is likely to erupt again (Walker 1990). Waimea, at an elevation of approximately 800 m, is located at the juncture where the flows of Kohala Volcano and Mauna Kea meet.

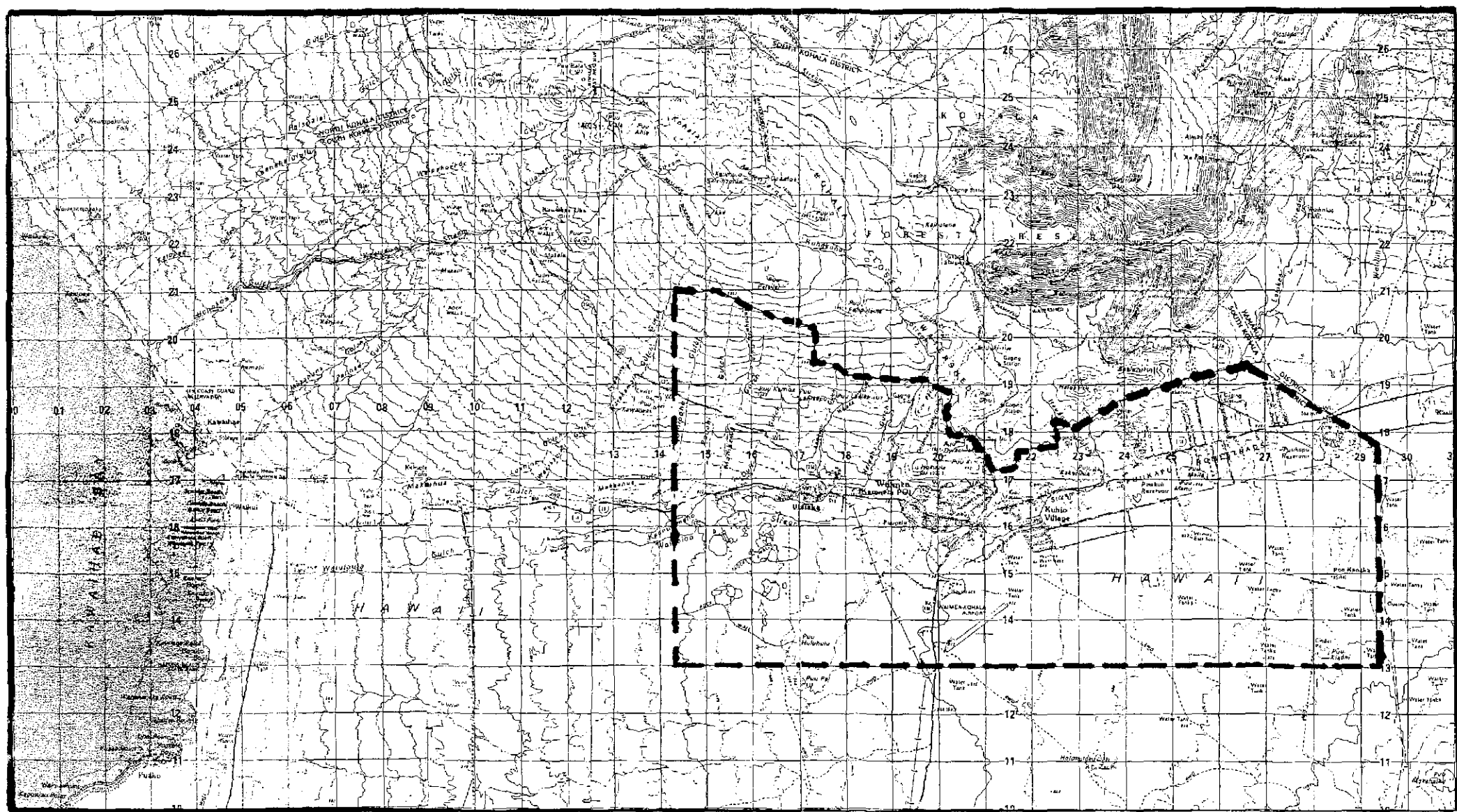
The island of Hawai'i has a population of approximately 150,000 (Ifuku 2001) and is divided into nine districts: North Kohala, South Kohala, North Kona, South Kona, North Hilo, South Hilo, Hāmākua, Puna, and Ka'ū (Figure 1.3). These districts are based on the island's ancient political districts. There were six ancient districts: Kohala, Kona, Hilo, Hāmākua, Puna, and Ka'ū. Waimea is located on the northern half of Hawai'i Island in the district of South Kohala. The area consists of rolling hills with intermittent streams. Waimea literally means "reddish water," as from the erosion of red soil (Pukui, Elbert, and Mookini 1974).

Today Waimea town (Figure 1.4) is a thriving community with a population of approximately 7000 (Ifuku 2001). It is an attractive place to live

with amenities such as a police station, fire station, hospital, library, stores, restaurants, and schools. Practically all the comforts of modern day living can be found in Waimea. Figure 1.4 shows the approximate boundaries of Waimea town. The forest line comprises the northern boundary, the Kohala-Hamakua district boundary approximates the eastern boundary, the southern boundary is near a large rock wall, and the western boundary is near 500 m in elevation at its lowest point.



**Figure 1.3. The Districts of Hawai'i Island**

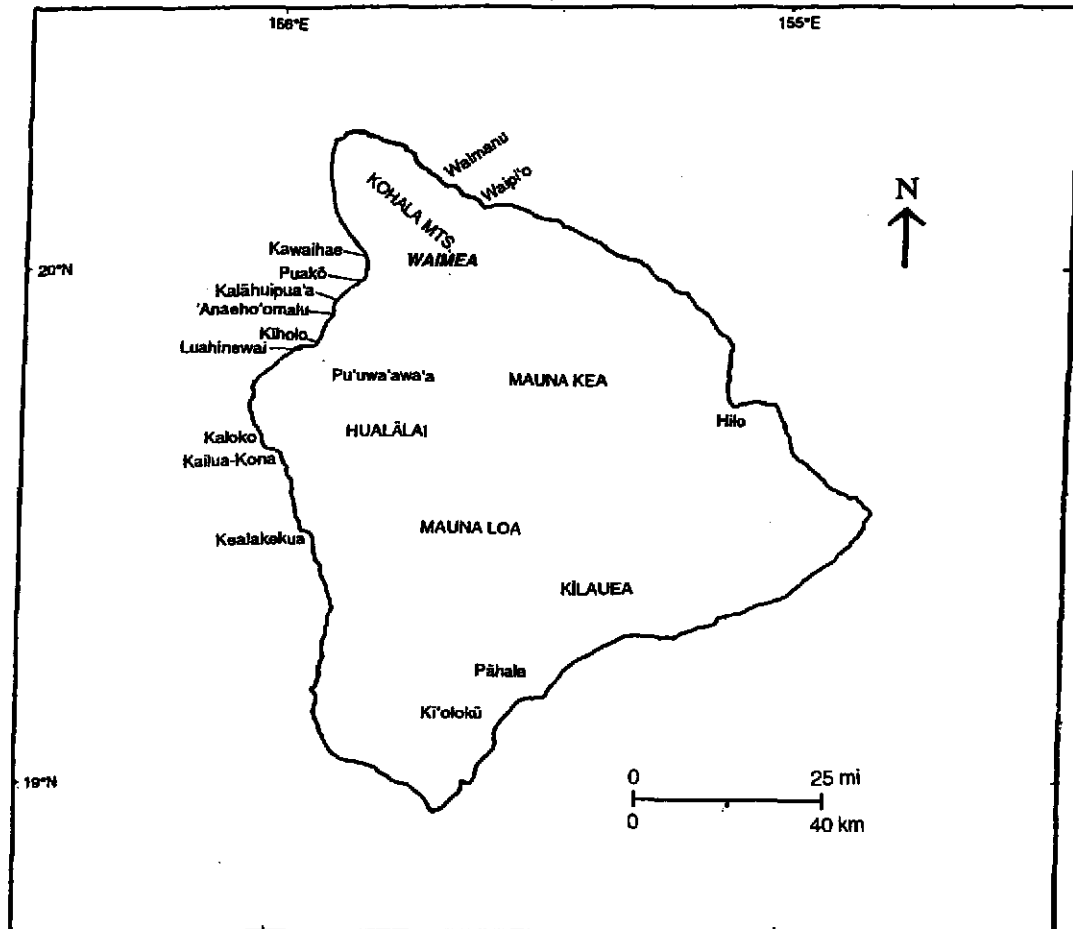


elevation in meters

0 6000  
kilometers



Figure 1.4. U.S.G.S. Topographical Map, Waimea Town Outlined



**Figure 1.5. Places Mentioned in Thesis**

The island of Hawai'i displays a variety of climates. Temperatures vary from below freezing atop the summits of Mauna Kea (4205 m) and Mauna Loa (4169 m) to the nineties at low elevations. The lowest temperature recorded on the island of Hawai'i is  $-12.8^{\circ}\text{C}$  ( $9^{\circ}\text{F}$ ) at the summit of Mauna Kea. The highest temperature recorded is  $37.8^{\circ}\text{C}$  ( $100^{\circ}\text{F}$ ) at Pāhala on the southeastern side of the island (Price 1983). Rainfall varies

from less than 250 mm a year in coastal Kawaihae, located only 10 km from Waimea, to more than 7700 mm per year, upslope from the city of Hilo on the windward side of the island (Giambelluca and Schroeder 1998). Kailua-Kona, on the leeward side of the island, has consistently light and variable winds, while northeast tradewinds dominate on the windward side of the island. Waimea, located between the Kohala Mountains and Mauna Kea, often experiences gusty tradewinds, as the mountains funnel the winds and accentuate them. This research focuses primarily on today's residential area of Waimea. This region begins at approximately 585 m in elevation, which is about 9.7 km from the coast, and ends at about 17 km inland, with a maximum elevation of approximately 975 m. Rainfall varies widely within this area; the lower elevations receive about 325 mm while the upper slopes receive nearly 1000 mm of rainfall annually (Clark 1986). The wet season is during the winter months of December, January, and February, while the driest months are June through September (Giambelluca and Schroeder 1998).

The topography of Waimea is varied. The northern, upslope areas consist of fairly steep hillsides, interspersed with a few deep gulches. At lower elevations, undulating hills comprise the southern and western portions of Waimea. The eastern end of Waimea, which receives the greatest amount of rainfall, is nearly flat. Within Waimea, there are several streams that are perennial, going dry only during droughts.

Waimea's soils are volcanic ash-based andisols, aridisols, and mollisols (Gavenda, Smith, and Vollrath 1998). These soil types are fertile, although aridisols need to be irrigated for agriculture. Waimea's current vegetation consists of grasses, shrubs, and trees, most of which are non-native.

### **1.3 The Approach**

#### **1.3.1 Introduction**

Landscape in environmental history is regarded as the result of interactions between nature and culture (Worster 1990). In this view, nature itself is a participant in the formation of landscapes. In contrast, many cultural geographers describe landscapes as text (Demeritt 1994). Combining these two viewpoints results in a reciprocal process in which, as stated by White (1983:323), "social change clearly has environmental consequences, but environmental change, in turn, also affects societies."

The relationship between social change and environmental change are examined in this thesis. The transformation of the landscape is described in terms of social constructs. The evolution of Hawaiian society resulted in landscape changes that accelerated as the population expanded and native culture was defined. This study investigates the major landscape modifications in Waimea and explains how they developed according to the needs of the society and how the resulting landscape then influenced further changes in both society and landscape. By exploring the relationship between nature and culture, an account of Waimea's landscape transformation is attained.

#### **1.3.2 Landscape Modification**

Landscape transformation and modification has been the most important emphasis in historical geographic writing (Williams 1994). Many of these writings have explained changes of the earth's surface through descriptions of past landscapes. Studies of vegetation changes and the role of humans in changing their environment deal directly with landscape modification.

In a study of landscape modification, the change in vegetation is often the focus. Goudie (1990) describes the human impact on vegetation. He includes in his discussion the use of fire, the role of grazing, and the causes and effects of deforestation. Goudie (ibid.: 25-26) discusses five principal stages of interference:

1. natural habitats: developed in the absence of human activities.
2. degraded habitats: produced by sporadic, yet incomplete disturbances. Examples include the cutting of a forest, burning, and the non-intensive grazing of natural grassland.
3. ruderal habitats: disturbance is sustained but there is no intentional substitution of vegetation. Example: roadsides.
4. cultivated habitats: constant disturbance is accompanied by the intentional introduction of plants.
5. artificial habitats: developed when humans modify the ambient climate and soil. Example: greenhouses.

Westhoff (1983: 7) also looks at human influence on vegetation and describes a four-part scheme. His model below fits quite well to Hawaii's ecological succession:

1. natural: a landscape or ecosystem not influenced by human activity.
2. subnatural: a landscape or ecosystem partly influenced by humans, but still belonging to the same formation type as the natural system from which it derives. Example: a wood remaining a wood.
3. semi-natural: a landscape or ecosystem in which flora and fauna are largely spontaneous, but the vegetation structure is altered so that it belongs to another formation type. Example: a pasture deriving from a wood.
4. cultural: a landscape or ecosystem in which flora and fauna have been essentially affected by human agency in such a way that the dominant species may have been replaced by other species. Example: arable land.



The change in Hawaii's vegetation and the transformation of Hawaiian landscapes is widely documented in the literature. Cuddihy and Stone (1990) describe the effects of aboriginal people on the vegetation and changes in the vegetation during the early post-European contact period and since 1850. Other authors have described the change in vegetation for specific areas. Burney et al. (2001) used core samples from a sinkhole and cave on Kaua'i to reconstruct the vegetation in a coastal area and found the pre-human landscape to be very diverse. Athens (1997) used sediment coring and pollen analysis for lowlands on O'ahu to provide a baseline account of the pre-human vegetation. He also showed how the vegetation changed as humans settled on the island and the population grew. Based on some of the same research, Athens and Ward (1993) found that pollen and spore data indicated a steep decline around 1000 A.D. in the dominant lowland forest plants, which were replaced by grasses, shrubs, herbs, and ferns. According to these authors, the absence of charcoal in the core samples suggests that the use of fire may not have been the impetus behind the disappearance of the mature vegetation. They suggest that the change in vegetation may have been caused by an introduced plant disease, or by an interruption in the symbiotic relationship of the natural vegetation attributed to Polynesian plant and/or animal introductions.

Both Clark (1986) and Wellmon (1969) have described landscape change in the Waimea area. In looking at settlement patterns of the Waimea-Kawaihae area over time, Clark (1986) divided up the region into elevation zones and described the pre-human and current vegetation in each. Wellmon (1969), in writing the history of Parker Ranch, described the changes in vegetation as it related to the needs of a growing cattle industry.

Cordy (2000) combines archaeological evidence with an analysis of oral histories to describe Hawai'i Island's history. In doing so, he chronicles the island's change in landscape and culture over time.

Kirch (1982) has approached the subject of landscape modification through archaeological and paleoecological evidence. He looks at the "transported landscapes" of Hawai'i and discusses the impact of introduced plants and animals and the effects of forest clearance and habitat modification. He describes how the transformation of the Hawaiian landscape resulted in extinction of endemic species, alteration of vegetation communities, and erosion.

Spriggs (1986) also discusses landscape modifications by the early Hawaiians. He reviews the same processes of modification: forest clearance and erosion and deposition. However, he interprets the landscape modifications as enhancements rather than the more usual interpretation that deforestation and erosion lead to a degradation of the land. Spriggs makes the case for enhancement based on the fact that the modifications were beneficial to humans and allowed for the sustainability of a large human population.

In referring to the migrations of the Pacific Islanders, Spriggs (2001: 58) writes that these agricultural people "had a pioneering spirit of the 'Go West, young man' type, except that it was mostly 'Go East!'" The islanders continued to move eastward as they were able to find new islands to colonize. In colonizing these islands, they brought with them their most important plants and animals, creating what Kirch (1982) describes as "transported landscapes."

Europeans also made introductions and created their own "transported landscapes." Alfred Crosby (1986) has termed the biological

conquest of non-European areas through the overseas migration of western Europeans and their plants and animals as ecological imperialism. Crosby points out that Europeans are the most successful overseas migrants because their descendents make up the majority of the population in all of the temperate zones, excluding Asia. These Lands of the Demographic Takeover have been biologically altered with respect to both human and non-human populations. Ecological imperialism is a one-way exchange of people, weeds, animals, and infectious diseases. The conquered lands are “Europeanized” according to Crosby, who defines the term as follows:

It refers to a condition of continual disruption: of plowed fields, razed forests, overgrazed pastures, and burned prairies, of deserted villages and expanding cities, of humans, animals, plants, and microlife that have evolved separately suddenly coming into intimate contact (1986: 291-92).

Crosby goes on to say, “The success of the portmanteau biota and of its dominant member, the European human, was a team effort by organisms that had evolved in conflict and cooperation over a long time” (ibid.: 293).

In *Epidemics and History*, Watts (1997) explores the links between the movement of epidemics and the manifestations of imperial power around the world. He examines great epidemics over the last six centuries, discussing their effects on both Europeans and Non-Westerners. The processes that Watts deals with could be considered “ecological imperialism” although he never uses the term.

