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History on Stones: A Newly-Discovered Petroglyph Site at Kahikinui, Maui

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Introduction

Archaeologists have listed more than 135 petroglyph sites in the Hawaiian Islands (Cox and Stasack 1970; Kirch 1985:271), yet for the vast majority of these there is little or no settlement-pattern context, material culture assemblage, or temporal association. Thus Hawaiian petroglyphs have typically been studied as a thing apart, of interest primarily for their aesthetic qualities, rather than as integral components of larger cultural and social systems.

To give meaning to rock art is a challenging matter (Millerstrom 1997), requiring close attention to context, associations, and temporality. Here we report on a newly discovered petroglyph site in the ancient *moku* of Kahikinui, Maui, designated site 1197 in the U. C. Berkeley site recording database for Kīpapa and Nakaohu *ahupua'a.* Although several rockshelters have been recorded within the Kīpapa and Nakaohu *ahupua'a* of Kahikinui, as part of a major settlement-pattern survey (Kirch 1997), this is only one of two known to be associated with petroglyphs. It is a small site, with six glyph panels, one that might not ordinarily draw much attention from "rock-art" enthusiasts. However, given that the site exhibits a dog motif and several anthropomorphs, in association with built architecture, surface lithics, and excavated lithic and faunal materials, and has been radiocarbon dated, it offers a rare opportunity to explore how such images were integrated into the Kīpapa-Nakaohu settlement landscape, and thus to inform more generally on Hawaiian rock art.

Background

Archaeological survey in Kahikinui *moku,* a leeward district located on the southeastern part of Maui, commenced in 1966, directed by Peter S. Chapman under the auspices of the Bishop Museum (Kirch and Van Gilder 1996:38–52; Kirch, ed., 1997). Inspired by Roger Green's pioneering settlement pattern approach in Polynesia (Green 1970), Chapman planned to record all visible cultural remains in two *ahupuaʻa* units, Kīpapa and Nakaohu, located within the core of the Kahikinui *moku.* A total of 544 sites was recorded (Kirch, ed. 1997). Due to Chapman's untimely death, only the *mauka* part and the entire coastal strip of Kīpapa and Nakaohu was mapped, and no report or publication resulted from the survey.

Chapman's goal of undertaking a comprehensive settlement pattern study was finally realized in 1994 when P. V. Kirch recommenced Chapman's survey, including adjoining blocks of land not covered in 1966. In 1995, three decades after Chapman's initial efforts, P. V. Kirch, assisted by a team of University of California at Berkeley students, recorded and mapped an additional 462 archaeological sites, bringing the total to 1,006 sites (Kirch, ed. 1997: Kirch and Van Gilder 1996:38–52). In order to determine site use and identify household activities, the Berkeley team excavated several sites the following field season (Kirch 1997:12–27; Van Gilder and Kirch 1997: 45–59).

Between February 1 and April 8, 1997, the Berkeley team systematically surveyed and mapped the entire area between Highway 31 and the Pacific Ocean (excluding a walled area, below Highway 31, already mapped by Chapman), including Chapman's transect following a *mauka-makai* jeep trail. During this 1997 survey phase, 252 new sites were located and mapped, thus bringing the total number of sites to 1,258. Several selected structures were also excavated. During the 1997 field survey, a cliff site (assigned number 1197) with several images, was discovered in Nakaohu *ahupuaʻa* in the elevation zone ca. 150 m above sea level (Figure 1).

Two additional archaeological teams have also conducted research at Kahikinui. Under the direction of Dr. Boyd Dixon, the State Historic Preservation Division has, since 1995, intensively investigated the upper elevation zones of Kīpapa, Nakaohu, and Nakaaha *ahupuaʻa* (Dixon et al. 1997:28–43). In addition, Michael Kolb of Northern Illinois University has been studying *heiau* on Maui for several years, and since 1996 Kolb and his students have focused on the *heiau* of Kahikinui (Kolb and Radewagen 1997:61–77). Based on a substantial suite of radiocarbon dates obtained through these projects, the Kahikinui *moku* was occupied from the early Expansion Period through the Historic Period, from approximately A.D. 1100 to 1860. The legacy of this occupation is a dense cultural landscape with remains of *heiau,* household structures, and agricultural features (Kirch, ed. 1997).

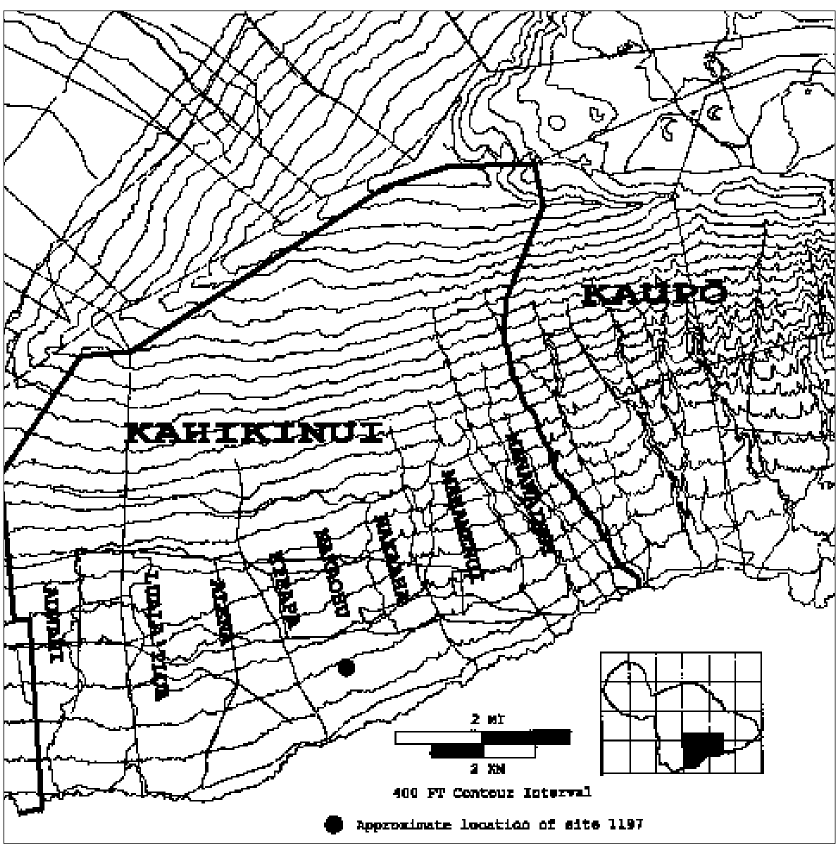

Figure 1. Map of the Kahikinui region, showing the location of Kīpapa and Nakaohu *ahupuaʻa,* and the approximate location of site 1197. Inset shows the location of this map on Maui Island.

Site 1197

Site 1197 consists of a cliff face running east-west, with images centered around a shallow overhang rockshelter (Figure 2). The main part of the shelter is approximately 7 m long with a maximum depth of 1.80 cm (Figure 3). The height of the shelter's interior ranges from 0.5 to 2 m. Several roof-fall boulders fill the shelter, leaving little space for habitation. Facing south and *makai,* the site commands a panoramic view of the ocean. While the western side offers shelter from the strong prevailing winds, on sunny afternoons the area in the lee of the cliff gets extremely hot.

Skirting the rock shelter is a 1.8–2 m wide boulder talus slope which drops steeply to a swale ca. 5 m below (Figure 4). A dry stream channel is located to the west of the swale depression. During the months of February to March the vegetation in the swale was dense and relatively green; foraging pigs were observed in the underbrush.

Figure 2. View of site 1197 from the north, with S. Millerstrom carrying out the test excavation.

Located approximately 15 m west of the rockshelter is a 1.7 m high terrace built into the slope (site 1197A). The crudely-constructed platform measures 5 x 2 m and is paved with smooth boulders, cobbles, and *a'a* clinkers (Figure 2). Cores and flakes were found on the terrace surface. This feature was tentatively interpreted as a shrine.

Above the cliff, the grassy area is relatively level. Two 2–3 course stacked boundary walls, with heights averaging 0.6 m partly enclose two small stone structures (site 1217). These walls do not extend directly above the cliff face.

We recorded six petroglyph panels clustered around the shelter of site 1197. Each panel was traced onto transparent polyethylene sheets, which were later reduced to scale drawings. Three panels are located on the cliff face and three panels are placed on boulders inside the shelter. A description of each panel follows, and Panels A–D are illustrated in Figure 5.

Panel A. A dog image, measuring 31 x 11 cm, is located on a smooth vertical section (80 x 50 cm) of the cliff face to the west of the shelter opening. It is placed 32 cm above the ground. The dog motif was formed by pecking the yellowish patina on the cliff wall with a blunt tool, leaving marks up to 5–7 mm wide. With a long body, pointed ears, an open mouth, and a long tail with a curled tip, the quadruped appears to be stylistically unique when compared to dog images documented elsewhere in the Hawaiian islands.

Panel B. Panel B is located to the west of the shelter opening. The panel consists of one incised anthropomorphic stick figure (Ba), an unidentified element (Bb), and lines that appear to be randomly placed. Traces of additional images occur on the cliff face; they are, however, invisible in full sunlight.