### 1.3.3 Sources

The sources used in this research treat many different subjects. For general information about the vegetation in Hawai‘i, Abbott (1992), Sohmer and Gustafson (1987), and Wagner, Herbst, and Sohmer (1990) contain

descriptions of both native and introduced plants. Prehistoric vegetation analyses based on sediments and pollen can be found in Athens (1997), Athens and Ward (1993), Burney et al. (2001), and Juvik and Lawrence (1982). Cuddihy and Stone (1990) describe Hawaii's vegetation since European contact and the effect humans have had on the vegetation.

In the category of fauna, two excellent sources for descriptions of Hawaii's extinct native bird population are James and Olson (1991) and Olson and James (1991). Native snails are the subject of Hadfield's (1986) and Henshaw's (1912-1914) writings. Henshaw is of particular relevance because he describes an occurrence of tree snails in the Waimea area. Other sources of information on the native fauna include Pratt and Gon (1998) and Steadman (1997).

Human impact on Hawaii's native ecosystems is the subject of Kirch (1982) and Spriggs (1986). These two authors have different viewpoints regarding Polynesian impact in Hawai'i. Kirch (1982) describes the change in the landscape as degradation, while Spriggs (1986) maintains that Polynesian activities enhanced the landscape by making it more useful to humans.

The subject of population change in Hawai'i can be found in the writings of Nordyke (1989a, 1989b), Schmitt (1968, 1977), Dye (1994), and Dye and Komori (1992). *Before the Horror* is Stannard's (1989) detailed argument for a pre-European contact native Hawaiian population of nearly one million. For population information specific to leeward Hawai'i and Waimea, Clark (1986), Cordy (2000), and Doyle (1945) were examined.

Explorers' journals, such as those of Cook (1967a, 1967b, 1971) and Vancouver (1967a, 1967b, 1967c), contain excellent information on a variety of subjects including vegetation, cultural practices, and the impact of

diseases upon the native population. Vancouver's (ibid.) and Menzies' writings are especially relevant because they refer to the Waimea area specifically.

The ranching era in Waimea is the subject of the works of Bradley (1942), Brundage (1971), Brennan (1974), and Cowan-Smith and Stone (1988). Wellmon's (1969) *The Parker Ranch: A History* is an excellent source of information for this time period. A complete description of life during this era can be found in Doyle's (1945) *Makua Laiana: The Story of Lorenzo Lyons*.

Other sources that contain valuable historical information about Waimea include Ellis (1963, 1969), Clark (1983a), Cordy (2000), and Kamakau (1992). Ellis, a missionary, writes of his observations while traveling throughout the Hawaiian Islands. Clark and Cordy provide information on land tenure and population in Waimea within their writings of leeward Hawai'i. Kamakau is a source of historical events related from a native Hawaiian's point of view. He details many events in Hawaii's past, including battles that took place in the Waimea and Kohala areas.

Archaeological studies provide data on a wealth of subjects including population, vegetation, land tenure, and cultural activities. Many of these studies have been conducted as a requirement prior to the construction of roads or subdivisions (Bonk 1985, Ching 1971, Rosendahl 1973, Schilt 1984). Those that have concentrated on the Waimea area include Clark (1983a, 1983b, 1983c, 1983d), Kirch and Clause (1981), and McEldowney (1983).

This thesis is a contribution to the literature available on the Waimea area and is presented from a cultural geographer's perspective.

#### **1.4 Research Questions**

This study investigates the creation of Waimea's landscape. What was the pre-human landscape like? What flora and fauna existed in Waimea during this period and how did they come to exist there? How did the Polynesians arrival affect the landscape? During the pre-European contact era, a number of modifications were made to Waimea's landscape. What were these alterations and what factors instigated these landscape changes? How did these modifications affect the native flora and fauna? The arrival of Europeans in Hawai'i in 1778, led to more changes in the landscape. What were these post-contact landscape changes and how did they affect the flora, fauna, and Hawaiian people? This research examines the changes in Waimea's landscape from pre-human times to the mid-19<sup>th</sup> century and the factors that initiated those changes.

#### **1.5 Outline of Thesis**

Chapter 2 examines the pre-human landscape of Waimea in terms of the flora and fauna were established in the region prior to the arrival of humans. Waimea's pre-European contact landscape is described in Chapter 3. The landscape is analyzed over the period of time from the colonization of the Hawaiian Islands up to European contact in 1778. Chapter 3 looks at how the landscape changed over time in response to human occupation. In short, chapters 2 and 3 investigate Waimea's transformation from a natural landscape to a cultural landscape.

Chapter 4 examines the changes in Waimea's landscape from the time of European contact in the islands up to 1860. Major events and their effects upon the land and the people are described as well as the change in

population in Waimea during this time frame. This chapter details Waimea's transformation from a Hawaiian cultural landscape to a "paniolo" landscape.

Chapter 5 summarizes the results of the study and evaluates the theory of ecological imperialism as it applies to Hawai'i. It also includes my evaluation of the expansion of Waimea in terms of the push factor of overpopulation that may have sent people in search of uncrowded lands versus the pull factor of attraction that the fertile lands of Waimea may have held.

## CHAPTER 2

### PRE-HUMAN LANDSCAPES

#### **2.1 Introduction**

The Hawaiian Islands are extremely isolated from other lands. Johnston Atoll, the nearest land not belonging to the Hawaiian archipelago, is more than 1300 km away from Honolulu and the nearest continent is more than 3800 km away (Juvik and Juvik 1998). Hawaii's isolation has resulted in a unique flora and fauna by means of long-distance dispersal via air and ocean currents. Over millions of years these organisms evolved into many species through adaptive radiation, filling the various ecological niches that were available. Usually, endemic plants make up a small percentage of indigenous plants, but in Hawai'i the percentage is quite high. In the *Manual of the Flowering Plants of Hawai'i*, Wagner, Herbst, and Sohmer (1990) calculate an 89:11 ratio of endemic to indigenous plants in Hawai'i. This is one of the highest endemic to indigenous ratios in the world for plants.

#### **2.2 Pre-Human Landscapes**

Pratt and Gon (1998) have classified native Hawaiian terrestrial ecosystems into six categories: alpine desert; subalpine forest, woodland, and shrubland; montane dry and mesic forest and woodland; wet forest and woodland; lowland dry and mesic forest, woodland, and shrubland; and lowland dry shrubland and grassland. According to this classification system, the landscape of Waimea during the late pre-human era can be classified as a combination of two categories. The upper slopes of Waimea fall into the montane dry and mesic forest and woodland classification, as the distribution of this ecosystem occurs primarily on leeward slopes of Hawai'i Island and



Maui where there is a strong seasonal component with dry summers, a temperate climate, and annual precipitation less than 2500 mm. The lower elevations of Waimea fall into the lowland dry and mesic forest, woodland, and shrubland category. These areas occur on old lava flows of Hawai'i and have an annual rainfall of 500-2000 mm and a warm to hot climate.

According to Pratt and Gon's (ibid.) ecosystem classification, the natural vegetation of upper Waimea was closed and open canopy forests of *Metrosideros* ('ōhi'a), *Acacia koa* (koa), *Sophora* (māmane), and possibly *Chamaesyce* ('ākoko), *Sapindus saponaria* (mānele), and *Santalum freycinetianum* ('iliahi). Koa and 'ōhi'a were also present in the lower regions of Waimea, as were *Diospyros sandwicensis* (lama), *Erythrina sandwicensis* (wiliwili), *Nestegis sandwicensis* (olopua), and *Pleomele* species (halapepe). Grasses of these lower areas included *Heteropogon contortus* (pili grass) and *Eragrostis variabilis* (kāwelu grass). The shrub-type vegetation included *Dodonaea viscosa* ('a'ali'i), *Wikstroemia* species ('ākia), *Bidens* species (ko'oko'olau), and *Osteomeles anthyllidifolia* ('ūlei).

Charcoal from fire pits in or near Waimea has been identified as remains of native trees and shrubs (Murakami 1983). The most common type of charcoal identified belonged to the genus *Chenopodium* ('āheahea or 'āweoweo). Other genera identified were *Nothocestrum* ('aiea), *Psydrax*, formerly known as *Canthium* (alahe'e), *Nototrichium* (kulu'i), *Colubrina* or *Alphitonia* (kauila), *Diospyros* (lama), *Sida* ('ilima), and *Acacia* (koa).

Several species of *Bidens*, commonly known as beggar's ticks, were probably well distributed throughout Waimea during the pre-human era since they are known to occupy a great diversity of habitats from sea level to about 2200 m (Carr 1987).

According to Pratt and Gon (1998), fauna of the uplands included native spiders, beetles, butterflies, and birds such as *Vestiaria coccinea* ('i'iwi) and *Chasiempis sandwichensis* ('elepaio). Fauna of lower Waimea included the native birds 'elepaio, *Himatione sanguinea* ('apapane), *Loxops virens* ('amakihi), and the Hawaiian goose (*Branta sandvicensis*, nēnē). The Hawaiian hoary bat (*Lasiurus cinereus semotus*, 'ōpe'āpe'a) was also probably present in this area since Waimea's ecosystem type is its favorite habitat (ibid.).

In addition to the bird species mentioned above, the fauna probably included some of the flightless geese and rails that evolved in Hawai'i. Olson and James (1991) found bones of an extinct goose species in lava tubes in the Kona and Kohala districts. Recent excavations in the uplands of Pu'uwa'awa'a, approximately 40 km to the southwest of Waimea, have produced about 80 fossils of large flightless geese which have been radiocarbon dated as existing somewhere between 700 A.D. and 900 A.D. (Mark Merlin pers. comm.). These birds probably inhabited Waimea also, since the two areas are at approximately the same elevation and receive similar amounts of rainfall.

In the absence of predatory mammals, several species of raptors evolved in the Hawaiian Islands. The remains of owls, eagles, hawks, and harriers have been found on several of the islands (Olson and James 1991). So far only the Hawaiian hawk is known to have inhabited the island of Hawai'i, but other raptors may have been a part of the landscape as well since these birds were not flightless.

Less conspicuous yet still part of the landscape during the pre-human era were native insects and land snails. The endemic land snails, which include both ground and tree dwellers, were undoubtedly very abundant

during the pre-human era. Shells from many different land snail species have been found on Hawai'i. These land snails were of various sizes, shell shapes, colors, and patterns (Cooke and Kondo 1960). An examination of fossil and subfossil land snails in a corridor from the coast to the uplands of Waimea revealed abundant endemic land snail remains in a buried burn layer (Christensen 1983). This burn layer marks the change in vegetation from dry forest to grasslands.

## **CHAPTER 3**

### **PRE-EUROPEAN CONTACT LANDSCAPES**

#### **3.1 Introduction**

The pre-European contact era of Hawai'i encompasses many changes to the landscape and has been divided into cultural-historical periods by archaeologists and prehistorians. These periods are: the colonization period (A.D. 300-600); the developmental period (A.D. 600-1100); the expansion period (A.D. 1100-1650); and the proto-historic period (A.D. 1650-1795) (Kirch 1996).

#### **3.2 Colonization Period: A.D. 300 - 600**

Although not all scholars agree, Hawai'i was probably first settled by a group of Polynesians from the Marquesas in the first few centuries A.D. (Kirch 1990). Based on the rarity of sites dated to the earliest settlement period, the initial group of settlers was small, perhaps a hundred or so individuals who arrived in several canoes (Kirch 1996). These first inhabitants of Hawai'i were descendants of the Lapita, people who settled all of Polynesia from Northwestern Melanesia. The Lapita's eastward migration started around 1600 B.C. and continued for some 2000 years, ending with the colonization of the outermost regions of the Polynesian Triangle: New Zealand, Easter Island, and Hawai'i (ibid.).

There was likely some long-distance voyaging between Hawai'i and other island groups subsequent to the first permanent settlement (McGregor 1996). Cordy (2000) states that even if long-distance voyaging did take place, the voyages were few, and if immigration did take place it would have consisted of one or a few canoes. Nevertheless, these seafaring people

were skilled navigators and were able to travel between the Pacific islands using their knowledge of the currents, winds, and skies. This long-distance voyaging between the Hawaiian Islands and the islands of central Polynesia occurred for some time—until about 1200 A.D. according to Kirch (1996).

A detailed discussion of long-distance voyaging in early Hawai'i can be found in *Exalted Sits the Chief* by Cordy (2000). Cordy also includes a thorough discourse to support his opinion that the migration wave theory, which supports multiple voyages of fleets of canoes to Hawai'i, is incorrect. Cordy describes all 18 Hawaiian oral accounts that he could find of these long-distance voyages. He claims that the oral accounts indicate that 11 of the 18 voyages originated in Hawai'i and that in the 6 that originated elsewhere, only a canoe-load of people arrived, not the many canoes that would constitute a fleet. Thus, although the Polynesians were able to colonize many islands, the Hawaiian Islands were far enough away that traveling back and forth was probably a risky venture rarely, if ever, taken (ibid.).

The voyagers who settled Hawai'i brought with them their vision of a cultural landscape. They transported many of the same plants and animals that their relatives and ancestors had settled other islands with. By this time, their people had been making long-distance voyages for several thousands of years and knew how to propagate their basic, most important plants. In fact, 23 of the 29 plants introduced to the Pacific by the people of Oceania were established in Hawai'i prior to 1778 (Abbott 1992). Clearly the plants that the early Hawaiians brought with them were very important since space was extremely limited on their canoes. In addition to plants, the voyagers transported pigs, dogs, rats, and chickens (Kirch 1985).

### 3.2.1 Earliest Landscape Transformations

The earliest settlers on Hawai'i Island probably lived in the valleys on the windward side because of the presence of fresh water (Stannard 1989). The valleys provided an ample supply of water from streams and springs, and the inhabitants could sustain their small populations on the foods they cultivated and resources from the sea. In these areas where the introduced plant species flourished, the native plants were displaced (Sohmer and Gustafson 1987).

The direct impact on the environment by humans and the introduced plants and animals was that the ecosystem was thrown out of balance and this altered the natural landscape. The early settlers cut down trees for dwellings, cooking, and heating. Fire may have been used to clear small tracts of land for agricultural plots, killing native species in the process. The introduced pigs, dogs, and rats likely preyed on native birds and ate native fruits and seeds. The habitats of native species were reduced, and some native plants never reestablished in their original locations. Such was the case of the *Pritchardia*, a native palm which was a dominant lowland component in pre-human times, but is now only found on steep mountains and the remote areas of windward valleys (Burney et al. 2001). As plants and animals gradually disappeared, and habitats and food sources were lost, organisms that could not adapt quickly became scarce or died out completely. Chain reactions of these processes occurred affecting the entire environment.

During the first few hundred years of Hawaiian settlement when the population lived primarily on the windward sides of the islands, Waimea's landscape was probably minimally affected. The extent of the landscape changes would be the result of introduced animals that had gone wild and

extended their range throughout the island. Pigs, dogs, and rats may have established themselves in the Waimea area causing native species of birds to decrease. Some introduced plants may have started to establish themselves in Waimea as pigs, dogs, rats, and birds could have transported the seeds. This type of landscape alteration would take place slowly over time, as they were indirect results of human activities.

### **3.3 Developmental Period: A.D. 600 - 1100**

By 600 A.D. permanent settlements were established on all of the main Hawaiian Islands (Kirch 1982). This was the end of the colonization period and the beginning of the developmental period that lasted until about 1100 A.D. During this developmental period, the population of Hawai'i expanded primarily from natural internal growth, and to a smaller extent from continued migrations from Polynesia (McGregor 1996). The population established itself throughout the lowlands during this period (Cuddihy and Stone 1990). This expansion into the drier leeward areas suggests that high population densities were occurring in the preferred windward areas (Kirch 1996). During this period large extended families made up the social structure and production was subsistence based (McGregor 1996).

The population of the islands at the end of the developmental period is estimated at about 20,000. This figure is based on radiocarbon dating of charcoal remnants from all of the major islands except Lāna'i and Ni'ihau (Dye 1994). The dating method used in Dye's (ibid.) population estimates is based on the idea that changes in population are reflected in changes in the amount of wood charcoal found at archaeological habitation sites. Thus, periods of higher population will produce more domestic charcoal due to the increased needs for food, light, and heat.

During the early developmental period the landscape of Waimea was probably largely "natural" as described in Westhoff's model (1983). I believe Waimea's resources would have been exploited more than they had been in the past but still largely unchanged from its natural composition. The Hawaiians wouldn't have needed to clear the upland areas such as Waimea—the areas they occupied were still ample for sustaining the population through agriculture and fishing. However, some introduced plants by the late developmental period, several hundred years later, may have established themselves in the wild in areas with favorable conditions. It is probable that some introduced species were well established in Waimea by this time. According to Athens (1997), these introduced species may have interrupted the symbiotic relationships of native species. Athens states:

While predation on seeds by the introduced Pacific Rat (*Rattus exulans*) has frequently been suggested as the major contributor [to the decimation of the native lowland forests], it is difficult to see how so many plant species would have been equally susceptible (ibid.: 265).

The ecosystems of Hawaii's natural landscape were not complex. A simple ecosystem leads to diminished stability and the lack of competition enables introduced species to broaden their range (Goudie 1990).

There are many examples of post-European contact introductions establishing themselves in the wild rapidly after introduction. Mint, chamomile, turnips, and mustard went wild after introduction in Peru (Crosby 1986). Half a century after horses were introduced in the pampas, their numbers were staggering (ibid.). Livestock was introduced to Australia in 1788 and by 1804 wild herds of cattle numbered from three to five thousand head (Crosby 1988).



On the island of Hawai'i, fountain grass (*Pennisetum sectacaeum*) was introduced as an ornamental plant in the 1920s (Ching 1971). It spread quickly and today, less than a century later, fountain grass is a dominant species along roadsides and in undeveloped areas on the leeward side of the island. Another plant that dominates leeward Hawai'i today is the kiawe tree (*Prosopis pallida*), which was introduced to the islands in 1828 (Rock 1917). It is reasonable to conclude that Polynesian introductions could similarly affect the native flora and fauna within several hundred years.

Introduced animals and plants both Polynesian and European, are the primary cause of the extinction of native flora and fauna in the uplands and are also contributors to extinction in the lowland areas (Vitousek, Loope, and Stone 1987). Areas in which these plants established themselves can be described as subnatural. Subnatural landscapes have been partly influenced by human activity but still belong to the same formation type as its natural landscape (Westhoff 1983).

Waimea, during the first half of the developmental period until around 900 A.D., was slowly transformed from a natural landscape to a subnatural landscape. Introduced plants were living among the indigenous plants and unintentionally introduced animals were living within the plant community along with indigenous fauna. The native bird population may have already started to decline due to predation by rats. Burney et. al. (2001) suggest that rats were feral in some areas well before Hawaiians had densely settled those areas. The presence of rats would have most affected the non-passerine birds that nested on the ground (Olson and James 1991).

Waimea was likely first settled by humans during the second half of the developmental period (Cordy 2000). There has been very little dating of sites in upland Waimea thus far, but one sample from agricultural soils suggests

human occupation at 800-1000 A.D. (ibid.). Although the results are preliminary and needs further research, this early settlement date of Waimea does not seem unreasonable. Cordy (1994) believes that Waipi'o and Waimanu valleys were some of the first areas settled due to the optimal conditions. Waimea, located just over the mountain ridges of Waipi'o and Waimanu valleys, could have been discovered by Hawaiians as they explored beyond their settlements. As the population explored inland areas they found arable lands, a cool climate, and sources of water in Waimea. Waimea was most likely one of the first leeward areas settled due to these favorable conditions. Additional evidence for an initial settlement during this period is the fact that many sites in Waimea's lower elevations have been dated to 1200-1300 A.D. and oral histories for Kohala and other leeward areas refer to significant populations in these areas during this same time period (Cordy 2000). According to Cordy (ibid.), with evidence for a substantial population in the 1200s, it is conceivable that initial settlement in the area would have occurred several centuries earlier. This would put the initial settlement of Waimea around 900-1100 A.D., during the last part of the developmental period.

Clark (1986) also argues for an early expansion into Waimea. He states that productive inland areas would be cultivated soon after colonization because farming was an integral part of the founding society.

The initial group of settlers to Waimea was probably small, settling near streams and clearing only enough land for their dwellings and crops, for fuel, and for construction of tools and other necessities. Their settlements may have been only temporary in nature, providing part-time residences to complement seaside communities. The impact on the landscape was probably minimal, as the small population would not have a need to alter the

landscape extensively. After this initial settlement it is likely that the Hawaiians were pleased with the rich soils of the area and the close proximity to freshwater and mountain resources. They adapted to living in an inland area and became less dependent on coastal resources. Yet, the coastal resources were not that far away and the nearest coastline was—and from 13 years of personal experience still is—one of the easiest to harvest from due to the calm conditions that prevail there. Being in the proximity of so many resources led to permanent residency and an increasing population as the inhabitants encouraged others to move to Waimea. This was the beginning of the transformation of Waimea from a subnatural landscape to a cultural landscape.

#### **3.4 Expansion Period: A.D. 1100 - 1650**

The Hawaiian population began to increase dramatically around 1100 A.D. (Kirch 2000). In addition to internal growth, the population may also have increased due to migrations of Polynesian chiefs and priests from Tahiti during this period. According to McGregor (1996), these migrations are chronicled in chants and legends and the descendents of these settlers eventually ruled over the Islands through intermarriage and battles.

On the west side of Hawai'i Island the population doubled every century (Kirch 1985), requiring the expansion of agricultural systems. To increase the amount of arable land, the leeward slopes and valleys were cleared of the native forest and replaced by intensively cultivated field systems. The population of the islands continued to increase until about 1650 A.D., when population reached a peak, usually estimated to be several hundred thousand people (Cuddihy and Stone 1990, Kirch 1996), although Stannard (1989) estimates the peak to be at least 800,000. Dye (1994)

estimates a much lower peak population of 140,000 to 200,000 based on radiocarbon dating techniques derived from a method developed by Rick (1987).

Dye and Komori (1992) summarize Rick's (1987) method as such:

A frequency distribution of  $^{14}\text{C}$  age determinations that is relatively free of investigation, preservation, and creation biases can be used to estimate absolute population numbers if the amount of carbon added to the archaeological carbon deposit *per capita* per unit time is known or can be estimated (Dye and Komori 1992: 116).

In the case of Hawai'i, the period of  $^{14}\text{C}$  dating included the years of the missionaries' censuses. Dye and Komori (1992, 1994) calibrated the  $^{14}\text{C}$  results of household charcoal to the 1832 census data to establish a baseline mean *per capita* amount of carbon deposited annually. They believed that the *per capita* amount of household charcoal was consistent throughout the pre-European contact era and into the 1830s and 1840s since commoners had little access to most Western goods until then (Dye and Komori 1992). Thus, the household charcoal produced would be free from creation biases (*ibid*). Once the amount of carbon deposited annually *per capita* was determined, Dye and Komori (1994) used that variable to arrive at population estimates for the duration of pre-European contact Hawai'i.

During the expansion period, Waimea's small initial population likely grew into a fairly large community. The settled areas expanded into the hillside slopes and into the drier Waimea plains. This population growth is supported by the number of sites dating to 1400-1500 A.D. in the coastal areas downslope of Waimea such as Puakō, Kalāhuipua'a, and 'Anaeho'omalu (Cordy 2000). Waimea's people would have utilized these areas for coastal resources. More evidence for a large and mobile Waimea population exists in the number of shelter caves found along inland foot trails

that connect Waimea to Kona. Radiocarbon dating for some of these shelter caves place human activity at A.D. 1200s-1400s, with one cave's use dating back to the A.D. 800s-1100s (Cordy 1994).

#### 3.4.1 Waimea's Date of Settlement

Waimea's date of settlement will probably never be known. Estimations of settlement have been made based on radiocarbon dating of charcoal (Clark 1983d) and volcanic glass dating (Olson 1983). Volcanic glass dating alone is generally not relied upon by archaeologists (Cordy 2000). However when the two methods are both applied to samples, dates generally fall within the same time frame (ibid.). The problem with these methods for Hawaiian research is that the margin of error can be more than 200 years (ibid.). For Hawai'i, this range of error is significant because the population expanded into different regions fairly rapidly, perhaps within less than a thousand years.

In 1983, Clark (1983b) estimated that human activity in Waimea first occurred in the 13<sup>th</sup> or 14<sup>th</sup> century and that the area was occupied, perhaps temporarily, in the 15<sup>th</sup> century. His analysis conformed to the general belief that windward areas were settled first, and expansion into leeward areas occurred much later (Kirch 1985, Stannard 1989). Clark's data, however, were based on sites that are mostly in the drier regions of Waimea, outside of Waimea's core area where the majority of today's business takes place. Still, a few of his samples fell within a range that includes the 11<sup>th</sup> century and one sample may date back to about 800 A.D. (Clark 1983d). By 1986, however, Clark (1986) proposed that Waimea was permanently settled at least by the 14<sup>th</sup> century.

The reasons for settlement on the leeward side of Hawai'i are still unknown (Cordy 2000). Some writers feel that expansion into leeward and inland areas occurred due to population pressures on the windward sides of the islands (Kirch 1985; Stannard 1989). Cordy (2000) suggests that some windward residents may have felt crowded, felt oppressed by their chief, or may have just wanted to start up a new area for themselves.

According to Cordy (ibid.), current archaeological evidence puts the settlement of leeward Hawai'i between the A.D. 900s–1100s. In Waimea, dates for some sites have been placed to the 1100s–1200s but the bulk of the sites date to the 1600s–1700s (ibid.). These findings are logical considering that the region's most populous period was during the 1600s–1700s. But the question may always remain: when was Waimea *first* settled? I believe that as radiocarbon dating is applied to additional Waimea sites, more results will fall in the 900s–1100s timeframe. Finding these earlier sites may be difficult, however, since houses and the town's business district now occupy the area of Waimea that would likely have been settled first. This area of Waimea has a cool climate, is located near streams, and receives more than 760 mm of rain yearly. The walk to the coast at Kawaihae would have taken the Hawaiians only a couple of hours. The coastal area surrounding Kawaihae was certainly important to Waimea's residents because gathering food there would have been easy. This area of the coast has predominantly calm conditions—there is no trade wind swell on the west side of the island and the Kawaihae area rarely sees high surf conditions because the other Hawaiian Islands block most of the winter surf. Because of its proximity to so many resources, I believe Waimea was one of the first leeward or inland areas settled.

### 3.4.2 Field Systems

As the population of Waimea grew, the amount of land that needed to be cleared for agriculture increased. Thus in the latter part of the expansion period, the Waimea's mesic forest was cleared. The inhabitants likely used fire to clear away the native vegetation, as fire was the primary tool used by Hawaiians when preparing land for cultivation (Kirch 1982). The land cleared by the growing population was large and is known as the Waimea field system, one of four large field systems in leeward Hawai'i (Kirch 1985).

Because Hawai'i Island is relatively young and its tall mountains create a rain shadow on the leeward side of the island, there are few streams available for irrigation water. The leeward area's field systems are at fairly high elevations where rainfall was adequate to sustain the crops and the soils were fertile (Kirch 1996). Areas that were not cultivated with food crops were used for pili grasslands, producing crop mulch and thatch for roofs and walls (Spriggs 1986). In developing these fields, the Hawaiians completely cleared the original dry and mesic vegetation (Cuddihy and Stone 1990).

The Waimea field system, as well as the other field systems, occurred only in the areas of western Hawai'i with arable lands and a minimum yearly rainfall of 5000 mm. The Waimea field system, approximately 20 km<sup>2</sup> in size, was part of an estimated 260 km<sup>2</sup> of Hawai'i Island that was converted into these field systems (Newman 1972). These field systems were intensifications of past shifting agriculture (Kirch 1985). The locations of these field systems were centers of population on the island (Cuddihy and Stone 1990).

The neighboring Kohala field system, approximately 57 km<sup>2</sup> in size, was first occupied around 1300 A.D., with slash and burn techniques employed to clear the land for agriculture during the following 200 years

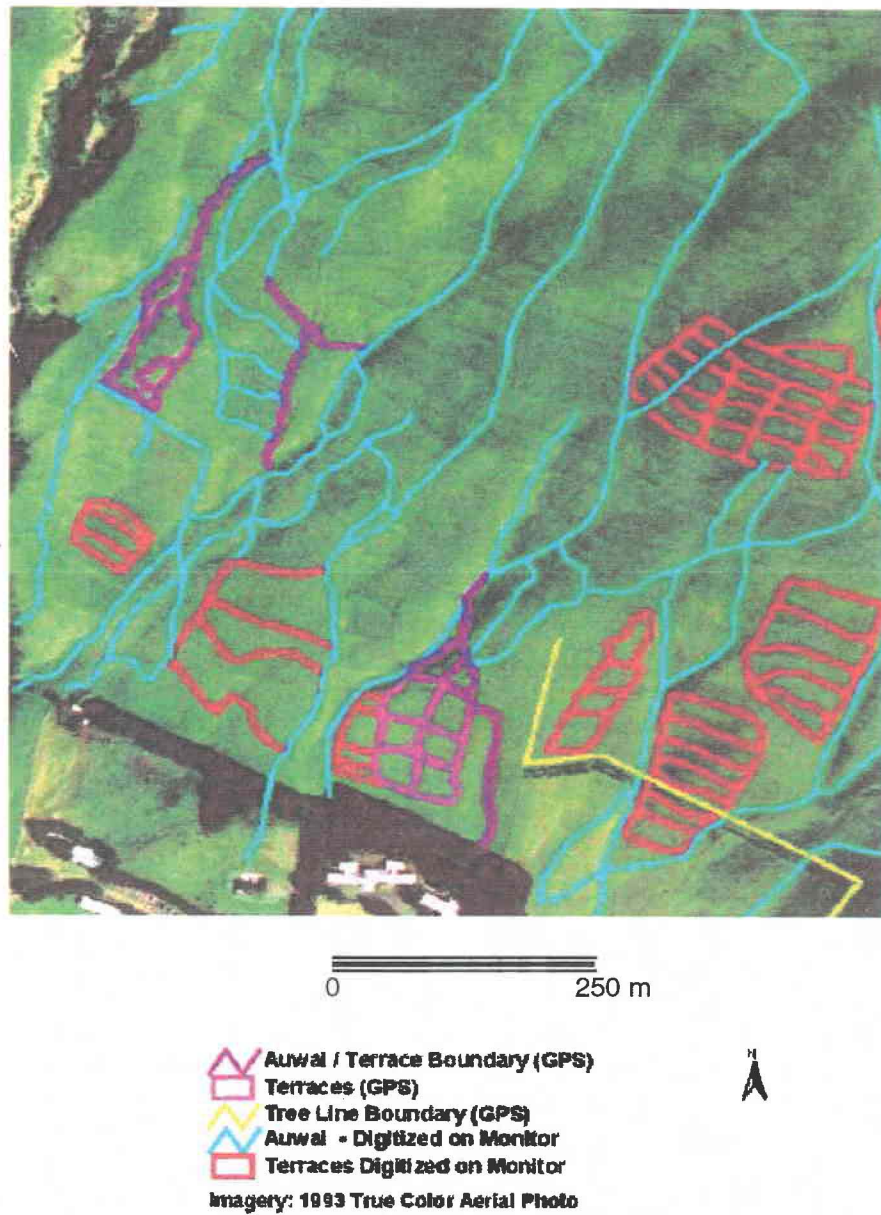
(Rosendahl 1974). Intensification greatly increased in the area after 1450 A.D. (Kirch 2000). In a 1968-1972 study, University of Hawai'i archaeologists determined that the area was developed over several centuries from about 1300 A.D. until European contact (Kirch 1996). Peat cores from a Kohala bog at 1100 m show a correlation between the time of occupation and a change from native tree species to herbaceous plants (Juvik and Lawrence 1982).

In these agricultural systems the field walls, or *kuaiwi*, were made of stones that were piled up. These walls probably served several purposes. They were storage areas for the stones that had to be cleared from planting areas. The walls probably delineated garden plots (*kihāpai*) and were helpful in soil retention. They also supported windbreaks of sugarcane and *ti* (*ki*, *Cordyline terminalis*) plants (Kirch 1996). The fields were irrigated using canals, or *'auwai*, that tapped the Waimea streams. The canals were spread throughout the fields, allowing the crops to soak up the water (Cordy 2000).

The proximity of the Kohala and Waimea field systems and the similarities between them in rainfall and elevation suggests that Waimea was also occupied around 1300 A.D. Clark (1983b) estimates the Waimea agricultural complex was occupied from the 13th or 14th century. As discussed in section 3.4.1, it is likely that an earlier settlement date will be established for Waimea as more dating techniques are applied to the area.

Figure 3.1 shows an upslope area of Waimea with terraces and *'auwai* added. Morriss (2001) collected data in the field using a global positioning system (GPS) to identify the features' locations. She used the data to map the features, then combined the mapped features with an aerial photograph to produce a virtual map. Morriss didn't map residential structures due to time constraints, but the image indicates the complexity of the field systems.





**Figure 3.1. Upslope Area of Waimea with Ancient Features Outlined**  
(modified from Morriss 2001)

Near the period of peak population, Hawaiians began to inhabit less favorable coastal areas (Tuggle and Griffin 1973) and barren zones between the coast and uplands (Rosendahl 1973). The area just below the Waimea field system, between Waimea and Kawaihae, was occupied between 1600 and 1800 A.D. based on archaeological remains of dryland crops (Welch 1983). This finding conforms to the theory that Hawaiians began to inhabit previously uninhabited areas at the time of the population peak around 1650 A.D. or shortly prior to it.

#### 3.4.3 Terracing as a Response to Population Growth

Once Waimea's advantages were known, the population expanded quickly and agricultural techniques had to keep up with population growth. The agricultural terraces were developed next to streams so that the water could be used to its potential. By controlling the flow of the water to irrigate successive terraces, more food could be grown and the land was used judiciously. As the population expanded outwards from the core area, so did the terraces, into marginal extremes (Kirch 1983). The products grown in this manner, along with animals that were raised, birds that were hunted in the forests, and seafood that was gathered and caught at the ocean, provided a healthy variety of food for the people of Waimea.

#### 3.4.4 The Effect of Forest Removal

The deliberate removal of forest is one of the most significant methods of landscape modification (Goudie 1990), Hawai'i being no exception. The Hawaiians changed their local vegetation substantially through the use of fire, as did their Polynesian relatives in New Zealand where fire was used to clear land for cultivation and hunters used fire to facilitate travel and to

frighten and trap the flightless moa (Cochrane 1977). In New Zealand, by the time the Europeans first arrived in 1642, the moas were gone and a large proportion of their habitat had been burned away by the native Maori who had transformed the eastern half of South Island from forest to grassland (Crosby 1986). The Hawaiians likely used fire for the same reasons as the Maori: to trap Hawaiian endemic flightless birds and to clear land for their crops.