Panel C. Placed above the shelter and 2 m above the talus, Panel C depicts two incised anthropomorphic stick figures, a series of incised parallel lines, and some randomly placed lines. Both anthropomorphs have triangular heads dissected by a vertical line. While figure Ca has double outlined legs and opposed arms, figure Cb has arms in the downward

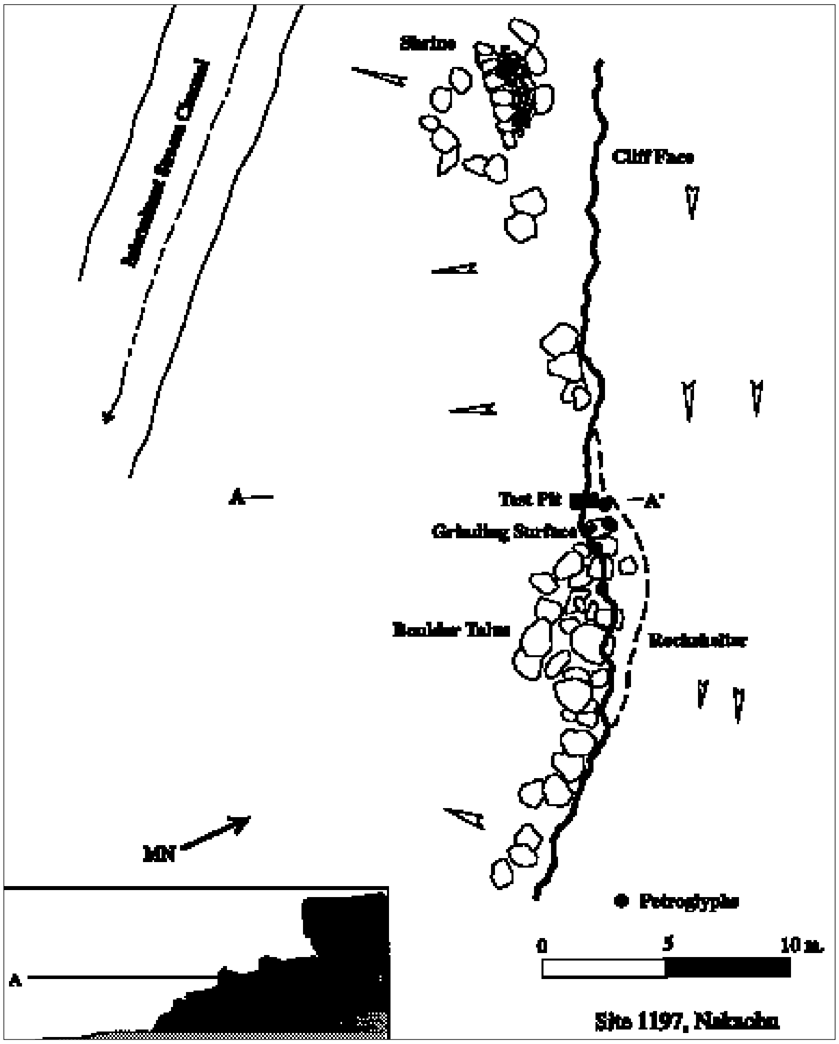

Figure 3. Plan and cross-section of site 1197, showing the location of the test excavation unit, and the locations of the petroglyph units. Also note the location of the small shrine at the north end of the cliff face.

Figure 4. View of the rock face and overhang at site 1197, on which the petroglyph panels are located, from the west.

position. Superimposed 1–1.5 cm long hatched marks cover the largest figure (Figure 5C).

Panel D. A boulder, measuring 107 x 77 cm with a height of 50 cm, is located beneath the overhang (Figure 6). Facing up are two unfinished incised anthropomorphs, one of which is a stick figure (Da), the other a headless triangular-bodied anthropomorph (Db). Part of figure Da has exfoliated. One of the anthropomorphs depicts a triangular head similar to the two stick figures on panel C described above. A circular grinding area (31 x 22 cm) with a highly smoothed surface is located on the south part of the boulder. The outer edge of the boulder has been heavily flaked, probably from use as an anvil in bipolar percussion of basalt cores.

Panels E and F. Two boulders, located inside the shelter, each have a panel with vertical and horizontal lines. The reason for these randomly positioned lines is unclear.

Different tool types were used to produce the various images at site 1197. The dog image comprising Panel A was pecked with a blunt or rounded implement, possibly the butt or poll of a basalt adz, a basalt hammerstone, or simply a suitably-shaped cobble. In contrast, the incised figures and superimposed hatch marks on Panel C were, in our opinion, made with iron implements. Cox and Stasack (1970:38) suggest that occasional petroglyph figures were made after 1800, especially images of ships, guns, names written in the missionary-introduced alphabet, and calendar dates.

The first pieces of iron to reach people residing in Kahikinui were likely to have been derived through trade with the La Pérouse expedition of 1786. On May 27, the *Astrolabe* and *Boussole* sailed along the Kahikinui coastline, pursued by canoes eager to trade. The French ships came to anchor in Keoneʻoʻio Bay (La Pérouse Bay), where a brisk trade was established (Dunmore, ed., 1994:82–83). La Pérouse remarked that the Hawaiians "were most meticulous in their

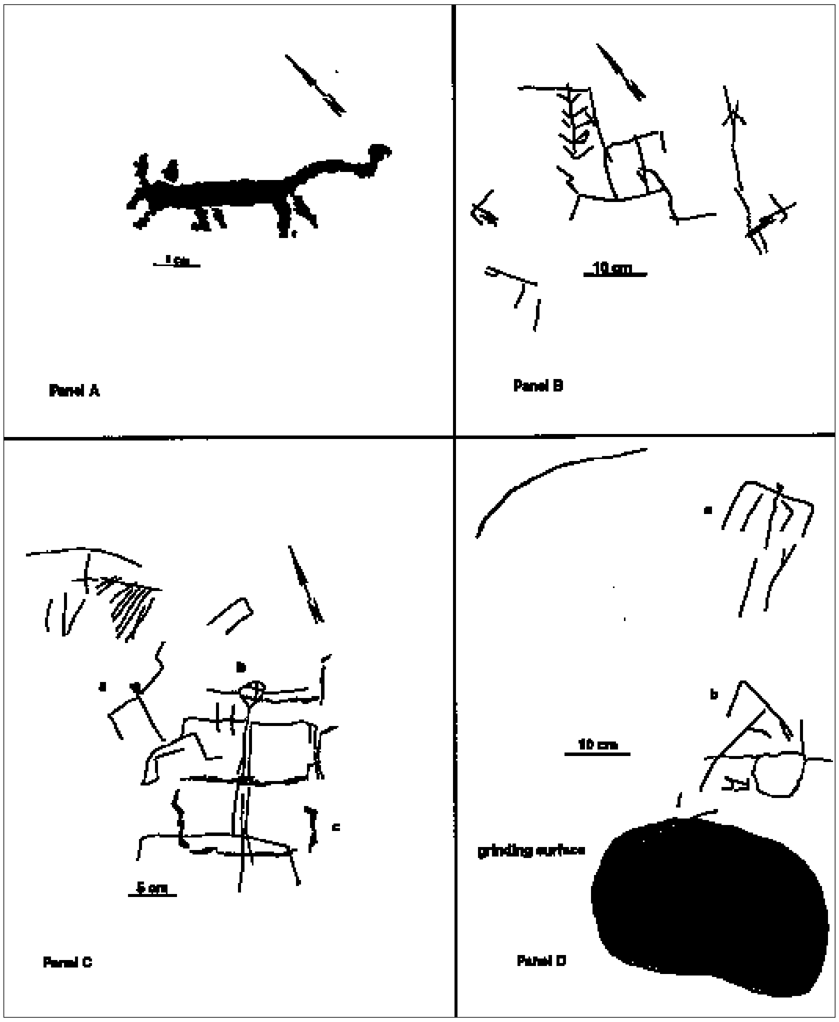

Figure 5. The petroglyph panels at site 1197: Panel A, pecked image of dog; Panel B, anthropomorphic stick figure, unidentified figure, and randomly placed lines; Panel C, two anthropomorphs with triangular heads bissected with a line, and with superimposed hatched marks on one anthropomorph; Panel D, one stick figure and one triangular-bodied anthropomorph, both positioned north of a circular grinding surface.

bartering; our old metal hoops appealed greatly to them, and they were very skillful in their attempts to obtain them; they never sold a quantity of cloth or several pigs as one lot, fully aware that they would get a better deal by agreeing to a price for each item" (1994:83). It is probable that some of these metal hoops or other metal items were obtained by Kahikinui residents. If so, they could have been used to produce the incised petroglyph panels at site 1197.[1]

Figure 6. The large boulder with flaked edge and grinding surface, also the location of Panel D.

Test Excavation (TU-1)

We placed a 1.0 m by 0.5 m (north-south) test unit on the talus below the dog motif, 30 cm from the cliff wall (Figure 3). All excavated sediments were screened through a 1/8 inch mesh. Layer I, approximately 10 cm thick, consisted of sandy loose overburden. In the next 5 cm, candlenut endocarp fragments *(Aleurites moluccana),* fragments of marine shell, fine grained basalt adz flakes, and one basalt core were uncovered. A flaked core was located in the south-east corner 8 cm below surface. Several stones encircled the south-east section of the unit. A concentration of charcoal flecking was observed in the central north half of the unit. In the interface between Layers I and II we exposed a 45 x 35 cm dark stain (Feature 1). The feature was excavated as an individual unit and the contents bagged separately. Shell fragments, small pieces of coral, large triangular basalt flakes, and charcoal were uncovered in Feature 1. Feature 1, probably a hearth used for warmth or light, was 40 cm deep (Figure 7). A layer of ash lined the base of this combustion feature. While a few *Cellana* shells were discarded around the hearth, there are no indication that foods were necessarily cooked there.

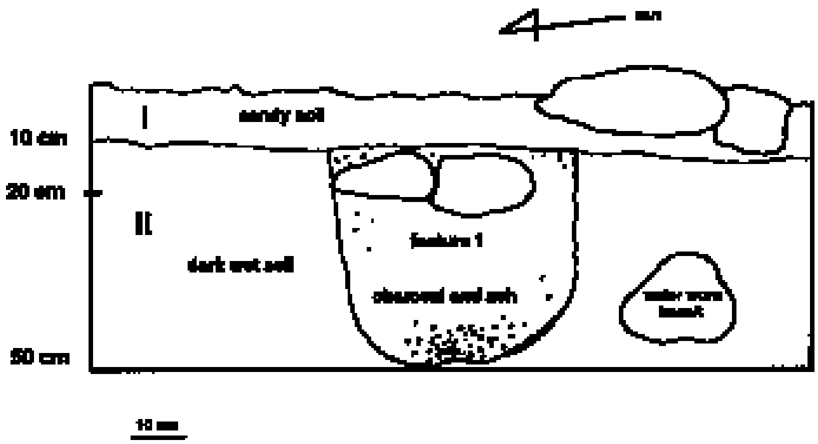

Figure 7. Stratigraphic section of the east face of Test Unit 1, showing the hearth (Feature 1) in Layer II.

Layer II consisted of dark, moist soil with charcoal flecking throughout. No significant changes occurred in Layer II. Candlenut endocarp fragments and marine shell *(Cellana)* fragments continued to be uncovered. Part of a water-warn basalt boulder was found in the lower part of level II.

Radiocarbon Dating

Charcoal fragments, collected from the base of the Feature 1 hearth, were submitted to Beta Analytic, Inc. for radiocarbon dating. Sample Beta-106763 was given a standard laboratory pretreatment sequence of acid/alkalai/acid baths. The measured ^{14}C age was 100.7 ± 0.6% modern, with a $\delta^{13}C$ value of -20.4 o/oo, yielding a conventional ^{14}C age of 20 ± 50 B.P.

Calibrating this conventional age, at two standard deviations (95% probability), results in three possible calendar age ranges: cal A.D. 1700–1720, 1820–1855, and 1860–1920. We reject the last of these calibrated age ranges on independent archaeological evidence, given the total absence of post-contact (Euro-American) material culture in the site. As we shall argue below, however, it is probable that site 1197 was used over a period of years that spans the pre-contact and early post-contact eras (i.e., roughly the 18th and early 19th centuries). Thus either of the earlier two calibrated age ranges are compatible with the archaeological evidence for site use.

Cultural Content of the Test Unit

In terms of faunal material, the test excavation yielded only a small quantity of marine shell, specifically one chalky dorsal portion of a limpet (*Cellana* sp.) from Layer I, and 5 fragments of *Cellana exarata* from Layer II. Another fragment of *C. exarata* was found in Feature 1.

While faunal materials were sparse, the test unit produced a substantial quantity of lithics, totaling 140 whole or fragmented basalt flakes and cores (weighing a total of 2.78 kg). Layer I had 16 flakes and 1 core, Layer II contained 113 flakes, 1 core, and 1 waterworn stone, and another 5 flakes were recovered from Feature 1. The material appears to be of local origin, and is not particularly fine-grained. Up to 50% cortex was observed on some 59 flakes, suggesting that the lithic production activity at site 1197 was part of an early stage in reduction. Some of the flakes are likely to have been derived from the flaked edge of the large grind-surface boulder, as described above. Most flakes range in size between 0.9–8.3 cm long, 0.6–7.3 cm wide, and 0.1–5.6 cm thick. In addition, however, there are three unusual flakes, with lengths of 21.5 cm, 21.1 cm, and 9.1 cm.

Discussion: Rock Images in Hawai‘i

Most of our knowledge of Hawaiian rock images derives from published and unpublished works by anthropologists and art historians (e.g., Emory 1922, 1924; Cox and Stasack 1970; Lee 1988, 1989, 1995; Stasack and Lee 1993; Stasack, Dorn, and Lee 1996; Stasack and Stasack 1997; Lee and Stasack 1998). No other Polynesian island or island group contains as many individual glyph figures as the Hawaiian archipelago. The Hawaiian art rock database currently consists of 31,249 petroglyph units, a large number of which are from the Pu‘uloa site on Hawai‘i Island (G. Lee, pers. comm., 1998). However, in Hawai‘i the size of an island does not directly correlate with the number of rock art sites. The majority of sites and individual images are located on Hawai‘i Island, with a total land area of 10,458 square kilometers, yet Lana‘i with only 361 square kilometers ranks second in number of documented glyph units (Cox and Stasack 1970). Geological conditions might account for some of this disparity in site distribution, as Hawai'i Island has vast areas of recent *pahoehoe* lava, a particularly suitable surface for petroglyphs. Older islands such as O'ahu and Kaua'i have fewer suitable rock surfaces (Lee and Stasack 1998).

Maui ranks third in the number of recorded images, with more than 18 sites, containing at least 450 individual glyph elements.[2] Documented petroglyph sites on Maui are located along the coast on the southern side in the Kaupo region, and on the west in the vicinity of Lahaina; another cluster of site occurs in the Makawao region (Cox and Stasack 1970:92–93).

Relatively close to our own Kahikinui survey area, several painted and pecked figures are found on a cliff face at Nu'u Bay, Kaupo (Bishop Museum site MA-A30-2). Regrettably, many of the painted figures have faded and are now obliterated. Emory (1922) reported observing more 100 pecked, bruised, or scratched figures (about 30 were painted) on the Nu'u cliff faces and in the vicinity. The Nu'u images consisted mainly of linear, triangular, and naturalistic anthropomorphs. As some of the painted images are superimposed on the carved figures, and some appeared to be fresher than others, Emory reasoned that the images had been made at different times.

Site 1197 is not the only petroglyph site now documented for Kahikinui, although such sites are still rare with this *moku.* Emory (1922) reported 31 "footprints" (in 10 pairs) on a *pahoehoe* surface near a trail at Papakea, north of the Luala'ilua Hills (Cox and Stasack 1970:92–93). During our 1997 field season, we also found a single naturalistic-looking anthropomorph on *pahoehoe* near the coastal trail makai of Luala'ilua. This figure, measuring approximately 45 cm tall, is covered by a shiny silica glaze. Two glyphs have also been recorded at a small rockshelter some distance inland from site 1197, and C. Van Gilder (pers. comm., 1998) reports that a few petroglyphs were recorded during her recent intensive survey of the coastal sector between Manawainui and Nakaohu.

While we now know that petroglyph images do occur at various localities in Kahikinui—though sparsely distributed—none of the others appears to resemble the site 1197 motifs. The three anthropomorphs at 1197 (two of which have triangular heads bisected by a line, see Figure 5, C, D), appear to be unique to the Kahikinui area. However, similar anthropomorphs have been found on Kaho'olawe Island (G. Lee, pers. comm., 1998).

A total of 135 dog motifs have been recorded in Hawaiian Island petroglyph sites, most of them on the island of Lana'i (Cox and Stasack 1970; Lee and Stasack 1998; Stasack and Stasack 1997). Dog figures are found on all islands except Kaua'i and Moloka'i; few dogs have been recorded on Hawai'i (Lee and Stasack 1998). On Maui, dog figures have been noted on cliff faces and boulders at Hana, Makawao, Wailuku, and Lahaina (Cox and Stasack 1970: 92–93).

Dogs played an important role in traditional Hawaiian culture. They feature in certain origin myths, and were a manifestation of the god Ku (Titcomb 1969; Valeri 1985:6, 15–16). Dogs were a major food for elite women. They may also have represented ancestral guardians or *'aumakua* (Lee and Stasack 1998). Great affection was often shown to dogs, and early European travelers observed Hawaiian women nursing puppies (Portlock 1789:188; Macrae 1922:42). While travelling about, Hawaiians were at times observed to carry their dogs so that their paws would not be hurt (Valeri 1985:47). To quote Tyerman and Bennett, "in travelling, they frequently take up their dogs, and carry them over dirty or rugged parts of the road, lest they should soil their skins or hurt their feet; and it is said that a man would sooner resent an injury to his dog than to his child" (1832, II:257). In the Kahikinui area, there is a well-known legend that attributes the discovery of a subterranean well near the coast to a dog who sniffed out the precious water; the location became known as Wai-a-'ilio ("water of the dog") (Rev. Kealakea, pers. comm., 1997; Sterling 1998:205).

Site 1197: Some Tentative Interpretations

Some Hawaiian petroglyphs appear to be connected to myths and legends (Cox and Stasack 1970:7378; Stasack and Stasack 1997:21–27), while others are thought to be associated with *ahupua'a* boundaries, ancient trails, family, genealogy, lineage, ancestors, and *'aumakua* or spirits (Lee 1988, 1989, 1995; Lee and Stasack 1989). More importantly, research on various sites in Hawai'i demonstrates that "petroglyph designs relate to the function of the individual site" (Lee 1995:47).

In Hawai'i, spatial distribution of ritual and domestic places, and patterns of values and norms were partly dictated by the complex *kapu* system. The choice and use of site 1197 presumably reflects such cultural rules. The location was perhaps chosen for the *mana* or supernatural power attached to the place. In our view, it is probable that this cliff area was used by men, possibly ritual elders, who met periodically to perform certain rituals; certainly this would be consistent with the presence of a small shrine at the site. Basalt tool production seemingly constituted part of the activities that took place at site 1197, but judging from the shallow grinding surface on Panel D, there were not a large number of adzes sharpened at the site. Could it be that some important tools were ritualized at the cliff site, and that these adzes or other tools were imbued with *mana* by rubbing them on the grinding surface?

Rituals associated with adz production in Hawai'i are not well understood. However, comparative ethnographic information from the Marquesas, Easter Island, and Tikopia suggest that Polynesian adz making, under certain circumstances, was governed by rules and rituals (Handy 1923:149; Linton 1925:165; Metraux 1940:137; Firth 1967:213–25). Generally, it is believed that only men in prehistoric Polynesia worked with tools associated with house structures and canoe building. While ethnographic accounts from Easter Island and the Marquesas relate that men used stone adzes, in Tikopia, a Polynesian outliner, a legend states that the original *toki tapu* or sacred adzes ". . . were made by Pakora—the Atua [god] in Porima—and his two sisters" (Firth 1967:215). Nonetheless, the relationship between gender and tool specialists has not been closely investigated in Polynesia.