Menzies (1920) recorded a historic account of the use of fire for agricultural clearing. In 1792 he observed a large fire spreading over the plains of Waimea, Kaua'i. Local chiefs told the Europeans that the fire had been set to burn down the old grass and vegetables. This allowed for a crop of grass better suited for thatching. It is likely that this type of burning was a customary practice of the Hawaiians that had been going on for centuries.

The use of fire to clear vast tracts of land was probably the first large-scale impact on the Waimea landscape. The native plants of the area were greatly impacted by the use of fire. Fire destroyed the plants, and as the Hawaiians transformed the land into agricultural plots, regeneration of these plants was inhibited. Additionally, with the destruction of plants, faunal species were lost as their habitats disappeared. In a study of land snails in Waimea, endemic land snails were found in abundance in a buried burn layer but none was found in upper soil layers representative of vegetation succeeding native forests (Christensen 1983). The upper soil layers are representative of the vegetation which succeeded the native forests of the natural landscape. These results indicate that the use of fire was a large factor in eliminating the endemic snails from the area.

Habitat destruction may also have begun the disappearance of the achatinellines (tree snails) with the first colonization of Hawai'i (Hadfield

1986). The clearing of lowland vegetation in all probability accounts for the disappearance of many low altitude populations and species (Kirch 1982). As increased agricultural activity pushed back the forest boundary into the mountains of Waimea, the tree snails' habitat decreased and species that could not survive in the colder and wetter environment died out. Although the snails once populated a range of altitudes, by the mid-1800s the achatinellines were primarily on mountain slopes and ridges (Hadfield 1986). However, one species, *Partulina confusa*, still densely inhabited a part of the Waimea plain in 1903 (ibid.). Henshaw (1912-1914: 96) called the population an "isolated colony" living in about 150 pua trees (olopua, *Osmanthus sandwicensis*) growing in a 1.3 km<sup>2</sup> area. The trees were scattered and about 4-6m in height. Henshaw (ibid.: 97) wrote, "it was possible to ride under the trees and from their trunks, leaves, and branches to pick shells literally by the handfuls." By Hadfield's (1986) estimation, the average number of snails per tree would have been an extremely dense 2000. This relict population may indicate a previously abundant snail population.

Other animals, such as native birds, were also victims of forest removal. In addition to losing their habitat, birds perished in the fires. Bones of flightless birds have been found on all of the main Hawaiian Islands. Almost all went extinct prior to European contact but after Polynesian settlement of Hawai'i. Habitat destruction may have been the biggest contributor to the extinction of these birds (Olson and James 1991). The loss of habitat left surviving birds more susceptible to predation by humans, rats, pigs, and dogs (Steadman 1997). Prehistorically introduced diseases are another possible reason for the birds' demise (Olson and James 1991). Spriggs (2001) points out that in Hawai'i and New Zealand, where faunal

data is available, rapid extinction of many bird species occurred within a few hundred years of human settlement.

The fossil records show that all of the main Hawaiian Islands once had endemic species of non-passerine land birds, of which almost all were flightless or raptors, but none of these survived into the historic period except on Hawai'i Island. Their former existence was determined through radiocarbon dating and stratigraphic analysis. Only one species of rail and one species of raptor survived into the historic period on the island of Hawai'i (Olson and James 1991).

For the smaller passerine birds, human predation was probably not a major cause of extinction. Still, by 1778 about a third of the endemic passerines were extinct (Sheila Conant pers.comm.). Although a few extinctions may be attributed to mammalian predation by introduced species, since most of the passerines were tree nesting, it is likely that pre-European contact habitat alteration was the leading cause of extinction for these species (James and Olson 1991).

More than 92 of the aforementioned endemic bird species of Hawai'i including many flightless water birds have been identified, of which only about 47 still existed at European contact in 1778 (Olson and James 1991). By 1778 nearly all of the flightless birds were gone, and by 1990 only 31 of the endemic birds survived (ibid.). This rate of extinction has been compared to the mammalian extinction of the Pleistocene (Sheila Conant pers. comm.).

Once the native forests were cleared to make room for agricultural plants such as taro and sweet potato, the "natural" landscape of Waimea ceased to exist. Even when fields were abandoned or left fallow, introduced plants were the successors in reclaiming the land (Cuddihy and Stone 1990). Above Waimea, however, where the terrain becomes steeper at elevations

near the 900 m level, the natural landscape and original vegetation were left basically untouched by the Hawaiians (Kirch 1982).

#### 3.4.5 Waimea: A Cultural Landscape

By the time of the pre-European contact population peak of the late expansion period, Waimea was the center of a large community and Hawaiian society had complexities such as a social hierarchy, ruling chiefs, and power struggles, including war. Land tenure was established in the ahupua'a system throughout the islands. Ahupua'a were land divisions, usually pie shaped and running from the mountains to the sea, which were ruled by local chiefs who were chosen to do so by the Ali'i Nui, the highest ranking person of the island. Commoners were allowed to live in the area and use its natural resources in exchange for labor and loyalty to the chiefs. In return, the chiefs were expected to take care of the commoners on their lands. This system of land tenure continued even after Europeans arrived and was not significantly altered until Kamehameha united the islands (except Kaua'i) in 1795 (Kame'eleihiwa 1992).

By the late expansion period, the people of Hawai'i had altered the landscape into a largely cultural and cultivated one. The land had to be cultivated intensively in order to meet the population's needs. The Waimea field system, like the island's other major field systems, was an irrigated one. Water was directed to the fields from streams with the use of 'auwai or ditches (Figure 3.1). These 'auwai allowed for periodic watering, and in upslope fields the ditches were used to drain the fields (Clark 1983c). The upland section of Waimea was the major area of occupation during this period. There were scattered settlements along the northern part of the Waimea Plain, at the foothills of the Kohala Mountains. The main agricultural crops

consisted of wetland irrigated taro near the foothills along streams and dryland taro and sweet potatoes on the drier slopes of Waimea (Rosendahl 1972). The complexity and size of this agricultural system suggests high population levels in the past.

Kamakau refers to the large pre-European contact population in *Ruling Chiefs of Hawai'i*. He states:

In ancient times the land was covered with people. All the lands from Hawaii to Ka'ula were peopled except the low coral reefs. From the summits of the mountains to the shore are to be found the remains of their cultivated fields and the sites of their houses (1992:235).

The upper slopes of Waimea alone are said to have supported more than 10,000 people prior to contact (Wellmon 1969). Therefore it is conceivable, and highly likely, that the entire Waimea area contained more than 10,000 people during its peak population period.

A society dependent on a complex agricultural system is vulnerable to drought and early Hawaiian society must have endured such dry periods. Droughts would have left the streams dry and damaged the crops. In times such as these, the population would have harvested what they could from forest areas, surviving on, among other things, edible tree ferns, vines, weeds, and other plants known to have been used during times of famine such as *Pandanus* (hala) and *Morinda citrifolia* (noni) (Cuddihy and Stone 1990, Abbott 1992). The birds were no doubt prized in times of famine. As large as the population was, the forests must have been seriously depleted during droughts (Handy 1972).

Kamakau (1992) referred to one of these dry periods in a description of the Waimea battlefield, quoting Kamalalawalu's counselors as having said, "Waimea is not a good battle site for strangers because the plain is long and

there is no water" (ibid.: 58). Kamalalawalu's men then went to the "grass-covered plain of Waimea" (ibid.). This passage indicates that grasslands had already replaced trees and shrubs by the mid-1600s, since Kamalalawalu ruled over Maui during the years 1640-1660 (Cordy 2000). Kamakau (1992) writes that the only water the men could find was rainwater caught in hollows.

During the late expansion period, Waimea was transformed from a subnatural landscape to a cultural landscape. The inhabitants needed to expand their range throughout the area as the population rapidly increased, and because Waimea is located miles from the coast, agriculture was an important part of their society. Sustainability was dependent on the ability to grow and harvest enough food for the large population, which was likely more than 10,000 at its peak. Thus it was necessary to alter the landscape by clearing large tracts of land and establishing irrigation systems for agriculture. In addition, trees and other plants were harvested in order to build dwellings, make tools and clothing, for firewood, and for medicinal purposes. The everyday needs of the inhabitants came largely from the landscape that surrounded them.

### **3.5 Proto-Historic Period: A.D. 1650 - 1795**

The last time period of the pre-European contact cultural-historical framework used here is the proto-historic period. The beginning of this time period approximates the population peak of the islands of Hawai'i by most accounts, although Dye (1994) estimates the population peaked closer to 1450 A.D. based on agricultural burning.

Most scholars agree that the native population of the Hawaiian Islands started to decline during the proto-historic period and prior to European contact (Hommon 1980; Kirch 1990), although this theory has recently been



challenged (Cordy 2000). Several hypotheses have been suggested as to why population decline occurred; none of the proposed contributing factors can be completely rejected at this time (Dye 1994). One possibility is that the islands had reached their carrying capacity with all arable lands already in production. Maximum production may have occurred in some but not all areas of Hawai'i. In Waimea it is unlikely that carrying capacity was reached, as not all areas of Waimea were as intensively cultivated as the field system.

Drought may have been a contributing factor to the declining population. Although Hawaiians certainly lived through periods of drought in earlier times, the lack of rainfall when marginal areas were occupied would have a much larger impact on society. These marginal areas would experience crop failure more often and the inhabitants would have to rely on other areas for their food. This pressure from outlying areas would put additional strain on the more productive regions. As Hommon (1986: 66) puts it, "with the expansion of population into marginal regions came an increase in the frequency and intensity of the adverse socio-political effects of crop failure and famine resulting from drought."

Another possible explanation for population decline suggested by Dye (1994) is introduced diseases by pre-Cook mariners. There have been suggestions in the past that the Hawaiians had contact with Spanish or Japanese mariners prior to Cook's arrival in 1778. At the time of Cook's arrival, Hawaiians had iron blades that were similar to Japanese knives (ibid.). Spanish maps from the 1500s show a group of Pacific islands that some scholars have suggested are the Hawaiian Islands (Stokes 1939). If either Japanese or Spanish sailors had been shipwrecked in Hawai'i, they could have introduced diseases for which Hawaiians had limited immunity. This hypothesis for population decline has less credibility than the

hypotheses that suggest social pressures were to blame since written accounts from Cook's earliest voyage to Kaua'i, in January of 1778, failed to mention the presence of disease affecting the natives. The earliest observations of an epidemic were made in November of 1778 when the surgeon on Cook's voyage confirmed the presence of venereal disease amongst the natives of Maui (Cook 1967a). Midshipman Edward Riou wrote of the possibility that shipwrecked Spaniards had introduced the disease, but even he acknowledged that his shipmates were the likely culprits. Riou noted:

They were asked about it and said a great many men and women were afflicted with it on Shore, and spoke of the Isle Atowi [Kaua'i], as if we had left it at that place the Last year, if this Account proves true tho' it is hoped it will not, but that this Horrible disease was left here by some Spaniards before us, we need not have taken the Unnecessary precautions we did on the 22<sup>d</sup> of Nov<sup>r</sup> yet the former is much to be feared and in the end that it will appear it has been we ourselves that has entailed on these poor, Unhappy people an everlasting and Miserable plague (ibid: 475).

Stokes (1939) presented a case to dispel the theory that the Spanish had arrived prior to Cook. He pointed to the fact that the Spanish had two routes across the Pacific, neither of which would take them in the vicinity of the Hawaiian Islands. The northern route passed more than 1600 km away from the islands while the more traveled southern route passed 560 km south of the island of Hawai'i. In addition, Stokes (ibid.: 45) notes that "the natives' accounts recorded were also unanimous that all iron previously received came from the sea." In an examination of unpublished journals, Stokes found that the two knives owned by Hawaiians were of Japanese origin and had washed ashore.

Regarding the Spanish maps from the 1500s which supposedly chart the Hawaiian Islands, Stokes (1939) retraced the history of the maps and

found that the islands were originally mapped in 1570 at the eastern portion of the Philippines. The islands were then moved over time in several versions by different cartographers, eventually being placed in the vicinity of the Hawaiian Islands. Stokes points out that the maps made following the 1570 version had many discrepancies in delineation and nomenclature. In addition, underestimation of longitude was common in the 16<sup>th</sup> century, but these maps represented the cartographic authority during that era.

Warfare may also have contributed to population decline (Vancouver 1967a). During this time period Hawaiian society was quite complex and power struggles were prominent, especially on the island of Hawai'i. Regional chiefs often led their armies in battles against one another. Warfare led to many consequences in the population. Men were killed during war, which had an immediate effect on population. Armies traveled to different districts and other islands, resulting in fewer births. Maintenance of agricultural plots would be difficult during times of war as men spent less time tending gardens.

In 1792, Vancouver (ibid.) noticed that Waikiki had many houses that appeared to be abandoned, and Waimea, on the island of Kaua'i, was much smaller than when he had visited in 1778 and 1779. He attributed the decline to warfare:

That external wars and internal commotions had been the cause of this devastation, was further confirmed by the result of my inquiries off Owhyhee [Hawai'i], when it did not appear that any of the chiefs, with whom I had been formerly acquainted, excepting Tamaah-maaha [Kamehameha], was then living; nor did we understand, that many had died a natural death, most of them having been killed in these deplorable contests (ibid.: 188).

War itself may have had a direct impact on agricultural sites as well. Archibald Menzies, who visited the Hawaiian Islands several times between

1786 and 1794 on British vessels, walked through Ki'olokū on the south side of the island of Hawai'i in 1794. He wrote in his journal:

We observed a great deal of ground on both sides of our path lay waste, which appeared to have been cultivated many years ago. This we ascribed to the late commotions on this part of the island, as it is the common custom of these people to destroy the plantations of the vanquished (Menzies 1920: 185).

The destruction left after battles was detailed by Vancouver in 1793. Vancouver noticed the poor condition of Maui and was told by Kahekili, the chief of Maui, that his diminishing wealth and the condition of the island were completely due to the ravages of Kamehameha's forces. Kahekili's explanation was that Kamehameha's forces,

not content with the vast quantity of provisions consumed during their stay in these islands, nor with loading their canoes with the productions of the soil, had laid waste the lands on all sides, broken the fences of the plantations, thrown down the banks of the little canals made for watering the crops, which were torn up by the roots; and that all the hogs, dogs, and fowls, that could not be carried away, were killed, or dispersed over the country (Vancouver 1967b: 185-86).

With such occurrences the food supply would be severely reduced for the population. Results would be similar to those in drought conditions.

During the proto-historic period, the population of the Hawaiian Islands peaked and began to decline. Waimea, however, apparently continued to grow throughout the 1700s. The number of sites dating to the 1600s and 1700s supports this population increase. Clark (1986) used 113 volcanic glass and 46 radiocarbon measurements for a total of 159 chronometric determinations in the Waimea-Kawaihae area. The data showed a significantly higher number of sites for this time period compared to the previous two centuries. There were also numerous sites from the 1800s, with a decline in the number of sites from about 1830. Thus, the bulk of the

archaeological dates for Waimea suggest the area reached its maximum population in the 1600s-1700s and the early 1800s (Cordy 2000). The growth of Waimea during this period of time can be attributed to chiefs staying in Waimea and nearby Kawaihae for extended periods. Alapa'inui, ruler of Hawai'i Island from 1740-1760, and Kalani'ōpu'u, ruler of the island from 1760 - 1782, spent time in both places during the 1700s (ibid.). Kamehameha had two prolonged stays in the area, in 1791-1792 during the building of Pu'ukoholā heiau at Kawaihae and in 1794-1795 when Kamehameha prepared his fleet for wars against Maui and O'ahu (Barrère 1983).

By the time of European contact in the late 1700s, the population of the Kohala district may have been in the tens of thousands (Kirch 1996). During the latter part of the proto-historic period, the Waimea field system, as well as the other field complexes, were abandoned, according to Kirch (ibid.). This event occurred after European contact in 1778 and was largely due to the dramatic decrease in the Hawaiian population from introduced diseases. This population decrease and other changes in Waimea following European contact are discussed in the next chapter.

## **CHAPTER 4**

### **EUROPEAN CONTACT AND SUBSEQUENT LANDSCAPE CHANGES**

#### **4.1 Introduction**

Hawaii's first European contact was in 1778 when Captain James Cook arrived. There are various estimates for the native population at the time of contact. By this time the Hawaiian population was already on the decline. John Ledyard, a British Navy corporal on Cook's voyage, claims to have consulted with the Hawaiian natives in determining an estimated population of 100,000 for Hawai'i Island (Munford 1963). Lieutenant James King, also on Cook's voyage, estimated the island's population to be 200,000 based on the amount of cultivated land and comparing it to Tahiti (Cook 1967a). Stannard's (1989) estimate of 800,000 at the time of contact is perhaps the highest; however, most historians dismiss his figure as being much too high (Nordyke 1989a, Schmitt 1989, Dye and Komori 1992). A detailed discussion of the change in population can be found in section 3.4.

The Waimea landscape at the time of European contact was much as it had been during the late expansion period: houses, crops, and terraced fields meshed into a Hawaiian cultural landscape. Although the native population as a whole was on a downward trend, by this time the political structure of Hawai'i had stabilized and land tenure was well defined (Kamakau 1992).

Hawaii's landscape went through many transformations after European contact due to European introductions that changed Hawaiian culture. The most significant effects upon the Waimea landscape following European contact were due to the introductions of diseases and cattle.