Handy (1923:149) writes that in the Marquesas, chants mention the processes of rubbing and polishing a new adz of the sacred first-born male. Firth (1967), who examined both technical and ritual aspects of adzes in Tikopia, provides a detailed account:

> For canoe building adze blades must be sharpened. So an important ritual feature of the sacred canoe building was the formal sharpening of the sacred adze. After the log had had some of the rough work done on it, it was dragged to the building place. The same day the chief went off with his sacred adze to sharpen it. The sharpening stone *(fuanga)* lay at Fakaseketara, near the path to Maunga on the eastern side of the island. The sacred adze blade was rubbed on the stone until it was cleansed" (Firth 1967:216–17).

Site 1197 is unique in combining a dog image and several anthropomorphs in association with formal architecture (a shrine), a significant number of lithics, grinding surface and anvil stone, and limited faunal materials. We suggest that it may have functioned as a place where men pecked and incised visual symbols related to their belief system, and perhaps ritualized adzes or other basalt tools. If our interpretation has validity, it adds yet another dimension to our understanding of the complex ways in which the natural landscape of Kīpapa and Nakaohu were imbued with cultural meanings.

Acknowledgments

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Notes

1. During additional site survey carried out in August 1998, as this paper was ready for submission, a new petroglyph and rockshelter site was discovered farther inland along the same stream drainage as site 1197. The new site (1285) has two petroglyph panels, one pecked and one incised. Significantly, the incised panel appears to depict a European sailing ship. This site will be reported in full at a later date.

2. This is probably a low estimate, as the number of individual glyphs is not recorded for some sites.

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Settlement Patterns and Subsistence Strategies in Kahikinui, Maui

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Introduction

The nature of pre-Contact settlement patterns and subsistence practices in dry leeward portions of the Hawaiian islands has been one focus of archaeological investigations for over three decades. This research has revealed two basic agricultural and settlement systems which are largely defined by geographical and environmental parameters—"enclosed" systems which are found in narrowly circumscribed but relatively well watered valleys on the older islands, and "open" systems which are found in areas lacking such valleys and water courses on the younger islands. Archaeological studies of enclosed leeward systems include Nuʻalolo Valley on Kauaʻi (Bennett 1931; Soehren ms.), the Mākaha (Green 1969, 1970) and Hālawa (Klieger 1995; Damp 1998) valleys on Oʻahu, and the Hālawa Valley on east Molokaʻi (Kirch and Kelley 1975). Open leeward systems have been studied in upcountry Kula on east Maui (Kolb, Conte, and Cordy 1997), and in Lapakahi (Rosendahl 1994) and Kaloko (Cordy et al. 1991) on the island of Hawaiʻi.

The archaeological remains of these two pre-Contact leeward systems vary not only between the two basic types of geographical features (valleys and slopes), but also within the individual islands themselves. In enclosed leeward systems with permanent water courses, irrigated taro pondfields (or *loʻi*) and terraces can be found close to the water sources at the head of the valleys, spreading out downstream as seasonal water flow permits. Permanent settlement in these valleys is generally concentrated toward the mouth of the streams (Kirch and Kelley 1975), with dispersed residential housing being located upstream near the field systems (Green 1969, 1970). In the karst landscape of leeward coastal Oʻahu, natural sinkholes constitute a separate agricultural component to this system (Davis 1995).

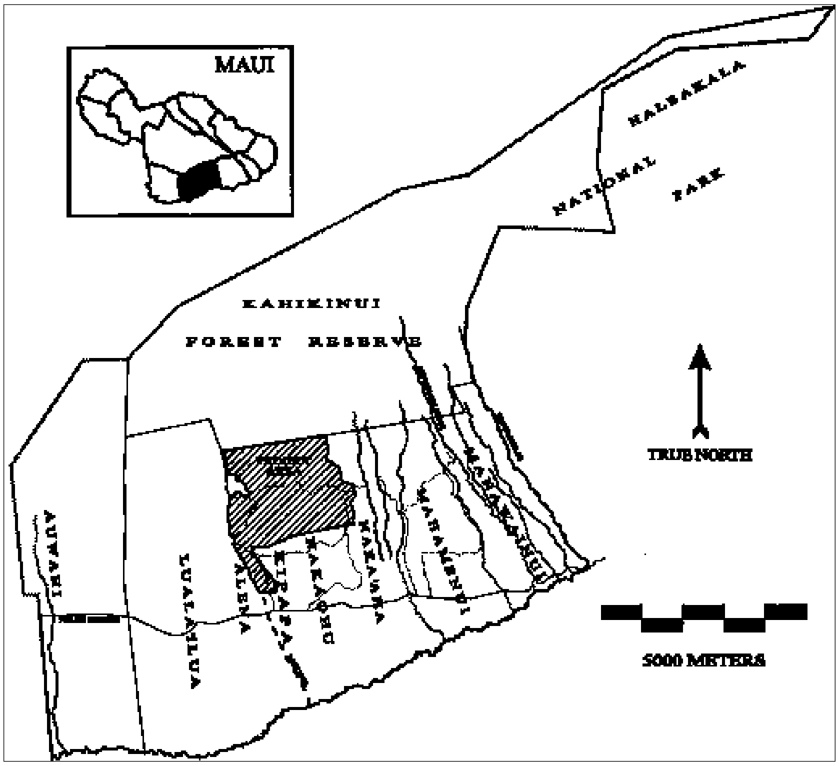

Figure 1. Location of Kahikinui District and Project Area on the Island of Maui.

In open leeward systems without permanent water courses, agricultural remains generally consist of linear terraces (Rosendahl 1994), enclosed garden areas (Kolb, Conte, and Cordy 1997), and swidden plots (Cordy et al. 1991) generally found at higher elevations conducive to rainfall and cloudfed farming of sweet potatoes and dryland taro. Permanent settlement in open leeward systems can be located close to the agricultural fields (Kolb, Conte, and Cordy 1997), although coastal settlement is also found when distance to the fields is under approximately six miles (Tuggle and Griffin 1973; Cordy 1977). Kahikinui, which is located on the southern slopes of east Maui, presents yet another variation on the open leeward system—one which is again defined largely by environmental constraints.

Agricultural pursuits in Kahikinui are largely restricted to areas above 1200 fasl which presumably received sufficient seasonal rainfall and cloud moisture in pre-Contact times. Adaptations to this unpredictable environment appear to have varied with elevation and degree of erosion, with a focus on swale soils and older ash falls below perhaps 2100 feet above sea level (fasl) (Kirch 1997b) and on rocky slopes and ridge tops up to approximately 3000 fasl (Dixon et al. 1997). Archaeological remains of the Kahikinui agricultural system are difficult to define in the field today due to dense vegetation and erosion, but they appear to consist of extensive small-scale modifications to the natural landscape, including small terraces, clearings and piles, enclosed garden areas, and floodwater/soil entrapment features in the swales. While this agricultural zone is located only two to three miles from the coastline, most pre-Contact permanent settlement appears to have been found above 1200 fasl, presumably due to the lack of dependable rainfall at lower elevations. Instead of being a marginal zone for agriculture, however, the east Maui slopes including Kahikinui were "... the greatest continuous dry planting area in the Hawaiian islands" (Handy 1940:161).

Project Area

The archaeological study presented here is based on the results of the 1995 to 1997 State Historic Preservation Division (SHPD) inventory survey of cultural remains within the Department of Hawaiian Home Lands (DHHL) "Kuleana Homestead" development area in Kahikinui (also referred to as "Kahikinui *mauka*") (Dixon et al. 1996, 1997, 1998), located in leeward east Maui (Figure 1). Although part of Hāna District today, the *moku* or ancient district of Kahikinui included eight *ahupua'a* or community land units, situated between Kanaio on the west and Wai-'ōpai Gulch on the east (Hammatt and Folk 1994). The district also extended originally from the sea coast to Pōhaku pālaha on the north rim of the Haleakalā volcano (Hunter 1997; Rosendahl 1978), at an elevation of 8105 fasl/2470 meters above sea level (masl). Seven of these *ahupua'a* totaling 22,809.3 acres are today located within Hawaiian Home Lands and are being managed by Ka 'Ohana O Kahikinui, a group of DHHL beneficiaries.

The DHHL Kahikinui *mauka* archaeological project area covered 2000 acres located between approximately 2100 fasl and the Kahikinui Forest Reserve boundary at 4000 fasl (TMK 1-9-01: 03), with a narrow corridor extending down to 1600 fasl along

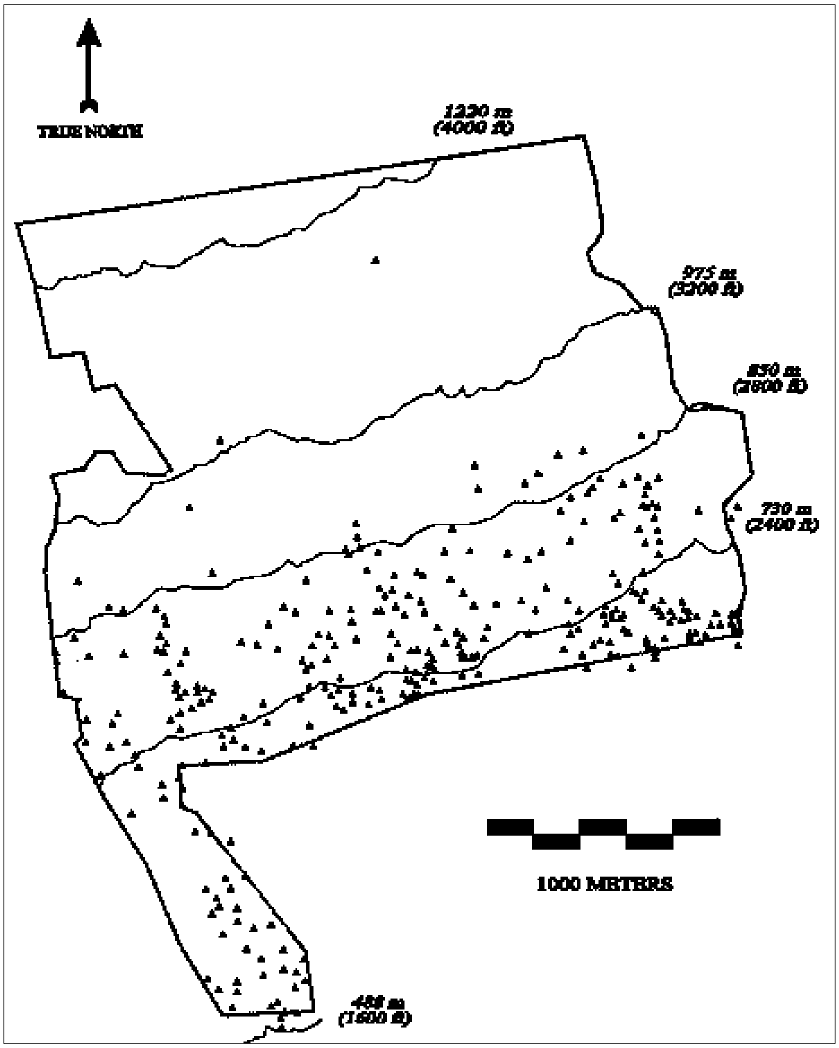

Figure 2. Archaeological Site Distribution within the Kahikinui Mauka Project Area.

the west side of a rough access road to Piʻilani Highway (Figure 2). This archaeological inventory survey resulted in the recording of 563 archaeological features grouped into 319 sites (10 are actually extensive agricultural planting zones). These sites are distributed across the three *ahupuaʻa* of Kīpapa, Nakaohu, and Nakaʻaha within roughly one half of the 100 Kuleana Homestead parcels, located below approximately 3000 fasl. A total of 179 sites (257 individual features) underwent subsurface excavations and analysis (291 test units). As the results of survey, mapping, excavation, and laboratory analyses are presented in the four volume technical report series prepared for DHHL (Dixon et al. 2000), only a brief overview of these data is presented below.

General Settlement Patterns

Broad patterns of pre- and post-Contact settlement within Kahikinui *mauka* are summarized here, based on multi-disciplinary data described below. It should be noted that the dispersed upland settlement which was present in the Kahikinui *mauka* project area by A.D. 1450 was very likely part of three *ahupuaʻa* or community settlement patterns, with many families occupying secondary residences on the coast, at other elevations, or even in other *ahupuaʻa*. Moreover, data presented below demonstrate that patterns of settlement and subsistence were not uniform between the three *ahupuaʻa* in the project area, so it is not expected that these observations necessarily reflect the situation found in communities to the west or east. Field data currently being gathered from along the coast of Kahikinui by the SHPD also suggest that community patterns varied considerably through time, especially after the introduction of cattle ranching in the mid- to late 1800s.

Pre-Contact Period

Based on a suite of radiocarbon dates from habitation features across the Kahikinui *mauka* project area (Figure 3; Table 1), permanent settlement in Kahikinui *mauka* seems to have been established by A.D. 1450, preceded by earlier short-term exploitation of natural resources. This was approximately the time when windward chief Kakaʻalaneo first divided the island of Maui into its present configuration of *ahupuaʻa* (Beckwith 1970). During this Period 1, permanent occupation was presumably associated with swidden farming in the upper reaches of the Lowland Dry Forest between 2100 and 2400 fasl (Kirch 1997). Temporary agricultural habitations were also found in several micro-geographical and geological zones up to approximately 2800 fasl (Figure 4). These areas included three north-south trending ridges located below Uma in Kīpapa Ahupuaʻa, three ridges surrounding an older eroded soil area in Nakaohu Ahupuaʻa, a relatively flat bowl-shaped depression in Nakaʻaha Ahupuaʻa, and to a lesser extent the grassy slopes and older soils above this same area.

By circa A.D. 1575 when windward chief Piʻilani first unified the island of Maui (Fornander 1996), Period

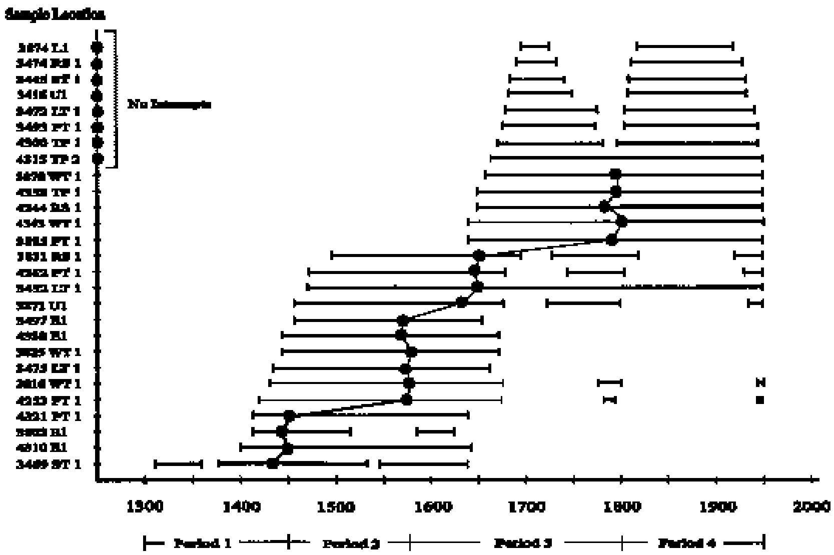

Figure 3. Chronological Sequence of Kahikinui Mauka Settlement by Periods.

2 settlement had intensified within existing habitation and agricultural areas, presumably being associated with the establishment of permanent field cropping. A strong correlation was noted between the location of permanent habitation sites and the presence of underlying *ʻaʻā* or *pahoehoe* bedrock, most sites being located on or within outcrops of usable construction material. Surrounding slopes more often contained evidence of small-scale agricultural modifications, while shallow swales were occasionally found to contain more substantial agricultural terracing. Temporary or secondary habitation sites also seemed to occur more often within or upon bedrock outcroppings, although their placement was more dispersed when found away from permanent habitation clusters, becoming the dominant site type above 2400 fasl in all three *ahupuaʻa*.

Table 1. Summary of Kahikinui Mauka Radiocarbon Age Determinations by Ahupuaʻa and Elevation

SHPD Site No. (50-50-15-)	Provenience	Context	Elevation (fasl)	$^{13/12}C$ ^{14}C Age B.P.	^{13}C Adjusted Ratio	Calendric Age	Range A.D.	Mean Intercept
Kipapa Ahupuaʻa								
3416 U1	TU 156 I/3 20–35 cmbs	Floor Zone	1610	100 ± 40	-26.2	80 ± 40	1680–1745 1805–1935	None
3445 ST 1	TU 176 I/2 16–30 cmbs	Imu (earth oven)	1860	101.8 ± 0.5% MODERN	-11.9	70 ± 40 MODERN		None
3497 E1	TU 180 I/2 10–20 cmbs	Floor Zone	2190	170 ± 40	-15.0	340 ± 40	1455–1655	A.D. 1573
3452 LT 1	TU 131 II/1 11–20 cmbs	Fire Pit	2280	290 ± 80	-27.8	240 ± 80	1470–1950	A.D. 1660
3802 E1	TU 188 I/2 10–20 cmbs	Floor Zone	2350	310 ± 50	-16.5	450 ± 50	1410–1515 1585–1625	A.D. 1445
3493 PT 1	TU 33 II/1 15–25 cmbs	Floor Zone	2500	40 ± 70	-25.2	40 ± 70	1675–1770 1800–1940	None
3816 WT 1	TU 63 I/4 30–40 cmbs	Floor Zone	2610	270 ± 70	-21.4	330 ± 70	1435–1675 1775–1800 1945–1950	A.D. 1571
3475 LT 1	TU 185 I/5 70–93 cmbs	Floor Zone	2670	170 ± 60	-13.3	360 ± 60	1435–1660	A.D. 1573
3469 ST 1	TU 16 I/3 24–33 cmbs	Floor Zone	2700	430 ± 80	-22.2	480 ± 80	1310–1365 1375–1535 1545–1635	A.D. 1435
3474 RS 1	TU 5 II/1 20–30 cmbs	Fire Pit	2750	30 ± 60	-25.9	20 ± 60	1690–1735 1815–1925	None

[Continued on next page]

Table 1. Summary of Kahikinui Mauka Radiocarbon Age Determinations by Ahupua'a and Elevation (continued)