## **4.2 European Contact**

### **4.2.1 The Earliest European Arrivals**

Captain James Cook's arrival in 1778 was the starting point of many changes in the Hawaiian way of life. It began an influx of introduced species, diseases, and ideas, setting the foundation for many changes in Hawai'i.

The Europeans, like the first Polynesian settlers to Hawai'i, brought with them their transported landscapes. They introduced many things to the islands including plants and seeds, animals, material goods, and commercial trading with foreigners. Early European explorers to Hawai'i knew the islands would be a provisioning stop for many ships and they introduced plants and animals in the hopes of establishing supplies for future seamen (Menziess 1920). Among the fruits and vegetables introduced by the explorers were watermelons, musk melons, cabbage, and oranges (ibid.).

Disease was a significant introduction made by Cook and his men to the islands. *The Hawaiians had little immunity to the various diseases that the men carried and this had a devastating effect upon the indigenous people.* Diseases spread throughout the islands and the native population declined rapidly. This is discussed in more detail later in this chapter.

Another introduction by Cook that had significant consequences was firearms. Hawaiians were frightened by gunfire when they first heard it, but by 1792 firearms and powder were the natives' most sought after items (ibid.). The addition of muskets to the Hawaiians' weaponry changed warfare in the islands. Firearms also contributed to the Hawaiians distrust of foreigners since natives acquired defective firearms through bartering. These defects were not visible and the Hawaiians discovered the problems only afterwards, when they were sometimes maimed or killed by the faulty weapons (Vancouver 1967c).

Another British explorer who played a large role in shaping post-contact Hawai'i was George Vancouver, who introduced cattle to Hawai'i. He had visited Hawai'i with Cook's expedition in 1778-1779 and returned with his own expeditions in 1792, 1793, and 1794. Vancouver's mission on his expeditions was to acquire more knowledge about the Pacific Northwest and the Hawaiian Islands (Vancouver 1967a). Vancouver found remarkable changes in Hawai'i from the time of Cook's expeditions. Most noticeably, he observed a decrease in the population of the country and in the number of chiefs (Kamakau 1992).

#### 4.2.2 The First European Observations of Waimea

Archibald Menzies was in charge of collecting natural history specimens on Vancouver's expeditions aboard the H.M.S. Discovery. Menzies kept a journal that detailed his experiences and observations throughout his journey, including his visit to Waimea.

On February 14, 1793, Menzies walked from Kawaihae to Waimea, accompanied by two native guides. He described the herbs and grasses of the lowlands as being "mostly in a shrivelled state" and he found few plants and flowers, but he observed "several fine plantations" as he got higher up in elevation (Menzies 1920: 56). His guides told him that the Waimea area was very fertile and was numerously inhabited. Menzies corroborated this by writing,

Indeed, I could readily believe the truth of these assertions, from the number of people I met loaded with the produce of their plantations and bringing it down to the water side to market, for the consumption was now great, not only by the ship, but by the concourse of people which curiosity brought into the vicinity of the bay (ibid.: 56).



### **4.3 Post Contact Landscape Changes**

#### **4.3.1 The Sandalwood Trade**

Sandalwood was collected in the Hawaiian Islands as early as 1792. In March of 1792, Vancouver and the crew of the Discovery met three seamen who were left on Kaua'i by their American captain to collect sandalwood (Vancouver 1967a). Around this time, the demand for sandalwood in China was greater than the amount that could be supplied from India and the West Indies (Merlin and VanRavenswaay 1990). Because of this, the sandalwood trade in Hawai'i developed rapidly.

American entrepreneurs in the sandalwood trade dealt with King Kamehameha and other chiefs during the early years of the industry, but eventually Kamehameha gave himself an exclusive monopoly (ibid.). Kamehameha traded sandalwood for material goods, for which he paid inflated prices. Kamehameha's commercial inexperience resulted in a great debt owed by the ruler, and the commoners were the ones who suffered the consequences. Men, women, and children were required to harvest sandalwood and carry it to the landings (Kepler 1984).

In Waimea, the residents would take the harvested sandalwood down to Kawaihae. The Reverend William Ellis was witness to this in the 1820s. He wrote:

Before daylight on the 22d, we were roused by vast multitudes of people passing through the district from Waimea with sandalwood, which had been cut in the adjacent mountains for Karaimoku, by the people of Waimea, and which the people of Kohala, as far as the north point, had been ordered to bring down to his storehouse on the beach, for the purpose of its being shipped to Oahu. There were between two and three thousand men, carrying each from one to six pieces of sandalwood, according to their size and weight (1969: 397).

The amount of sandalwood harvested required large amounts of land to be exploited. During the early years of the trade, the easily accessible sandalwood was harvested. But by 1824 these areas were gone, there was much less harvesting, and the trade slowed (Merlin and VanRavenswaay 1990). The reduced supply in China resulted in prices going up and encouraged American merchants to put pressure on the Hawaiian chiefs to pay their outstanding sandalwood debts (ibid.). Warships were sent to Hawai'i and in December of 1826, Kamehameha III, who had recently inherited the throne, was forced to acknowledge the Hawaiian Kingdom's debt of half a million dollars (ibid.).

To pay off the debt, a sandalwood tax was written into law. Every man was required to deliver half a picul of sandalwood or four Spanish dollars to the governor of his district. Every woman was required to deliver a 3.7 m x 1.8 m (12 ft x 6 ft) handmade mat or an equivalent amount of tapa cloth (ibid.). Since the easily accessible stands of sandalwood were gone, cutters had to go deeper and deeper into the forests to pay their taxes.

#### 4.3.1.1 The Sandalwood Trade's Effects on Waimea's Landscape

In Waimea, sandalwood harvesters most likely cut down the trees that were in the vicinity of their residences and fields prior to the tax law, since sandalwood grew in greater concentrations in dry forest regions. The resurgence in the sandalwood trade may have expanded Waimea's cultural landscape higher up into the mountain slopes where sandalwood could still be found but in lesser concentrations. At the same time that the cultural landscape was expanding, the areas that were cultivated began to deteriorate. As people spent more time collecting wood, less care was put into their agricultural fields. Some plots were likely neglected. This

indifference marked the beginning of the abandoning of Waimea's cultivated fields.

Periods of expansion into the mountains of Waimea likely continued until 1839 as the sandalwood market fluctuated. By 1839, sandalwood was confined to the most inaccessible areas and King Kamehameha III placed a kapu on the remaining sandalwood that essentially ended the trade in the Hawaiian Islands (Merlin and VanRavenswaay 1990).

The sandalwood trade not only eliminated the sandalwood in Waimea but also primed the area for future ecological impacts. Removal of the sandalwood changed the natural balance of the forest plants. This may have allowed alien species to establish themselves and cleared openings for ungulates to graze the areas (ibid.).

Intentionally set fires also may have impacted Waimea's landscape during the sandalwood era. Large areas of grassland and forests were burned on O'ahu to make sandalwood easier to find (ibid.). This method may have been used in other areas, including Waimea.

#### 4.3.1.2      *The Sandalwood Trade's Effects on Waimea's People*

In *The American Frontier in Hawai'i*, Bradley states:

The sandalwood trade was a picturesque and passing incident. Economically it contributed little to the Hawaiian chiefs or to their subjects except the destruction of the sandalwood forests; socially it was nearly as barren of result (1942: 119).

Bradley is correct in his assessment of the forests, but in economic terms the sandalwood trade resulted in enormous debts owed by the Hawaiian chiefs. These debts consequently had a devastating effect on the people of Waimea. Sometimes the harvesters were gone for weeks at a time, collecting

sandalwood in the mountains, and many of them died of exposure (Merlin and VanRavenswaay 1990). Kepler details the harvesters' plight:

It has been said that every piece of sandalwood cut during those boom years was stained with blood. Some villagers died in harness, crumbling motionless on the trails; others, less fortunate, turned into living skeletons, weak from the corroding effects of exhaustion, disease, malnutrition, and exposure to the chilly mountain winds without adequate clothing (1984: 125-26).

The harvesters were not the only people who suffered because of the sandalwood trade. While the people were out collecting the wood in the mountains, crops were neglected, resulting in food shortages that affected all Hawaiians. Kamakau described the situation as such:

This rush of labor to the mountains brought about a scarcity of cultivated food throughout the whole group. The people were forced to eat herbs and tree ferns, hence the famine called Hilaulele, Haha-pilau, Laulele, Pualele, 'Ama'u, or Hapu'u, from the wild plants resorted to (1992: 204).

According to Kepler (1984), at least two major famines occurred in the islands during the sandalwood era.

The combination of shortages of food, European-introduced diseases, and the strenuous labor involved in the sandalwood trade left the natives in poor physical condition. Many of them died and the native population never recovered from this crisis.

#### 4.3.2 The Early Cattle Trade in Waimea

Vancouver's most significant contribution to landscape change in Hawai'i was the introduction of livestock to the islands. In March of 1792 Vancouver gave chief Ke'eaumoku a pregnant goat, among other things, and when he returned to the Kawaihae area the following year, found that the

goat had produced twins (Menzies 1920). Vancouver, pleased with the way Ke'eaumoku had taken care of the goats, gave the chief a ram, two ewes, and a ewe lamb in February of 1793 when he returned to the islands (Vancouver 1967a). He also sent a bull and a cow ashore near Kealakekua on February 18, 1793, and two days later presented Kamehameha with four cows, two ewes, and a ram (Menzies 1920). In January of 1794 Vancouver landed a bull, two cows, two bull calves, five rams, and five ewes (Vancouver 1967c).

Vancouver persuaded Kamehameha to declare a kapu on the animals (ibid.: 53), which were taken to Waimea's "great tract of luxuriant, natural pasture" (ibid: 64). Vancouver felt Waimea would be the best place for the animals, where they could "roam unrestrained, to 'increase and multiply' far from the sight of strangers, and consequently less likely to tempt the inhabitants to violate the sacred promise they had made" (ibid: 64).

Due to Kamehameha's kapu on cattle, the number of head increased rapidly and the cattle expanded its range throughout Waimea and beyond. By 1820, there was an estimated 1600 cattle in Waimea (Barrère 1983) and by 1823 John Parker was authorized by the government to hunt wild cattle (Brundage 1971). He and other men, mostly foreigners, were the first to earn a living by hunting the wild cattle (Wellmon 1969). Hunting was done on foot as horses were not yet well established on the island. The Hawaiian government paid these men to shoot and butcher the cattle, salt the meat, and have it delivered to the sea for the native navy (ibid.). Kawaihae was the main trading center for north Hawai'i and foreign ships used its port. During the 1820s, beef and hides were supplied to sandalwood traders, and as the number of sandalwood merchants declined, whalers began to take their

place. Thus the demand for salted beef remained steady and eventually increased as more and more whaling ships arrived (ibid.).

By 1825, cattle hunting was an established but rudimentary trade in Waimea. None of the hunters had been able to domesticate any of the cattle since the animals were extremely aggressive. Yet the demand for beef continued to grow and the cattlemen could not fill the need. To supply the market and to start domesticating the cattle, horses were brought into Hawai'i in 1828 (ibid.). Although American Richard J. Cleveland had landed a horse at Kawaihae in 1803 (ibid.), horses were rare in Hawai'i and most were owned by chiefs until the late 1820s (Kirch 1996).

During the 1820s Kamehameha III incurred more debts by purchasing luxury items. Pressure once again was placed upon the Hawaiian Kingdom to repay these debts and another warship was sent to Honolulu in 1828 (Merlin and VanRavenswaay 1990). Kamehameha III recognized that there was money to be made from beef, tallow, and hides, so he sent for Spanish American *vaqueros* to come to the islands to teach Hawaiians how to handle horses and cattle (Brennan 1974). The Hawaiians learned the riding and roping skills of the *vaqueros* quickly and began calling themselves "paniolas," a word derived from the "Espanols," who were their teachers (ibid.). With these new skills and with the help of the Spanish *vaqueros*, the Hawaiians began to domesticate the wild herds.

By 1846 the cattle population on the island of Hawai'i had grown to an estimated 35,000 (ibid.). Although 10,000 were domesticated by then, 25,000 were still of the wild variety (ibid.). Waimea, by this time, had become an important cattle-raising area.

#### 4.3.2.1      *The Effects of Cattle on the Waimea Landscape*

During the time when Kamehameha's kapu on cattle was in effect, the cattle were allowed to roam freely and eventually found their way into the natives' gardens. Because the people were not allowed to kill the animals, they had to find ways to protect their property. The natives built stone walls in some places to deter the cattle (Brennan 1974), but this tactic was not very successful. Cowan-Smith and Stone describe the impact of the wild cattle:

Vast herds of these long-horned beasts roamed freely throughout the island and quickly became a nuisance. The cattle, called *pipi* by the Hawaiians, from the English word *beef*, were soon destroying crops of taro, banana, and papaya and often attacking the natives as well. The Hawaiians tried building walls around their huts and around their crops but met with little success. The rampaging cattle went either through or over the barricades, trampling everything in their path. The missionary Lorenzo Lyons, in charge of the mission in Waimea, described that whole area as "nothing but a cattle pen", and went on to explain the impact of the cattle on the land as "the greatest evil from which we are now suffering" (1988: 7).

In 1847, two-thirds of Waimea was converted into government pastureland, forcing human occupants to relocate (Doyle 1945). Cattle, sheep, and goats roamed the fields, denuding much of the land of groundcover and causing Waimea to become a dust bowl. Lyons described a night in Waimea as "a perfect cloud of dust" and noted that the area had extremely fine soil which he thought seemed to be resistant to getting wet (ibid: 49).

According to Clark (1986), the conversion to government pasture occurred because 1) re-domesticating the cattle into a herding system allowed for better control of herd sizes, 2) the cost of having a controlled herd was much less than the cost of hunting feral cattle, and 3) influential foreigners were familiar with the herding style.

In areas of Waimea where koa trees thrived, the branches of the trees were cut and crisscrossed into crude fences to keep the cattle out (Brennan 1974). Still, by the mid-19<sup>th</sup> century, the cattle had destroyed whatever forests remained in Waimea and the region had been converted into open plains (Cuddihy and Stone 1990). Much of this open area was acquired and leased in the 1830s by John Parker, founder of Parker Ranch, Hawaii's largest ranch. Parker stocked his lands with captured and tamed wild cattle, and pens and corrals were built (Wellmon 1969).

As the cattle began to dominate the landscape, the cultivated grounds were further neglected. The cattle industry required beef, hides, and horns to be carried down to Kawaihae. The natives transported these items in exchange for food. Thus their time was spent carrying goods to shore instead of tending to their gardens (Doyle 1945).

Governor Kuakini, who established a residence in Waimea, also had corrals built and, after having a difficult time traversing the rocky trail between Waimea and Kawaihae, sentenced forty convicts to begin building a carriage road between the two localities in 1830 (Wellmon 1969). This was the first road in Waimea. Also entering the landscape during this time were the two-wheeled Mexican ox carts that transported the meat and other goods between Waimea and Kawaihae (ibid.).

As the landscape of Waimea changed due to the cattle, grasses became the dominant vegetation and the original vegetation types were unable to reestablish themselves. The continued grazing combined with the intentional and accidental introduction of grass and herb species are the most significant contributors to Waimea's pastured landscape (McEldowney 1983). During this transformation, as in earlier vegetation changes, endemic



and indigenous species were reduced and some were perhaps lost due to their limited competitive and defensive abilities.

In February of 1856, the *Sandwich Islands Monthly Magazine* published an article titled “The Influence of the Cattle on the Climate of Waimea and Kawaihae, Hawai’i”. The author (Anon. 1856) refers to the loss of forests due to the cattle but also claims changes in weather. He writes:

There is usually a much smaller difference now, in the temperature and in the moisture of the conflicting currents of air which are concerned in the formation of these wind-storms, than there was before the cattle destroyed the woods; and they are now less frequent and violent accordingly (1856: 47).

The author refers to how this may seem absurd, “yet a little examination shews it to be in a high degree probable not only that there is a connection, but that it is close and easily traceable” (1856: 47). Although the author gives no records of wind speeds or temperatures, he does give a fairly detailed rationale for his observations. Lorenzo Lyons, an early missionary, also commented on the change in the mumuku (strong) winds. He felt that the loss of forests due to cattle had reduced the strength of the mumuku (Doyle 1945: 49).

#### 4.3.2.2 Waimea’s Transition to a Paniolo Culture

The presence of the Spanish vaqueros influenced much of Waimea’s culture. People on horseback became more common as the paniolos captured and tamed wild horses. The vaqueros taught the Hawaiians how to tan leather, braid lariats, and build saddles (Brennan 1974). Their presence had everything to do with transforming Waimea into a cowboy town. In 1840, Francis Olmsted, a writer visiting Hawai’i on a whaleship, wrote of his visit to Waimea. He described what he saw at a store in the town:

a group of fine looking men, in a peculiar costume, were leaning against the counter of the store. Some of them were Spaniards from California, and they were all attired in the *poncho*, an oblong blanket of various brilliant colors, having a hole in the middle through which the head is thrust. The pantaloons are open from the knee downwards on the outside, with a row of dashing gilt buttons along the outside seam. A pair of boots armed with prodigiously long spurs completed their costume (1969: 230).