SHPD Site No. (50-50-15-)	Provenience	Context	Elevation (fasl)	$^{13}/^{12}$C ^{14}C Age B.P.	^{13}C Adjusted Ratio	Calendric Age	Range A.D.	Mean Intercept
3472 LT 1	TU 41 III/1 23–35 cmbs	Floor Zone	2780	90 ± 50	-25.7	80 ± 50	1675–1770 1800–1940	None
Nakaohu Ahupua'a								
1156	TU 254 I/3 20–30 cmbs	Floor Zone	2140	110 ± 50	-10.9	340 ± 50	1450–1660	A.D. 1573
4262 PT 1	TU 119 I/2 10–20 cmbs	Floor Zone	2422	280 ± 60	-25.5	280 ± 60	1470–1680 1745–1805 1935–1950	A.D. 1650
3825 WT 1	TU 68 II/2 20–35 cmbs	Floor Zone	2450	420 ± 60	-30.7	330 ± 60	1445–1670	A.D. 1571
3831 RS 1	TU 58 I/2 10–20 cmbs	Floor Zone	2475	20 ± 60	-10.7	250 ± 60	1495–1695 1725–1815 1920–1950	A.D. 1655
4244 RS 1	TU 112 I/2 10–20 cmbs	Fire Pit	2480	100.6 ± 0.8% MODERN	-14.4	130 ± 70		A.D. 1788
4358 TP 1	TU 225 I/2 10–20 cmbs	Floor Zone	2520	100.3 ± 0.7% MODERN	-14.2	150 ± 60		A.D. 1791
3871 U1	TU 107 I/2 10–20 cmbs	Floor Zone	2570	310 ± 60	-25.8	330 ± 60	1455–1675 1770–1800 1940–1950	A.D. 1640
3885 PT 1	TU 238 II/1 15–25 cmbs	Floor Zone	2663	140 ± 60	-22.4	180 ± 60	1640–1950	A.D. 1796
3878 WT 1	TU 203 I/2 10–20 cmbs	Floor Zone	2670	190 ± 50	-27.5	150 ± 50	1655–1950	A.D. 1791
3874 L1	TU 99 I/2 8–17 cmbs	Floor Zone	2680	60 ± 50	-26.7	30 ± 50	1695–1725 1815–1920	None
4253 PT 1	TU 134 II/1 40–50 cmbs	Floor Zone	2780	370 ± 80	-26.1	360 ± 80	1420–1670 1780–1795 1945–1950	A.D. 1573
Naka'aha Ahupua'a								
4343 WT 1	TU 284 I/1 8–20 cmbs	Floor Zone	2120	120 ± 60	-20.7	190 ± 60	1640–1950	A.D. 1798
4300 TP 1	TU 283 I/2 10–20 cmbs	Floor Zone	2210	80 ± 70	-26.3	60 ± 70	1670–1780 1795–1945	None
4338 E1	TU 235 I/2 10–20 cmbs	Floor Zone	2240	160 ± 60	-14.1	330 ± 60	1445–1670	A.D. 1571
4321 PT 1	TU 291 I/2 10–20 cmbs	Floor Zone	2520	210 ± 60	-12.2	420 ± 60	1415–1640	A.D. 1455
4315 TP 2	TU 288 I/3 10–20 cmbs	Floor Zone	2620	120 ± 70	-27.5	80 ± 70	1665–1950	None
4310 E1	TU 45 II/2 20–26 cmbs	Floor Zone	2820	480 ± 70	-27.8	440 ± 70	1400–1640	None

* All samples are wood charcoal.

** Beta Analytic Radiocarbon Dating Laboratory, 2 sigma range, 95% probability calibrations.

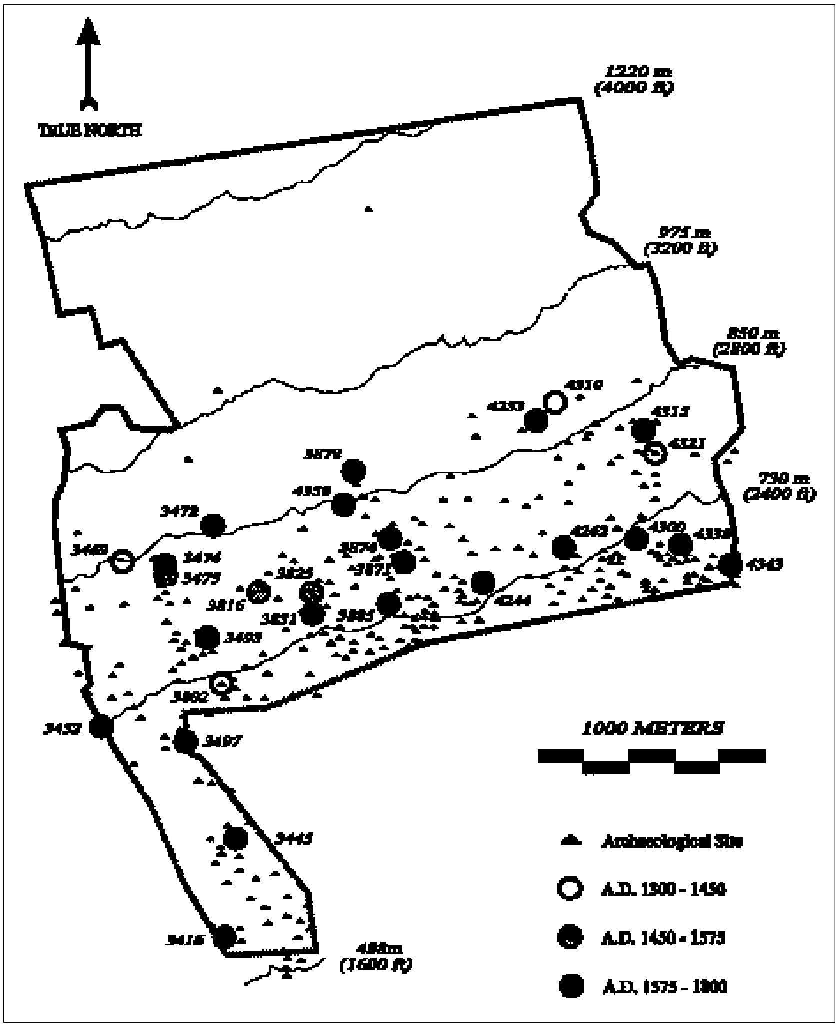

Figure 4. Location of Radiocarbon Dated Sites within the Kahikinui Mauka Project Area.

In Period 3, between A.D. 1575 and Euro American Contact (samples dating to A.D. 1650 may be contaminated by the Little Ice Age), settlement appears to have extended further up the slopes to approximately 3000 fasl at the edge of the Dry Montane Forest. Similar settlement also expanded to lower elevations with sites recorded along the homestead area access road corridor in Kīpapa *ahupua'a* down to 1600 fasl, and lower settlement documented to approximately 1400 fasl outside the project area (Chapman and Kirch 1979). This pattern of agricultural expansion may reflect the pressure of growing local populations, the decreasing fertility of upland soils after over a century of erosion, and/or perhaps higher tribute demands on local communities. This is also the period in which the majority of *heiau* or temples were built in the project area (Kolb and Radewagen 1997), as well as the construction of an extensive *hōlua* sledding facility (Dixon et al. 1998).

Post-Contact Period

After Euro American Contact in Period 4, the suite of radiocarbon dates presented in Figure 3 and paucity of foreign manufactured remains found during excavation (see below) suggests that the upper reaches of the Lowland Dryland forest were abandoned over a relatively short period of time. Above 2100 fasl, the lack of high (over 1 meter tall) habitation and garden enclosure walls to exclude imported livestock might suggest this abandonment occurred before the effects of loose cattle were seriously felt in forest periphery agriculture or on traditional house construction. Alternatively, the effects of introduced diseases in concert with the ravages of cattle on agricultural fields may have influenced the Hawaiian population toward rapid lower elevation resettlement as a natural defensive response to forces beyond their control. Proximity to circum-island communication routes along the Hoapili and *mauka* horse trails may also have been a consideration.

Population estimates from the 1831–1832 and the 1836 missionary census portray a much lower number of residents in Kahikinui than in surrounding districts (Schmitt 1973), but do not indicate where the population was residing. Judging from the few remains of early 19th century Native Hawaiian habitation within the lower access road corridor between 1600 and 2100 fasl in Kīpapa Ahupua'a, it appears that many upland inhabitants moved downslope to be near the Santa Ynez Catholic church, first visited by a priest in 1846 (Shoofs 1978). But by 1853, a census map compiled by Coulter in 1931 (Figure 5) shows that the only cluster of over 50 inhabitants in the entire district was at the village of Hanamau'uloa on the coast of Luala'ilua.

After this time, the rest of Kahikinui including the project area became part of a large ranching operation perhaps begun by Portuguese immigrant Manuel Pico and his Hawaiian descendants in the 1880s (Janion 1976), later to become part of the famous 'Ulupalakua Ranch. The cattle wall and corral found

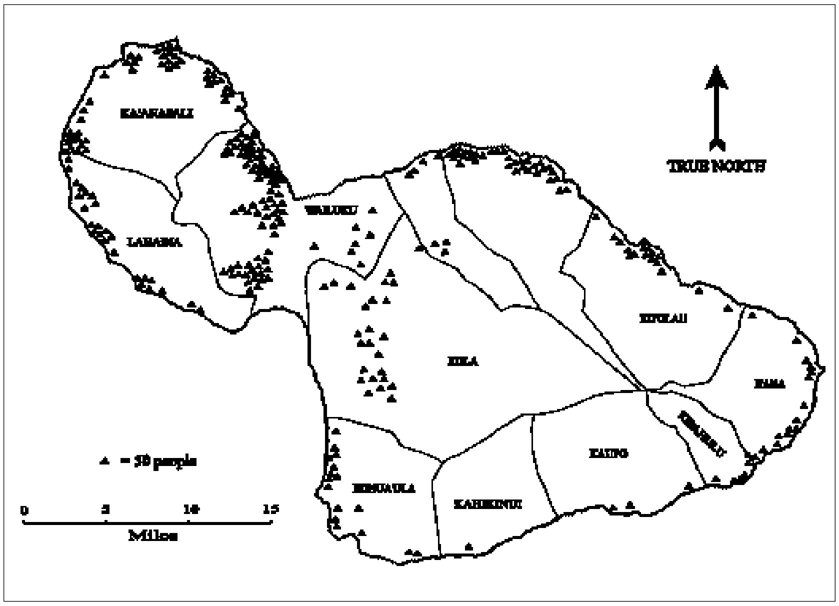

Figure 5. Maui Population Distribution Based on 1853 Census (after Coulter 1931).