As the cattle industry grew, side industries developed in Waimea. In the 1830s, tanning pits were established. Leather that was processed in Waimea supplied the Hawaiian Islands' demands (Brundage 1971). Olmsted (1969) on his visit to Waimea in 1840, referred to a tannery, a saddle maker, a shoemaker, and a carpenter in the area. By the mid-19<sup>th</sup> century, the cattle industry and its associated trades symbolized Waimea. Wellmon (1969: 44) explains Waimea's transformation, saying, "with the introduction of Latin American cattle handling methods, equipment, dress, and cow 'savvy,' Waimea took on the appearance of a Southwestern cattle raising community."

#### 4.3.3 Missionary Influence in Waimea

Although missionaries began arriving in the Hawaiian Islands in the 1820s, an outpost was not established in Waimea until 1832. Lorenzo Lyons, who became known as Makua Laiana, was stationed there along with Dwight Baldwin. Baldwin left Waimea in 1835 due to his failing health, leaving Lyons in charge of the large area of Waimea and the neighboring districts of Kohala and Hāmākua, which altogether contained 15,000 residents (Doyle 1945).

Lyons had a significant influence on the shaping of Waimea during his many years there. Although not a doctor, Lyons tried his best to care for

those who came to him for help. Schools were built where hundreds of children and adults learned to read. Many of the natives became members of the church and gave up drinking and smoking. By 1838 Christianity was ingrained in the lifestyle of the Waimea natives. Nearly 5000 Hawaiians became members of the church in Waimea during the 2 years ending in June 1839 (Bradley 1942). These members were not only residents of Waimea, but also of Kohala and Hāmākua. Considering the small population during that time, this means that approximately half of the population were church members.

The arrival of missionaries in Hawai'i had an effect on the population as well. The missionaries' presence accelerated the process of Europeanization in Hawai'i, which encouraged other white people to settle in the islands. Missionaries had the same effect in New Zealand, where the Europeanization of those islands eventually led to more "pakeha," New Zealand's version of Hawaii's "haole" or "white people," moving there (Crosby 1986).

Lyons kept a journal throughout his stay in Waimea and gives accounts of the hardships endured by the native people. He also documented his own struggles such as the loneliness he experienced upon arriving in Hawai'i and the despair he went through during the illnesses and subsequent deaths of his son and wife. Over time Lyons became very fond of Waimea and its people. His desire to help the natives is evident in his writings and he played a positive role in the lives of many residents of north Hawai'i. Lyons' writings in Doyle's *Makua Laiana* (1945) give excellent insight into the cultural transformation of Waimea from the 1830s to the 1870s. He describes events such as the process of converting the Hawaiians to Christianity, the building of schools and roads, and periods of famine.

#### **4.4 Population Change in Hawai'i and Waimea: 1778 – 1860**

Estimates of the Hawaiian Islands' native population at the time of European contact vary greatly. Most authorities place the figure between 200,000 and 300,000, with extremes ranging from McArthur's estimate of less than 100,000 to Stannard's estimate of at least 800,000 (Stannard 1989).

Lieutenant James King, who accompanied Captain Cook on his "discovery" of the Hawaiian Islands, originally estimated Hawai'i Island's population in 1778 to be 200,000 but later revised it to 150,000 (Cook 1967a). In reaching his first estimate, he believed, "the best Guide will be the Quantity of food produced, & comparing it in that Article with Otaheite [Tahiti], the most populous of the South Sea Islands" (ibid.: 618). King believed that the population of Tahiti was 120,000, and reached his population estimates for Hawai'i by comparing the amount of cultivated land between the two islands. Based on this methodology, King estimated the Hawaiian Island chain to have 500,000 residents. He admitted, however, "It is mere guesswork, founded principally upon the Numbers given to Otaheite, & the comparative size & Cultivation of these Islands with that" (ibid: 620). King's revised numbers of 150,000 for Hawai'i Island and 400,000 for all of Hawai'i (see Table 3.1) were based on an estimated six persons to a house around Kealakekua Bay (Cook 1967a).

Nordyke (1989b), using a base of 250,000 to 300,000 for the Hawaiian Islands, estimated the 1779 Hawai'i Island population to be 120,000. Population estimates from 1778–1860 are summarized in Table 4.1.

**Table 4.1. Population Estimates**

<b>Source*</b>	<b>Year</b>	<b>All Islands</b>	<b>Hawai'i Island</b>	<b>Waimea</b>
King, 1779	1778-79	400,000	150,000	-----
Nordyke, 1977	1778-79	250,000 – 300,000	120,000	-----
Author, 2002	1778			7000
Schmitt, 1971	1800	165,000 – 195,000	-----	-----
Ellis, 1823	1823	130,000 – 150,000	85,000	less than 2000
Missionaries, 1831-32	1831-32	130,313	45,792	1427
Lyons, 1835-36	1835-36	108,579	39,364	1396
Lyons, 1843	1843			1012
Census, 1850	1850	84,165	25,864	
Author, 2002	1850			760
Census, 1853	1853	73,138	24,450	
Census, 1860	1860	69,800	21,481	
Author, 2002	1860			500

\* source and year it was prepared or published

Waimea, at the time of European contact, may have supported about 7000 Hawaiians. This is a crude evaluation based on Cordy's (2000) estimate of the Kohala district's population in 1778. Cordy took the data from the first census and computed the percentage of decline based on an estimated 1778 archipelago-wide population of 300,000. Using 57% as the percentage of decline and the 1831-1832 census data, Cordy estimated that Kohala had a population of 23,503 in 1778. Figuring that maybe 30% of Kohala's people lived in Waimea gives us a value of 7000. This figure does not seem unreasonable since the Kohala district was one of the more populated areas on the island in the late 1700s. In the 1780s, Waimea was a major population area and Kamehameha counted on the residents of Waimea for support. According to Wellmon:

By the time Kamehameha I began his campaign to unite the big island under his leadership in the 1780's, he was able to draw upon the people of the district for support. According to legend, after many bloody victories Kamehameha successfully established his base for the conquest of the other islands on the large population of the Waimea region (1969: 12).

In the 1790s Waimea continued to be a population center. The construction of the massive heiau Pu'ukoholā at nearby Kawaihae, required a great deal of labor, and Kamehameha called in people from all over his kingdom to work on it during the years 1790 and 1791 (Cordy 2000). In 1793, Menzies (1920) described the Kohala area as being destitute of trees or bushes but with many small fields and a vast number of houses. He described the area as by far the most populous part of the island they had seen, and he had already traveled past much of the island, including south Kona and the Hāmākua coast. Kamakau (1992: 57) also states in his writings that "Kohala was known as a thickly-populated land."

Although Waimea and the island of Hawai'i were still well populated in the 1790s, the effect that the Europeans arrival had on the residents of the other islands began to show less than a year after Cook's arrival. Europeans introduced diseases that were unknown to the Hawaiians and for which they had little immunity, despite attempts by the European leaders to prevent the communication of disease. Cook noted in his journal:

As there were some venereal complaints on board both the Ships, in order to prevent its being communicated to these people, I gave orders that no Women, on any account whatever were to be admitted on board the Ships, I also forbid all manner of connection with them, and ordered that none who had the venereal upon them should go out of the Ships. But whether these regulations had the desired effect or no time can only discover (1971: 217).

Cook had good reason to doubt the effectiveness of his orders. He had placed the same restrictions upon his men at the Society Islands, but found out later that the islanders were infected nonetheless. He noted:

I am afraid this will always be the case where it is necessary to have a number of people on shore; the opportunities and inducements to an intercourse between the sex, are there too many to be guarded against. It is also a doubt with me that the most skilfull of the Faculty can tell whether every man who has had the venereal is so far cured as not to communicate it further, I think I could mention some instances to the contrary. It is likewise well known that amongst a number of men, there will be found some who will endeavour to conceal this disorder, and there are some again who care not to whom they communicate it (1971: 217).

Cook's portentous concerns proved to be correct. His sailors infected the Hawaiian women on Kaua'i with the venereal diseases syphilis and gonorrhea (Langlas 1998). Upon their return to the islands in November, 1778, after ten months at sea, James King, an officer on Cook's voyage to Hawai'i, wrote:

Notwithstanding all the precautions that Capt. Cook took when at Atoui [Kaua'i] yet we know that a pretty free intercourse took place, & it is certain that none got any new infection from them; but it is by no means so clear that we did not leave it; & [with] a people so ignorant of its contagious effects, & amongst whom a very free intercourse amongst the sexes is not criminal, its rapidity may be astonishing, & that in a much less time than 10 months (Cook 1967a: 498).

Although these venereal diseases did not kill the natives outright, they caused sterility, thus affecting population growth. As the Hawaiians were unaware of the consequences of such diseases, they no doubt spread the diseases among themselves. Evidence for this comes from King's notes in December of 1778. He wrote, "We were truly sorry to find that three of our guests (we had now 10 or 12 on board) had the venereal disease" (Cook 1967a: 500).

Cook's voyages to Hawai'i also brought tuberculosis, upper respiratory infections, and perhaps other diseases. Cook had left England while it was in the midst of a smallpox epidemic and deaths due to tuberculosis were at an all time high (Stannard 1989).

The diseases that were introduced by early Europeans took their toll on the Hawaiian population and the decrease was noticed as early as 1792. Vancouver, who had visited the islands with Cook and returned on his own voyages in the 1790s, commented on the decreased population many times in his journals (1967a; 1967c). One of his earliest entries regarding this referred to Kaua'i in March of 1792:

If we may be allowed to decide by comparing the numerous throngs that appeared on the first visits of the Resolution and Discovery, and which were then constantly attendant on all our motions, with the very few we have seen on the present occasion, the mortality must have been very considerable (1967a: 187).



Diseases continued to arrive in the islands as more traders stopped for provisions. In 1804, a catastrophic epidemic known as *ma'i 'ōku'u*, or "squatting sickness," occurred in the islands. This is believed to have been cholera, typhoid fever, or bubonic plague, and killed 15,000 or more Hawaiians (Stannard 1989).

By the early 1800s the introduced foreign diseases had affected a large portion of the native Hawaiian population. While some of the diseases caused deaths, others brought about sterility, reduced fertility, and an overall decrease in the health of the native people.

Introduced diseases decimated other native populations as well. New Zealand, whose native population has similar roots to Hawaii's, suffered the same tragic consequences. The 1840 native population of New Zealand was an estimated 100,000 to 120,000 and by the first census in 1857-58, their numbers were down to 56,000 (Crosby 1986). Venereal diseases took its toll on reproductive processes. In the late 1850s, Francis D. Fenton gathered data on 444 Maori women. Of these, only 221 had living children. Also around the same time, another survey of 230 Maori women showed only 106 of them had living children (*ibid.*). Overall in New Zealand, the native population dropped from an estimated 100,000 to 200,000 in 1769 and 42,113 in 1896 (*ibid.*).

Although the overall Hawaiian population was already in decline by the early 1800s, the population of Waimea during the first part of the 19<sup>th</sup> century was most likely still near its pre-European contact population. The sandalwood trade was growing, and being a source for the wood, Waimea remained a population center. People from nearby coastal areas may have stayed in Waimea for weeks at a time collecting sandalwood. Thus the number of people in the Waimea area may have remained relatively stable;

yet the composition of the population was changing. As people died from diseases, temporary residents, who normally resided in areas without sandalwood, replaced them. Also, there were probably fewer children than in the past due to dropping birth rates.

While the sandalwood trade was going strong in the 1810s and into the 1820s, the people of Hawai'i were weakening. In Waimea, the native population declined steadily during this period. Some people died from the stresses attributed to the sandalwood trade while others died from recently introduced diseases. Fertility was low while infant mortality was high. The overall health of the native people had declined dramatically since pre-European contact times.

In 1823, the Reverend William Ellis (1963: 16) opined:

*The rapid depopulation which has most certainly taken place within the last fifty years, is to be attributed to the frequent and desolating wars which marked the early part of Tamehameha's reign; the ravages of a pestilence brought in the first instance by foreign vessels, which has twice, during the above period, swept through the islands; the awful prevalence of infanticide; and the melancholy increase and destructive consequences of depravity and vice* (1963: 16).

The first part of Ellis' statement is fairly accurate. However, as a missionary whose objective was to introduce Christianity to the natives, Ellis may have been predisposed to proving the Hawaiians' sinful ways and thus embellished on the prevalence of infanticide and depravity. What Ellis considered "depravity and vice" is subjective and thus difficult to prove or disprove. The subject of infanticide by Hawaiians, on the other hand, has been the topic of further research. Stannard claims, "there is not a *single* piece of credible evidence that infanticide existed on a significant scale as a cultural practice in pre-*haole* Hawai'i—and there *is* positive evidence that it did not exist as such" (1989: 63). Stannard (ibid.: 63) cites John Turnbull, a

visitor to the islands during the first decade of the 19<sup>th</sup> century, as noting the absence in Hawai'i of "the horrid practice of infant murder."

Another instance of an early visitor commenting on the absence of infanticide occurs in David Samwell's journal. Samwell, the surgeon aboard the *Discovery* during Cook's voyages, commented on the lack of infanticide in Hawai'i. Regarding the Hawaiian natives, he wrote in his journal:

Their general behaviour is confined much more within the bounds of Decency than that of the Otaheiteans, whose horrid Custom of destroying their newborn infants these women are also totally unacquainted with, such a great number of fine lively Children that used to play about us every time we went on shore we never saw at any other place during this Voyage (Cook 1967b: 1182).

To disprove the prevalence of infanticide, Stannard (1989) also argues that only 4.3% of 1503 skeletal remains of two pre-European contact sites excavated were of infants. According to Stannard (*ibid.*), this percentage results in an infant mortality rate of about one-ninth that of mid-18<sup>th</sup> century England.

The diseases that are mentioned by Ellis (1963) as being contributing factors to the population decline are the primary reasons, according to Nordyke (1989b). She believes the major cause for the steep decline in Hawaii's population during the 50 years following Cook's arrival was a series of epidemics introduced by the people on visiting ships.

By 1823 the population of Hawai'i Island was down to about 85,000 (Schmitt 1968), and the landscape reflected this downward trend (see Table 4.1.). In that year Ellis (1963:16) observed "traces of deserted villages, and numerous enclosures formerly cultivated, but now abandoned, are every where to be met with." He remarked that the island's population had diminished by three-fourths over the last 40 years (*ibid.*). Waimea's

population had declined to less than 2000 individuals by then (Ellis 1969). A description of Waimea during this time is given by Ellis in *Polynesian Researches: Hawai'i*. Mr. Thurston, a member of Ellis' party, walked throughout the Waimea area to address the residents. Regarding the territory covered by Thurston, Ellis wrote:

The soil over which he had travelled was fertile, well watered, and capable of sustaining many thousand inhabitants. In his walks he had numbered two hundred and twenty houses, and the present population is probably between eleven and twelve hundred (ibid.: 399).

In 1831 missionaries conducted the first census in Hawai'i (see Table 4.1.). The population of the island of Hawai'i for the years 1831–1832 was 45,700. South Kohala, whose main population areas were Kawaihae, Puakō, and Waimea, had a population of 1427 (Schmitt 1977). By the 1830s Waimea's population was perhaps only one-fifth of what it had been 50 years prior.

The composition of Waimea's residents had changed as well. There were a number of foreigners who lived in Waimea by this time, drawn there by the cattle industry. That same cattle industry drove many native people from Waimea as they were unable to keep the wild cattle from encroaching upon their fields (Clark 1983a). The decreased population left fewer individuals to build and maintain stone walls as cattle barriers. The result was the abandoning of many agricultural fields by residents who chose to move away to places where cattle were less of a nuisance.

Lorenzo Lyons noticed Waimea's decreasing population and remarked on it in 1833. He wrote, "Deaths are more numerous than births. Hence the population is decreasing" (Doyle 1945: 74).

In 1835, Lyons took a census of the population in his missionary district and found 11,586 people living in Waimea, Kohala, and Hāmākua, of which 1396 were in Waimea (Doyle 1945). He acknowledged, however, that his numbers might have been inaccurate. He wrote, "Many think I am numbering them for the purpose of taxation, and conceal a part of their number" (ibid.: 83). A few years later, in 1839, he completed another survey and again mentioned the inaccuracy of his 1835 census. He wrote, "I have at length obtained a complete census that shows some hundreds more than were taken some years ago. It is not that population has increased—but that census was incorrect" (ibid.: 107). By that time he had spent several years in Waimea and was well acquainted with the area and its people. Unfortunately, Lyons did not state how many residents he actually counted in 1839. Table 4.1 summarizes Lyons' and the missionaries' tallies for the period 1831-1843.

The missionary censuses do not show a significant decline in Waimea's population in the 1830s. The missionaries admitted that their numbers may have been wrong, reporting that "there is some reason to believe that the population in 1832 was somewhat over-rated, and we think it may be a little under-rated by the present [1835–1836] enumeration" (Schmitt 1968: 16-17). Three possible reasons for this are discussed here. One is that the Hawaiians understated their numbers for fear of higher taxes (Doyle 1945). The 1831-1832 and 1835–1836 censuses would be influenced more than the 1839 census for this reason because by 1839 the natives were comfortable with Lyons and trusted him. Thus they would have no reason to understate their family size by that time.

Another possible reason for inaccuracies in the missionaries' censuses is that the natives still were required to travel for weeks at a time in

order to pay their taxes. Their mobility could have affected one or all of the missionaries' censuses. Lyons describes this practice in his journal. In April of 1833, many of Waimea's residents were gone for 2 or 3 weeks in the mountains getting koa logs for canoes as ordered by the governor. Lyons wrote:

The governor must be obeyed whatever else must suffer. A thousand people will probably be employed in drawing five large and heavy canoes from Mauna Kea, to somewhere near the shore, a great work. *The man who refuses to engage in it is to have his house burned down* (Doyle 1945: 73).

In 1835 Lyons described another instance where families are absent:

Parents and children are taxed for articles not obtained in the neighborhood. They must go in search of them, at a distance from home. That means an absence of several weeks, and children are drawn from school. Men and women are ordered by the chief to build a stone wall ten or twenty miles distant from their residence. Children must leave school to accompany their parents (Doyle 1945: 88).

Thus, if families were away in obligation of their tax requirements, they may not have been counted. Likewise, if people from other areas were in Waimea for tax purposes, the population count may have been too high.

Francis Olmsted, who visited the islands on a whaling ship in 1840, noted another reason for possible inaccuracies in the missionaries' censuses. He drew up a population table of the various islands for the years 1832 and 1836 and commented:

What alarming facts does this table declare! That the annual decrease of the population is, upon an average over *six thousand*. This estimate however, is much too high, I have been told, as it is formed by a comparison of the births and deaths that come to the knowledge of the missionaries, at their respective stations. A birth is regarded by the natives as a matter of so little consequence, that it is not made known to the missionaries, whereas a death is an affair of public notoriety (1969: 262).

The depopulation of the islands was also a subject on which Olmsted reflected. He wrote:

Still the depopulation of these islands is steadily moving forwards, and unless it is speedily arrested, the total extinction of the nation is inevitable, and these humble islanders must shrink away before the irresistible march of foreign enterprize, and like the aborigines of our own country, become exterminated (1969: 262-63).

On November 9, 1840, Kamehameha III approved the first census law of the Kingdom of Hawai'i. Censuses were attempted in 1847, 1848, and 1849, but all were incomplete and/or inaccurate (Schmitt 1968). In 1850, the first fully acceptable census of the Hawaiian Islands was completed (see Table 4.1). It found the total island population to be 84,165, of which 25,864 were residents of Hawai'i Island. The 1853 census showed the all-island and Hawai'i Island populations as 73,138 and 24,450, respectively. The districts of Hāmākua and South Kohala had a combined total of 3874. By 1860 the all-island total was down to 69,800, with 21,481 residents on the island of Hawai'i, of which 1321 lived in South Kohala (Schmitt 1968).

Waimea's population in 1843 was down to 1012. Lyons, who acquired this count and had a total of 5576 in his mission's district, stated that his district had decreased in population by 400 in only 2 years (Doyle 1945). Around this time many of Waimea's residents began to move away in order to avoid the wandering cattle. In 1845 Lyons stated that the "population of Waimea [is] rapidly diminishing by death and removal" (ibid: 140).

Waipi'o Valley, located on the opposite side of the Kohala Mountains from Waimea, had an estimated population of 1200 to 1500 Hawaiians in 1847. A measles epidemic in the islands occurred around this time, resulting in an 1848 death rate of 98 per 1000 persons and more than 10,000 deaths throughout the islands (Nordyke 1989b). In 1850 an influenza epidemic

occurred which had a devastating impact on the residents of Waipi'o Valley (McGregor 1995). By 1853 the Reverend Bates estimated that only 260 Hawaiians remained in the area (ibid.).

The same influenza epidemic hit almost every individual in Waimea, but was fatal in only a few cases (Doyle 1945). Due to this epidemic, the Waimea area experienced food shortages since the residents depended largely upon Waipi'o for food (McGregor 1995). Lyons remarked at this time that there had been 241 deaths and only 61 births in his field over the past year (Doyle 1945).

A smallpox epidemic in Hawai'i occurred in 1853, killing about 15,000 people before a government vaccination program was established (Nordyke 1989b). Lyons acquired vaccination supplies in Kohala and vaccinated many of Waimea's residents (Doyle 1945). It was fortunate that the government was able to administer smallpox vaccinations, otherwise the death toll would have been much worse, as it had been in Australia when smallpox affected the aboriginal population soon after the first European settlers arrived in 1788. It is estimated that one-third of the Australian aborigines died of the first wave of smallpox (Crosby 1986).

The population of Waimea in 1860 was probably around 500. This estimate is based on Lyons population counts of 1836 and 1843, and his estimate in 1867 of 400 (Doyle 1945), and calculating the population decline at approximately 4% per year. Assuming this rate throughout the years of 1836 through 1867 gives an estimated population of 760 in 1850 and 500 in 1860 (see Table 4.1). Four percent yearly does not sound significant, but it results in a decrease of one-fourth of Waimea's population every 25 years.

In less than 100 years, from the time when Europeans first made landfall in the islands up to 1860, Waimea's population decreased from a



possible 7000 residents to about 500. During this time the population shifted from being dispersed throughout a wide area to being concentrated in the upper elevations (Clark 1983a). Waimea was transformed from an agricultural society to a commercial one, and ranching eventually became the dominant trade. Native residents died from introduced diseases and many others moved away as the wild cattle encroached on their property and way of life. Only those who chose to adapt to “paniolo country” remained in Waimea.

## **CHAPTER 5**

### **SUMMARY AND CONCLUSIONS**

#### **5.1 Introduction**

Waimea is an anomaly among Hawaiian places because although it has a fairly large population today, the landscape still shows evidence of an ancient culture. Most populated places in Hawai'i today do not reveal many signs of its past, and those that are visible are not as expansive as Waimea's terraced hillsides unless they are part of a government preserve or historical park.

The remnants of agricultural terraces on Waimea's hillsides indicate that there was once a large population cultivating the area. I have shown that Waimea attracted a large population for several reasons over the course of its settlement until the early 1800s. The cattle that roam the Waimea plains represent the cowboy culture that has existed in Waimea since the 1820s. The cattle now graze upon the grass that covers the rock walls and terraces abandoned by residents who yielded to the wild cattle herds of long ago. I have shown why the residents deserted the terraces and how Waimea was transformed into "paniolo" country. I have also compiled population estimations for Waimea from the time of European contact until 1860. These figures show how quickly the population decreased in less than a hundred years. Ultimately, in post contact times, Waimea's landscape changed as quickly as its population dwindled.

#### **5.2 Summary of Landscape Changes in Waimea: 1778-1860**

The landscape of Waimea changed dramatically after the arrival of Europeans. The discovery of Hawaiian sandalwood by foreigners prompted

vast areas of Waimea's forests to be altered. The introduction of cattle to the islands resulted in the removal of additional vegetation in Waimea as the region was ideal for the growing herds. Native flora and fauna, unable to compete with the invasion of cattle, disappeared from the area. Many native Hawaiians also were unable to co-exist with the cattle that roamed freely and some felt compelled to move out of Waimea. Diseases that ravaged the islands left residents weak and unable to care for the land. The resulting landscape in Waimea was one dominated by introduced animals with residents having little control over what they had previously managed so successfully.

### **5.3 Ecological Imperialism?**

As stated in Chapter 1, ecological imperialism can be described as the one-way exchange of European people, weeds, animals, and infectious diseases (Crosby 1986). Based on this definition, Waimea's transformation from 1778 to 1860 can be attributed to some aspects of ecological imperialism but not all of them. It's true that starting in 1778, there was an influx of foreign people, animals, and diseases entering the islands. Weeds, in the form of many introduced plants and grasses, did eventually play a large role in Waimea's landscape, but not until the 1900s when Alfred Carter began importing many seeds in order to find appropriate ground cover and forage material for the cattle which had turned Waimea into a dustbowl (Brundage 1971). In addition, the exchange was not wholly "one-way." Hawaiian flora and fauna were collected by early explorers and taken back to Europe for scientific study (Menzies 1920). Members of Hawaiian royalty, such as Boki and Liholiho, traveled to London during the early 1800s (Kame'eleihiwa 1992). Other native Hawaiians relocated to California in the

mid-1800s to try their fortunes in the gold industry (Schmitt and Nordyke 2001).

In "Empires and Ecologies" David Lowenthal (1997) interprets the European imperial ambitions and their impacts upon new settlements. Lowenthal (ibid.: 233) claims these settlers' mission "was to subdue and civilize the wilderness, along with its indigenous inhabitants." In Hawai'i, the early 19<sup>th</sup> century missionaries' goal was undoubtedly to civilize Hawaii's indigenous people. After the first Calvinist missionaries arrived in 1820, Hawaiian language and culture declined rapidly as the new wave of settlers succeeded in converting Hawaiians to Christianity (Silva 1997).

Waimea, and Hawai'i in general, may have experienced ecological imperialism from 1778 to 1860 or so, but the same processes occurred in Hawai'i both before and after that period. Prior to 1778, the Hawaiian Islands experienced drastic changes in the landscape due to Polynesian settlement. These early settlers introduced animals and plants that "invaded" the natural landscape. Polynesian settlement may not be considered "imperialism," but the effects upon the land were the same.

On the opposite end of the timeline, humans, plants, animals, and diseases continued to enter Hawai'i after 1860 and this process continues today. Although ecological imperialism seems to be a good model for Hawaii's changes, in reality many of Hawaii's influences since 1860 have not been European. The end result may be the same in that Hawai'i, like other Lands of the Demographic Takeover, exemplifies areas where the natives have "interbred with and even absorbed the invaders" (Crosby 1988.:104). However, in Hawai'i, the invaders have come from many different places. According to *The State of Hawai'i Data Book 2000*, the number of residents who indicated "native Hawaiian" as their only race was 80,137 or less than

7% of the total population (Ifuku 2001). This figure is probably inflated, as it is unlikely that there are that many residents of pure Hawaiian descent. I believe a number of residents who are part-Hawaiian indicated Hawaiian to be their only race because it was easier to do this than to indicate more than one race. The percentage of residents who claimed to be at least part-Hawaiian was 20% (ibid.).

Upon review, ecological imperialism implies a purposeful intent to change an area by Europeans and their descendants. The term suggests that foreign introductions were "bad" because they altered what was natural. Yet these introductions have been occurring since the Polynesians' arrival. It may be that the period of European introductions was just one phase of many for the evolution of Hawaii's landscape.

### **5.3 Future Research in Waimea**

There will no doubt be additional studies conducted in Waimea in the future. As the town continues to develop and expand outward, artifacts and burial sites will be uncovered and hopefully analyzed. As dating techniques improve, the methods may be used to minimize the margin of error in dating Hawaiian sites. This would enable researchers to construct a more accurate timeline for the colonization of Hawaiian Islands and the expansion of its people throughout the island chain. The few sites in the Waimea area that have been dated to 800 A.D. are generally disregarded now, but further research with improved dating techniques may corroborate these dates.

In conducting this research, I have come to believe that many areas on the leeward side of the island of Hawai'i were settled during the developmental period instead of the later expansion period. In his inland expansion hypothesis, Hommon (1986) proposes that inland expansion was

initiated about 1400 A.D. due to a growing population's need for food. I don't agree that population pressure was the cause of leeward settlement, but rather that it only took some exploration by the early Hawaiians to realize West Hawaii's potential.

Clark (1986) also sees problems with Hommon's inland expansion hypothesis as it applies to Hawai'i Island. Clark points out that the samples from the Kohala area used by Hommon did not extend above the 385 m contour. Yet that field system extends for another 200 m, the upper regions of which have productive soils and annual rainfall of about 1500 mm.

Regarding the Waimea-Kawaihae area, Clark points out:

In general, however, there is no evidence of a significant chronological break between coastal and inland settlement remains. That is, the data do not indicate an early period of coastal settlement followed by later expansion into the uplands. If anything, the inland dates are slightly earlier, but contemporaneous activity in both zones is a more realistic interpretation (1986: 604-5).

The very settlement of Hawai'i shows that the native population possessed an adventurous spirit that, I believe, would have led them to settle leeward areas with an ample water supply soon after these areas were discovered. Finding such areas was possible on Hawai'i Island due to its varied geography. Though it may be true that, in general, leeward and marginal areas were settled after windward areas, I don't believe that Hawai'i Island fits this general pattern of the island chain. Therefore, I suggest that the settlement pattern on Hawai'i Island must be categorized on its own, apart from the other Hawaiian Islands, because its unique geography results in a unique settlement pattern. As Clark points out:

For some regions the timing of the inland expansion hypothesis may be appropriate but it does not hold up for the entire archipelago. Variation within the islands was probably

considerable. Attempts to treat the entire archipelago as falling into a single pattern are almost certainly over-generalizing (1986: 612).

The expansion of the agricultural region in Waimea was a response to population growth. I believe growth on the west side of the island initiated the need for Waimea to expand. The Waimea area, although inland and being somewhat leeward, has a supply of fresh water. The leeward side of Hawai'i Island also has many brackish water ponds that the Hawaiians had grown accustomed to drinking (Vancouver 1967a). The Hawaiian chiefs had many favorite places on the Kona and Kohala coasts of Hawai'i Island such as Kiholo, Luahinewai, and Kaloko. As the chiefs spent more time on the west side where the weather was more pleasant, there was a need for people to move from the windward side to the leeward side, in order to provide their services to the chiefs. Thus, I suggest that the impetus for Waimea's agricultural expansion was not an overcrowded windward side, but rather a growing leeward population due to a major shift in the population.

I expect that as advancements are made in dating techniques, and as upland sites are further investigated, a unique settlement pattern will emerge for the island of Hawai'i and the Waimea area.

## BIBLIOGRAPHY

- Abbott, Isabella A. 1992. *Lā'au Hawai'i: Traditional Hawaiian Uses of Plants*. Bishop Museum Press, Honolulu.
- Anonymous. 1856. The Influence of the Cattle on the Climate of Waimea and Kawaihae, Hawai'i. *Sandwich Islands Monthly Magazine* 1(2):44-47. A. Fornander, Honolulu.
- Athens, J. Stephen. 1997. "Hawaiian Native Lowland Vegetation in Prehistory." In Patrick V. Kirch and Terry L. Hunt (eds.) *Historical Ecology in the Pacific Islands: Prehistoric Environmental and Landscape Change*. Yale University Press, New Haven and London, pp. 248-270.
- Athens, J. Stephen and Jerome V. Ward. 1993. *Paleoenvironmental Investigations at Hāmākua Marsh, Kailua, O'ahu, Hawai'i*. International Archaeological Research Institute, Honolulu.
- Barrère, Dorothy B. 1983. "Report 2. Notes on the Lands of Waimea and Kawaihae." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 25-38.
- Bonk, William J. 1985. *An Archaeological Survey in Portions of Waikoloa, Pu'ukapu and 'Ouli, District of South Kohala, Hawai'i*. Prepared for Mauna Lani Resorts, Inc., Hilo.
- Bradley, Harold W. 1942. *The American Frontier in Hawai'i: The Pioneers 1789-1843*. Stanford University Press, California.
- Brundage, Lucille A. 1971. *Alfred W. Carter, Hawaii's Dean of Cattlemen and Notes on Hawaiian Livestock*. Lucille A. Brundage, Kamuela.
- Brennan, Joseph. 1974. *The Parker Ranch of Hawai'i: The Saga of a Ranch and a Dynasty*. The John Day Company, New York.
- Burney, David A., et al. 2001. Fossil Evidence for a Diverse Biota from Kaua'i and its Transformation since Human Arrival. *Ecological Monographs* 71(4): 615-641.
- Carr, Gerald D. 1987. Beggar's Ticks and Tarweeds: Masters of Adaptive Radiation. *Trends in Ecology and Evolution* 2(7): 192-195.
- Ching, Francis K.W. 1971. *The Archaeology of South Kohala and North Kona: Surface Survey Kailua-Kawaihae Road Corridor*. State of Hawai'i Department of Land and Natural Resources, Division of State Parks, Outdoor Recreation and Historic Sites, Honolulu.



- Christensen, Carl C. 1983. "Report 17. Analysis of Land Snails." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 449-471.
- Clague, David A. 1998. "Geology." In Sonia P. Juvik and James O. Juvik (eds.) *Atlas of Hawai'i*. University of Hawai'i Press, Honolulu, pp. 37-46.
- Clark, Jeffrey T. 1983a. "Report 3. The Waimea – Kawaihae Region: Historical Background." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 39-57.
- Clark, Jeffrey T. 1983b. "Report 7. Archaeological Investigations in Section 4." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 240-292.
- Clark, Jeffrey T. 1983c. "Report 8. Archaeological Investigations of Agricultural Sites in the Waimea Area." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 293-314.
- Clark, Jeffrey T. 1983d. "Report 9. Radiocarbon Chronology." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 317-324.
- Clark, Jeffrey T. 1986. *Waimea-Kawaihae, A Leeward Hawai'i Settlement System*. University Microfilms International. Ann Arbor, MI.
- Cochrane, Ross. 1977. "The Impact of Man on the Natural Biota." In A. Grant Anderson (ed.) *New Zealand in Maps*. Hodder & Stoughton, London, pp. 14-15.
- Conant, Sheila. 2002. Personal communication. Department of Zoology Chair, University of Hawai'i, Mānoa, Honolulu.
- Cook, James. 1967a. *The Journals of Captain James Cook on his Voyages of Discovery: The Voyage of the Resolution and Discovery 1776 – 1780, Part One*. The Syndics of the Cambridge University Press, Cambridge.