Table 2. **Land Grants in Kahikinui Between 1855 and 1911***

Name	Number	Date	Apana	Ahupuaʻa	Acreage Granted
Allen, Elisha	2986	1865		Manawainui	792.75
Helekunihi (w)	2824	1861		Mahamenui	119
Kalalau, Samuel		1911			15.83
Kailoiloi	2805	1855		Kaohuiki (?)	24.75
Kamakaole	2888		1	Lualaʻilua	8.7
			2	Lualaʻilua	2.7
Kanakaole	2901	1855	1	Kipapa, Nakaohu	69.75
			2	Kaohuiki (?)	5.62
Kawahalama	1978	1856		Alena	10
Kawahinekuewa	2794	1856	1	Alena	27.3
			2	Kipapa	71.34
Keaoililani	8586	1911		Lualaʻilua	18.52
Kuahine	2988	1857	1	Lualaʻilua	8.09
			2	Lualaʻilua	5.61
Maluhia	2746	1860		Louluapa (?)	19.96
Naluai	2857	1855			36
Needham, Cook	2743	1860		Manawainui	2394.04

* Based on data collected by Holly McEldowney (1997).

at the presumed border of Kīpapa and Alena Ahupuaʻa may have been constructed during the initial roundup of wild cattle from the forests and abandoned upland agricultural zone. Ranching activities then appear to have become centered at the Kahikinui Ranch house and corrals (Conte 1998), its location being conveniently located along the *mauka* trail midway between the coastal and upland pastures. By the beginning of the 20th century, this ranch house was the only locus of semi-permanent habitation in the district, with a windmill and cattle trough being located in Nakaʻaha Ahupuaʻa near the village of ʻUliʻuli (SHPD, in progress).

Historic Documentation

Historic documentation of native Hawaiian settlement patterns in the Kahikinui *mauka* project area is very limited, and is inferential at best. The arrest of local residents Helio Kaiwiloa and Simeon Kaoao in the infamous *pakaula* or "tying with ropes" of 1843 (Schoofs 1978) is likely to have occurred in Nakaohu Ahupuaʻa, as the burning of their first Catholic grass church was at Puʻu Aniani (Ashdown 1973:6) which then became the site of Saint Ynez Church. The only individual who was awarded an 1848 Land Claim Award within the entire Kahikinui district was a farmer named Makaole who claimed two house sites, one *kula* plot, and 15 potato patches within Lualaʻilua Ahupuaʻa (Native Register, vol. 6:286; Foreign Testimony, vol. 8:227; Native Testimony, vol. 5: 360). Makaole's *kuleana* just west of Lualaʻilua hills was later visited overnight by a Dr. Rae in 1853 (Kirch 1997:9), who noted native Hawaiian pedestrian traffic on the trail while passing through the surrounding area. Subsequent land grants to Hawaiians and *haole* within the district compiled by Holly McEldowney (Table 2) show that settlement was concentrated between the *mauka* horse trail and the coastal Hoapili Trail/King's Highway.

By the late 1880s, the *moku* of Kahikinui had become part of Manuel Pico's ranching operation (Ashdown 1971, 1973), based at the Kahikinui Ranch house in Nakaohu Ahupuaʻa (Bartholomew 1994). Scattered windmills and cattle troughs on the slopes and on the coast below are found on some turn-of-the-century maps and were occasionally mentioned by travelers

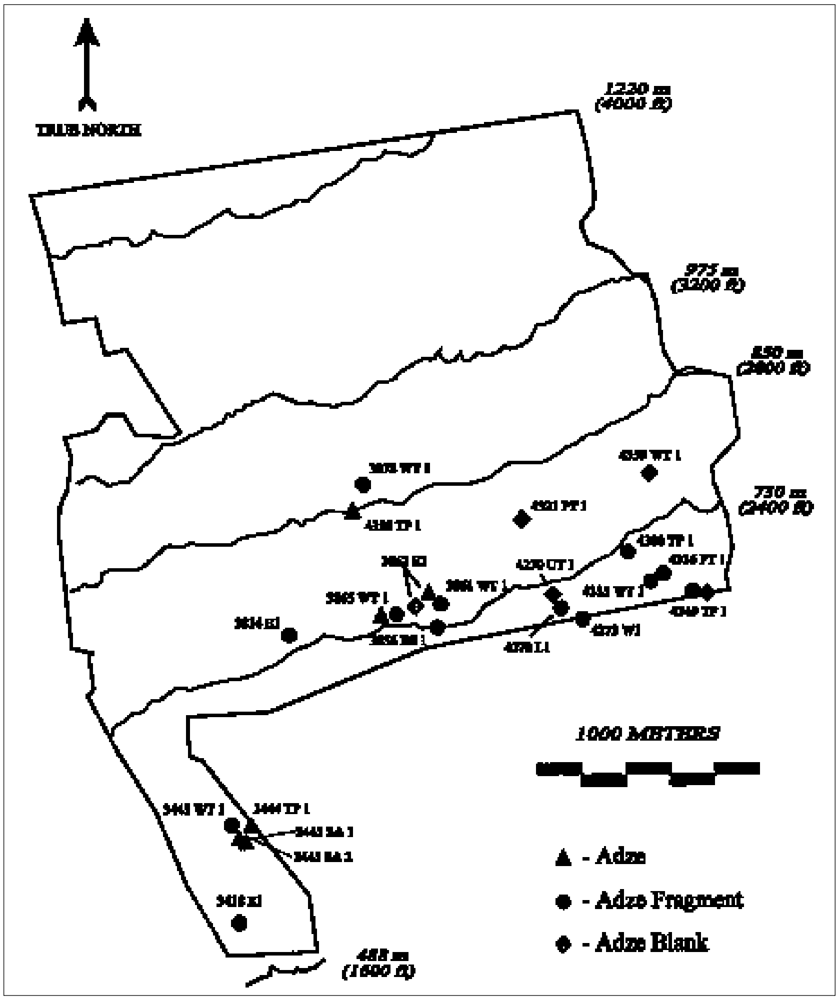

Figure 6. Distribution of Kahikinui Mauka Adzes, Adze Fragments, and Adze Blanks.

passing through the district (Baldwin 1881). A watering hole for pack animals was also mentioned on the original *mauka* foot trail above Luala'ilua hills (Sterling 1997:204), although the *mauka* horse trail was later realigned to cross between the hills at the written suggestion of government advisors (Anonymous manuscript, 1869). This realignment was apparently suggested in part to expedite pedestrian access to a new school to be constructed near the coast at this time, and is indicative of the gradual *makai* movement of settlement in the district after the construction of the Hoapili Trail in the late 1830s (Kirch 1997).

The lack of written documentation from Kahikinui *mauka* by this period therefore correlates well with artifactual and architectural evidence from the project area described below, which indicate that no permanent native Hawaiiansettlement was present above 2100 fasl in Kīpapa, Nakaohu, or Naka'aha Ahupua'a by the early 1800s. By the time of Winslow Walker's survey of the Kahikinui coastline in 1929, he found no remaining inhabitants on the coast of the entire district (Walker 1931).

Artifact Analyses

A comparison of the distribution of foreign made artifacts and post-Contact architecture, to traditional artifacts and architecture in the project area appears to reflect the rapid native Hawaiian abandonment of elevations above 2100 fasl not long after Euro American Contact in the early 1800s. As will be seen, the vast majority of artifacts and architecture recorded during survey and excavation are of pre-Contact manufacture and use, as a discussion of their raw materials, morphological attributes, and socio-archaeological context suggests below.

Artifacts of Indigenous Manufacture

The majority of traditional artifacts recovered from the project area were made of native materials easily found in Kahikinui between A.D. 1400 and 1778 (i.e. basalt, volcanic glass, coral, bone, and marine shell). Since there is no reason to believe that indigenous tool manufacture ceased immediately with the introduction of foreign tools after Euro American Contact, many of these artifacts may have been in use up until the abandonment of the project area in the early 1800s. Tool types identified by W. Koa Hodgins included nearly the full range of non-perishable domestic household implements: adzes, flake tools of basalt and volcanic glass, a sandstone food or *poi* pounder, bone food picks, a shell scraper, and possible shark tooth knives. Hodgins also identified recreational implements such as an *'ulu maika,* agricultural field tools such as large adzes, marine fishing gear such as a bone fishhook and an octopus lure sinker, and possible hunting or wartime tools such as basalt and coral slingstones. The distribution of adzes and adze blanks (Figure 6) appears to correlate with