- Cook, James. 1967b. *The Journals of Captain James Cook on his Voyages of Discovery: The Voyage of the Resolution and Discovery 1776 – 1780, Part Two*. The Syndics of the Cambridge University Press, Cambridge.
- Cook, James. 1971. *The Explorations of Captain James Cook in the Pacific as Told by Selections of his Own Journals, 1768 – 1779*. Dover Publications, Inc., New York.
- Cooke, C. Montague. and Yoshio Kondo. 1960. *Revision of Tornatellinidae and Achatinellidae*. B. P. Bishop Museum Bulletin 221. Bernice P. Bishop Museum, Honolulu.
- Cordy, Ross. 1994. *A Regional Synthesis of Hāmākua District, Hawai'i Island*. Historic Preservation Division, Department of Land & Natural Resources, State of Hawai'i.
- Cordy, Ross. 2000. *Exalted Sits the Chief: The Ancient History of Hawai'i Island*. Mutual Publishing, Honolulu.
- Cowan-Smith, Virginia and Bonnie D. Stone. 1988. *Aloha Cowboy*. University of Hawai'i Press, Honolulu.
- Crosby, Alfred W. 1986. *Ecological Imperialism: The Biological Expansion of Europe, 900 - 1900*. Cambridge University Press, Cambridge.
- Crosby, Alfred W. 1988. "Ecological Imperialism: The Overseas Migration of Western Europeans as a Biological Phenomenon." In Donald Worster (ed.) *The Ends of the Earth: Perspectives on Modern Environmental History*. Cambridge University Press, Cambridge, pp. 103-117.
- Cuddihy, Linda W. and Charles P. Stone. 1990. *Alteration of Native Hawaiian Vegetation: Effects of Humans, Their Activities and Introductions*. Cooperative National Park Resources Studies Unit, University of Hawai'i, Mānoa, Honolulu.
- Demeritt, David. 1994. The Nature of metaphors in Cultural Geography and Environmental History. *Progress in Human Geography* 18(2):163-185.
- Doyle, Emma Lyons. 1945. *Makua Laiana: The Story of Lorenzo Lyons*. Honolulu Star-Bulletin, Honolulu.
- Dye, Tom. 1994. Population Trends in Hawai'i Before 1778. *The Hawaiian Journal of History* 28: 1-20.
- Dye, Tom and Eric Komori. 1992. A Pre-Censal Population History of Hawai'i. *New Zealand Journal of Archaeology* 14: 113-128.
- Ellis, William. 1963. *Journal of William Ellis: Narrative of a Tour of Hawai'i, or Owhyhee; with Remarks on the History, Traditions, Manners, Customs and Language of the Inhabitants of the Sandwich Islands*. Advertiser Publishing Company, Ltd., Honolulu.

- Ellis, William. 1969. *Polynesian Researches: Hawai'i*. Charles E. Tuttle Company, Inc., Rutland, VT.
- Gavenda, Robert, Christopher Smith, and Nicole Vollrath. 1998. "Soils." In Sonia P. Juvik and James O. Juvik (eds.) *Atlas of Hawai'i*. University of Hawai'i Press, Honolulu, pp. 92-96.
- Giambelluca, Thomas W. and Thomas A. Schroeder. 1998. "Climate." In Sonia P. Juvik and James O. Juvik (eds.) *Atlas of Hawai'i*. University of Hawai'i Press, Honolulu, pp. 49-59.
- Goudie, Andrew. 1990. *The Human Impact on the Natural Environment*. The MIT Press, Cambridge, MA.
- Hadfield, Michael G. 1986. Extinction in Hawaiian Achatinelline Snails. *Malacologia* 27(1): 67-81.
- Handy, Elizabeth Green. 1972. "Ka'ū, Hawai'i, in Ecological and Historical Perspective." In E. S. Craighill Handy and Mary Kawena Pukui *The Polynesian Family System in Ka'ū, Hawai'i*. Charles E. Tuttle Company, Inc., Rutland, VT, pp. 207-252.
- Henshaw, Henry W. 1912-1914. "Observations on Hawaiian Achatinellidae." In Henry A. Pilsbry and C. Montague Cooke *Achatinellidae*. The Conchological Department, Academy of Natural Sciences of Philadelphia, PA, pp. 91-117.
- Hommon, Robert J. 1980. *Kaho'olawe: Final Report on the Archaeological Survey*. Prepared for the U.S. Navy by Hawai'i marine Research, Inc., Honolulu.
- Hommon, Robert J. 1986. "Social Evolution in Ancient Hawai'i." In Patrick V. Kirch (ed.) *Island Societies: Archaeological Approaches to Evolution and Transformation*. Cambridge University Press, Cambridge, pp. 55-68.
- Ifuku, Glenn K. (ed.). 2001. *The State of Hawai'i Data Book 2000*. State of Hawai'i, Department of Business, Economic Development & Tourism, Honolulu.
- James, Helen F. and Storrs L. Olson. 1991. Descriptions of Thirty-two New Species of Birds from the Hawaiian Islands: part II. Passeriformes. In Ned K. Johnson (ed.) *Ornithological Monographs No. 46*. The American Ornithologists' Union, Washington, D.C., pp. 1-88.
- Juvik, James O. and Lyn Lawrence. 1982. "Late Holocene Vegetation History from Hawaiian Peat Deposits." In C.W. Smith (ed.) *Proceedings, Fourth Conference in Natural Sciences, Hawai'i Volcanoes National Park*. Cooperative National Park Resources Studies Unit, Department of Botany, University of Hawai'i at Mānoa, Honolulu, p. 100.
- Juvik, James O. and Sonia P. Juvik (eds.). 1998. "Statistical Tables." *Atlas of Hawai'i*. University of Hawai'i Press, Honolulu, pp. 303-309.

- Kamakau, Samuel M. 1992. *Ruling Chiefs of Hawai'i*. Kamehameha Schools Press, Honolulu.
- Kame'eleihiwa, Lilikalā. 1992. *Native Lands and Foreign Desires*. Bishop Museum Press, Honolulu.
- Kepler, Angela K. 1984. *Hawaiian Heritage Plants*. Oriental Publishing Company, Honolulu.
- Kirch, Patrick V. 1982. The Impact of the Prehistoric Polynesians on the Hawaiian Ecosystem. *Pacific Science* 36(1): 1-14.
- Kirch, Patrick V. 1983. "Report 21. Discussion and Summary." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 527-532.
- Kirch, Patrick V. 1985. *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. University of Hawai'i Press, Honolulu.
- Kirch, Patrick V. 1990. The Evolution of Sociopolitical Complexity in Prehistoric Hawai'i: An Assessment of the Archaeological Evidence. *Journal of World Prehistory* 4(3): 311-345.
- Kirch, Patrick V. 1996. *Legacy of the Landscape*. University of Hawai'i Press, Honolulu.
- Kirch, Patrick V. 2000. *On the Road of the Winds*. University of California Press, Berkeley.
- Kirch, Patrick V. and Bonnie T. Clause. 1981. *The Mudlane-Waimea-Kawaihae Archaeological Project: Interim Report 1*. Department of Anthropology, Bernice Pauahi Bishop Museum, Honolulu.
- Langlas, Charles M. 1998. "History." In Sonia P. Juvik and James O. Juvik (eds.) *Atlas of Hawai'i*. University of Hawai'i Press, Honolulu, pp. 169-129182.
- Lowenthal, David. 1997. "Empires and Ecologies: Reflections on Environmental History." In Tom Griffiths and Libby Robin (eds.) *Ecology and Empire: Environmental History of Settler Societies*. Keele University Press, Edinburgh, pp. 229-236.
- McEldowney, Holly. 1983. "Report 16. A Description of Major Vegetation Patterns in the Waimea-Kawaihae Region During the Early Historic Period." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 407-448.

- McGregor, Davianna Pōmaika'i. 1995. Waipi'o Valley, a Cultural Kīpuka in Early 20<sup>th</sup> Century Hawai'i. *Journal of Pacific History* 30(2): 194-209.
- McGregor, Davianna Pōmaika'i. 1996. An Introduction to the Hoa'aina and Their Rights. *Hawaiian Journal of History* 30: 1-27.
- Macdonald, Gordon A., Agatin T. Abbott, and Frank L. Peterson. 1983. *Volcanoes in the Sea: The Geology of Hawai'i*. University of Hawai'i Press, Honolulu.
- Menzies, Archibald. 1920. *Hawai'i Nei 128 Years Ago*. Honolulu.
- Merlin, Mark D. 1993. Personal communication. Professor, Biology Program, University of Hawai'i, Mānoa, Honolulu.
- Merlin, Mark D. and Dan VanRavenswaay. 1990. The History of Human Impact on the Genus *Santalum* in Hawai'i. *Proceedings of the Symposium on Sandalwood in the Pacific, April 9 – 11, 1990, Honolulu, Hawai'i*. USDA Forest Service Gen. Tech. Rep. PSW-122. Pacific Southwest Research Station, Berkeley, pp. 46-60.
- Morriss, Veronica. 2001. *Utilizing GIS/GPS Technologies to Produce a Precise Map of a Historical Agriculture Site Located in North Kohala, Hawai'i*. <[http://legacy.hpa.edu/terrace\\_main.htm](http://legacy.hpa.edu/terrace_main.htm)> (29 Mar. 2002).
- Munford, James Kenneth (ed.). 1963. *John Ledyard's Journal of Captain Cook's Last Voyage*. Oregon State University Press, Corvallis.
- Murakami, Gail M. 1983. "Report 20. Analysis of Charcoal from Archaeological Contexts." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 514-524.
- Newman, T. Stell. 1972. "Man in the Prehistoric Hawaiian Ecosystem." In E. Alison Kay (ed.) *A Natural History of the Hawaiian Islands; selected readings*. University of Hawai'i, Honolulu, pp. 559-603.
- Nordyke, Eleanor C. 1989a. "Comment." In David E. Stannard *Before the Horror: The Population of Hawai'i on the Eve of Western Contact*. Social Science Research Institute, University of Hawai'i, Honolulu, pp. 105-113.
- Nordyke, Eleanor C. 1989b. *The Peopling of Hawai'i*. University of Hawai'i Press, Honolulu.
- Olmsted, Francis A. 1969. (Reprint of 1841 edit.) *Incidents of a Whaling Voyage*. Charles E. Tuttle Company, Inc., Rutland, VT.

- Olson, Larry. 1983. "Report 10. Hawaiian Volcanic Glass Applied 'Dating' and 'Sourcing': Archaeological Context." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 325-340).
- Olson, Storrs L. and Helen F. James. 1991. Descriptions of Thirty-two New Species of Birds from the Hawaiian Islands: part I. Non-Passeriformes. In Ned K. Johnson (ed.) *Ornithological Monographs No. 45*. The American Ornithologists' Union, Washington, D.C., pp. 1-88.
- Pratt, Linda W. and Samuel L. Gon III. 1998. "Terrestrial Ecosystems." In Sonia P. Juvik and James O. Juvik (eds.) *Atlas of Hawai'i*. University of Hawai'i Press, Honolulu, pp. 121-129.
- Price, Saul. 1983. "Climate." In R. Warwick Armstrong (ed.) *Atlas of Hawai'i*. University of Hawai'i Press, Honolulu, pp. 59-66.
- Pukui, Mary Kawena and Samuel H. Elbert. 1986. *Hawaiian Dictionary*. University of Hawai'i Press, Honolulu.
- Pukui, Mary Kawena, Samuel H. Elbert, and Esther T. Mookini. 1974. *Place Names of Hawai'i*. University Press of Hawai'i, Honolulu.
- Rick, John W. 1987. Dates as Data: An Examination of the Peruvian Preceramic Radiocarbon Record. *American Antiquity* 52: 55-73.
- Rock, Joseph F. 1917. *The Ornamental Trees of Hawai'i*. Joseph F. Rock. Honolulu.
- Rosendahl, Paul H. 1972. *Archaeological Salvage of the Hāpuna – 'Anaeho'omalū Section of the Kailua – Kawaihae Road (Queen Ka'ahumanu Highway), Island of Hawai'i*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu.
- Rosendahl, Paul H. 1973. *Archaeological Salvage of the Keāhole to 'Anaeho'omalū Section of the Kailua - Kawaihae Road (Queen Ka'ahumanu Highway), Island of Hawai'i*. Bernice P. Bishop Museum, Honolulu.
- Rosendahl, Paul H. 1974. *The Hawaiian Agricultural System at Lapakahi, Hawai'i Island*. Bernice P. Bishop Museum, Honolulu.
- Schilt, Rose. 1984. *Subsistence and Conflict in Kona, Hawai'i: An Archaeological Study of the Kuakini Highway Realignment Corridor*. Department of Anthropology, Bernice Pauahi Bishop Museum, Honolulu.
- Schmitt, Robert C. 1968. *Demographic Statistics of Hawai'i: 1778 – 1965*. University of Hawai'i Press, Honolulu.

- Schmitt, Robert C. 1977. *Historical Statistics of Hawai'i*. University Press of Hawai'i, Honolulu.
- Schmitt, Robert C. 1989. "Comment." In David E. Stannard *Before the Horror: The Population of Hawai'i on the Eve of Western Contact*. Social Science Research Institute, University of Hawai'i, Honolulu, pp. 114-121.
- Schmitt, Robert C. and Eleanor C. Nordyke. 2001. Death in Hawai'i: The Epidemics of 1848-1849. *The Hawaiian Journal of History* 35: 1-13.
- Silva, Kalena. 1997. The Adoption of Christian Prayer in Native Hawaiian Pule. *Pacific Studies* 20(1): 89-99.
- Sohmer, S. H. and R. Gustafson. 1987. *Plants and Flowers of Hawai'i*. University of Hawai'i Press, Honolulu.
- Spriggs, Matthew. 1986. Degradation or Enhancement? Prehistoric Human Impact on the Landscape of Oceania. Paper presented at the University of Hawai'i's 11<sup>th</sup> Annual Pacific Islands Studies Conference "New Directions in Pacific and Hawaiian Archaeology", March 21 and 22, 1986.
- Spriggs, Matthew. 2001. Future Eaters in Australia, Future Eaters in the Pacific? Early Human Environmental Impacts. *Australian Archaeology* 52: 53-59.
- Stannard, David E. 1989. *Before the Horror: The Population of Hawai'i on the Eve of Western Contact*. Social Science Research Institute, University of Hawai'i, Honolulu.
- Steadman, David W. 1997. "Extinctions of Polynesian Birds: Reciprocal Impacts of Birds and People." In Patrick V. Kirch and Terry L. Hunt (eds.) *Historical Ecology in the Pacific Islands: Prehistoric Environmental and Landscape Change*. Yale University Press, New Haven and London, pp. 51-79.
- Stokes, John F.G. 1939. *Hawaii's Discovery By Spaniards: Theories Traced and Refuted*. Hawaiian Historical Society, Honolulu.
- Tuggle, H. David and P. Bion Griffin. 1973. "A Summary of Lapakahi Lowland Research: 1969." In H. David Tuggle and P. Bion Griffin (eds.) *Lapakahi, Hawai'i: Archaeological Studies*. Social Science Research Institute, University of Hawai'i, Honolulu, pp. 1-68.
- Vancouver, George. 1967a. (Reprint of 1798 edit.) *Voyage of Discovery to the North Pacific Ocean, and Round the World, Volume 1*. Da Capo Press, New York.
- Vancouver, George. 1967b. (Reprint of 1798 edit.) *Voyage of Discovery to the North Pacific Ocean, and Round the World, Volume 2*. Da Capo Press, New York.

- Vancouver, George. 1967c. (Reprint of 1798 edit.) *Voyage of Discovery to the North Pacific Ocean, and Round the World, Volume 3*. Da Capo Press, New York.
- Vitousek, Peter M., Lloyd L. Loope, and Charles P. Stone. 1987. Introduced Species in Hawai'i: Biological Effects and Opportunities for Ecological Research. *Trends in Ecology and Evolution* 2(7): 224-227.
- Wagner, Warren L., Derral R. Herbst, and S.H. Sohmer. 1990. *Manual of the Flowering Plants of Hawai'i*. Bishop Museum Press, Honolulu.
- Walker, George P. L. 1990. Geology and Volcanology of the Hawaiian Islands. *Pacific Science* 44(4): 315-347.
- Watts, Sheldon. 1997. *Epidemics and History: Disease, Power, and Imperialism*. Yale University Press, New Haven and London.
- Welch, David J. 1983. "Report 5. Archaeological Investigations in Section 2." In Jeffrey T. Clark and Patrick V. Kirch (eds.) *Archaeological Investigations of the Mudlane-Waimea-Kawaihae Road Corridor, Island of Hawai'i: An Interdisciplinary Study of an Environmental Transect*. Department of Anthropology, Bernice P. Bishop Museum, Honolulu, pp. 138-180.
- Wellmon, Bernard B. 1969. *The Parker Ranch: A History*. University Microfilms, Inc., Ann Arbor.
- Westhoff, V. 1983. "Man's Attitude Towards Vegetation." In W. Holzner, M. J. A. Werger and I. Ikusima (eds.) *Man's impact on vegetation*. Dr. W. Junk Publishers, The Hague, pp. 7-24.
- White, Richard. 1983. *The Roots of Dependency: Subsistence, Environment, and Social Change Among the Choctaws, Pawnees, and Navajos*. University of Nebraska Press, Lincoln.
- Williams, Michael. 1994. The Relations of Environmental History and Historical Geography. *Journal of Historical Geography* 20(1): 3-21.
- Wilson, J. Tuzo. 1963. A Possible Origin of the Hawaiian Islands. *Canadian Journal of Physics* 41: 863-870.
- Worster, Donald. 1990. Seeing Beyond Culture. *Journal of American History* 76(4): 1142-1147.