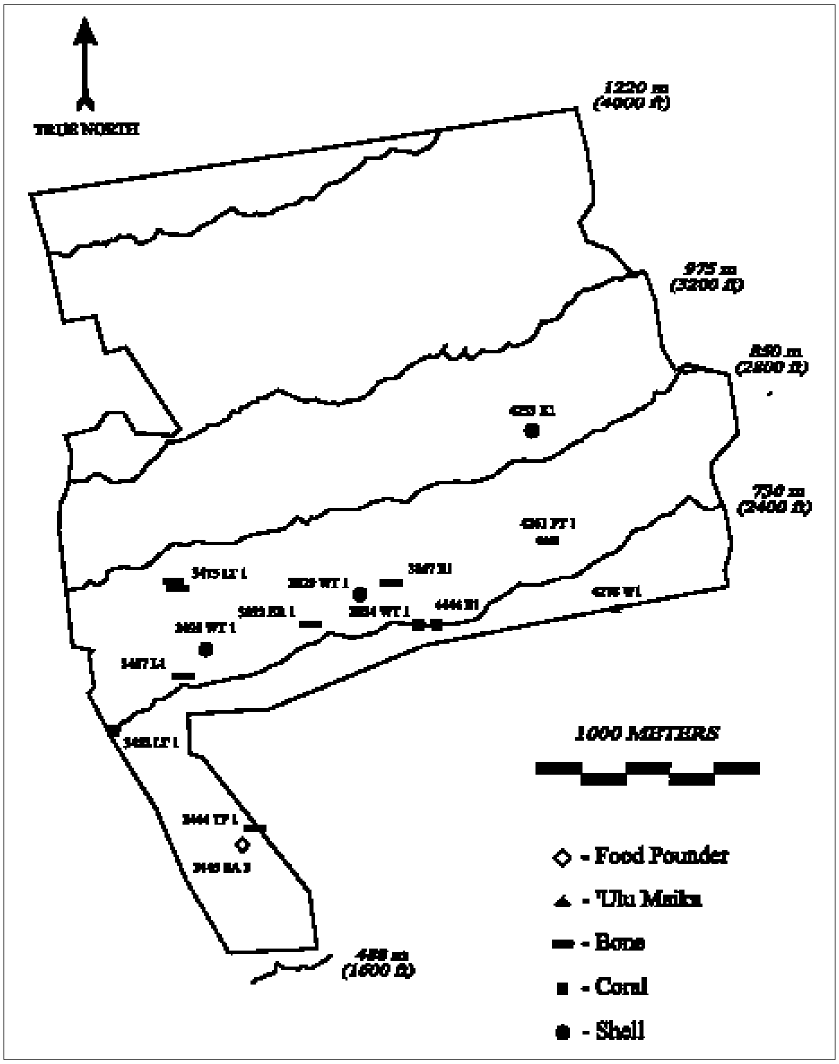

Figure 7. Distribution of Selected Kahikinui Mauka Traditional Artifacts.

the permanent habitation zone below 750 masl, while adze fragments were as often found in temporary field habitations above. The distribution of other traditional tools (Figure 7) is largely restricted to the permanent habitation zone.

Visual inspection of the finished pre-Contact stone tools does suggest that some were made from non-local raw material sources (some high-quality basalt adzes and the sandstone food or *poi* pounder for example), presumably entering the project area through intra- and inter-island exchange mechanisms prior to A.D. 1778. Source analysis and dating of specific tools and their raw materials (as in Weisler 1997) has yet to be conducted in Kahikinui, but will be critical to understanding the chronology and points of origin of pre-Contact exchange networks. For instance, some correlation might be expected between the radiocarbon dated appearance of tools from certain known off-island sources (i.e. Mauna Kea basalt adzes) and periods of inter-island *ali'i* conquest and/or intermarriage.

Artifacts of Foreign Manufacture

Only 13 of the 257 features (8 of the 179 sites) tested in the entire Kahikinui *mauka* project area produced post-Contact artifacts (Figure 8), and these sites were mostly found in Kīpapa Ahupua'a near cattle ranching era sites. Foreign manufactured artifacts identified by Hodgins included a few domestic household items (late 19th century glass bottles, ceramics, metal cans, and their fragments), limited elements of clothing (buckles and buttons of metal and ceramic), and one piece of a possible slate chalkboard, perhaps from the early schooling of Kahikinui inhabitants. The total absence of any early 1800s trade goods (e.g., glass beads, gunflints, or kaolin tobacco pipes) or traditionally modified foreign artifacts (e.g., bent nail fishhooks or flaked bottle glass tools) above 2100 fasl suggests a relatively early abandonment of the upper project area after Contact. Such artifacts were found at Site 3426 and 3428 just within the lower project area at 1600 fasl (Van Gilder and Kirch 1997:59), but were restricted to a set of high-walled habitation features and a corral obviously atypical of the general settlement pattern in higher elevations.

Foreign manufactured artifacts were found at two other habitation sites in the project area which do not appear to have been modified for post-Contact use, suggesting very limited continuity of traditional settlement after 1778. Site 3852 is a terraced platform located immediately above a *heiau* in Nakaohu Ahupua'a, perhaps being the home of a *kahu* of the structure after its abandonment (see Kolb and Radewagen 1997 for a similar feature in Luala'ilua Ahupua'a). Site 3444 contains another terraced platform which was found near a post-Contact corral only a few hundred feet in elevation above Site 3426 and 3428. Excavations here yielded traditional midden, a small broken adze fragment, and bits of metal beneath the

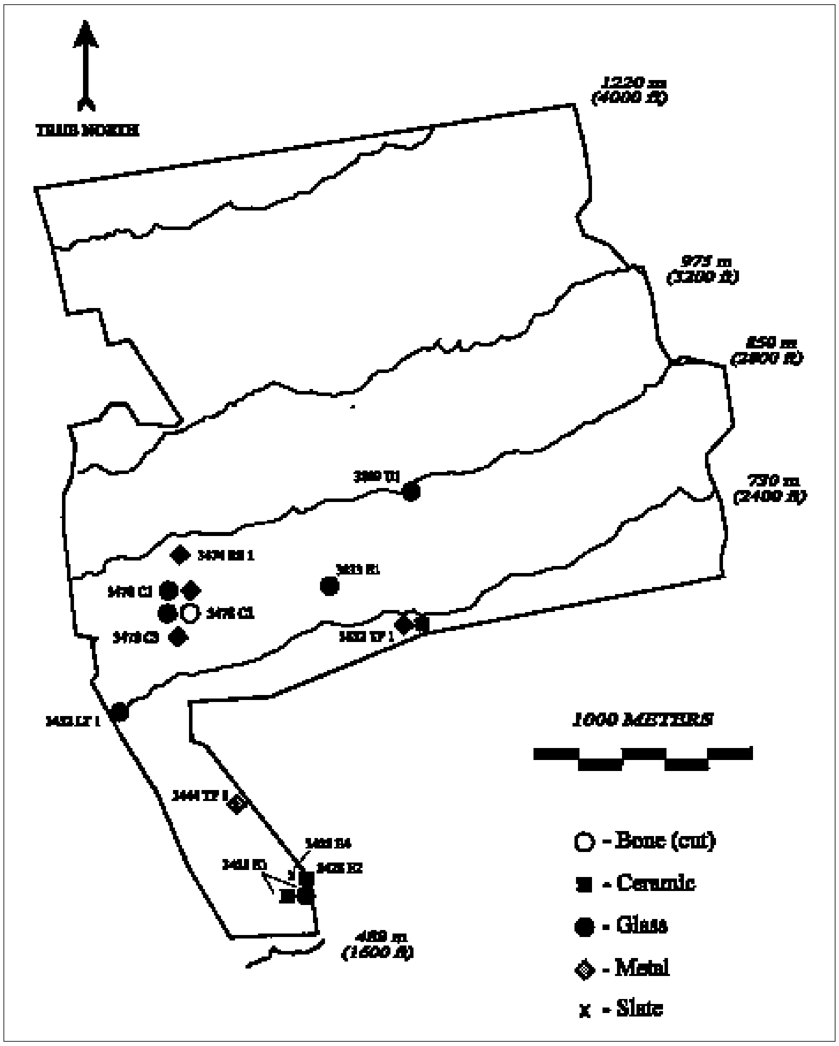

Figure 8. Distribution of Kahikinui Mauka Post-Contact Artifacts.

floor zone, again suggesting limited occupation into the 1800s before large domestic animals became a problem to local inhabitants.

The other artifacts manufactured in the late 1800s and early 1900s found above 2100 fasl did not occur in permanent habitation features, but were rather found in three C-shapes (Site 3478) and a modified lava tube (Site 3452), suggesting temporary use by local cowboys or *paniolo*. This observation is also corroborated by the fact that these particular artifacts (a liquor bottle, buttons, and metal can fragments) were from a narrow range of domestic objects available on Maui, and more likely associated with overnight camping or hunting than permanent habitation. Cattle ranching artifacts (i.e. horse shoes and metal tool fragments) occurred only within the corral at the Kīpapa/Alena Ahupuaʻa boundary wall, but were not collected during the survey. Excavations at Kahikinui House, Site 50-50-15-1536 (Conte 1998), on the other hand, produced a much broader range of both domestic and ranching artifacts.

Architectural Form and Function

The suite of radiocarbon dates from domestic habitations within the project area, in concert with the lack of 19th century documentation and the paucity of post-Contact remains found during testing, suggests that the upper Lowland Dry forest was occupied almost exclusively prior to Euro American Contact in Kīpapa, Nakaohu, and Nakaʻaha Ahupuaʻa. Negative architectural evidence corroborates this supposition, where, above 2100 fasl, the complete lack of high (over one meter tall) habitation and garden enclosure walls to exclude imported livestock indicate relatively quick abandonment of this zone. In fact, some have suggested that the introduction of cattle was a major cause of upland Kahikinui's abandonment (McGregor 1989:369; Matsuoka, n.d.).

However, the high quality, "core-filled" methods used in the construction of the post-Contact Kīpapa cattle wall, similar to those employed in pre-Contact structures throughout the area, suggest the use of native Hawaiian labor. It is also interesting to note that this *mauka-makai* cattle wall separating Alena and Kīpapa Ahupuaʻa has been built on a ridge line which may have been the traditional boundary between the two community land units, again suggesting that native Hawaiians were involved in its construction. Judging from the artifactual evidence recovered at Site 3426 and 3428 (Van Gilder and Kirch 1997) and at the Kahikinui House (Susan Lebo, personal communication 1998), it is likely that this wall system was already constructed by the 1880s.

Architectural indicators of the effects of loose cattle on traditional house construction (Ladefoged 1991; Sweeney 1992) are only visible within the project area at Site 3428 and 3426, a high-walled habitation complex with corral, animal pens, and garden enclosures. The Kīpapa/Alena boundary wall and corral

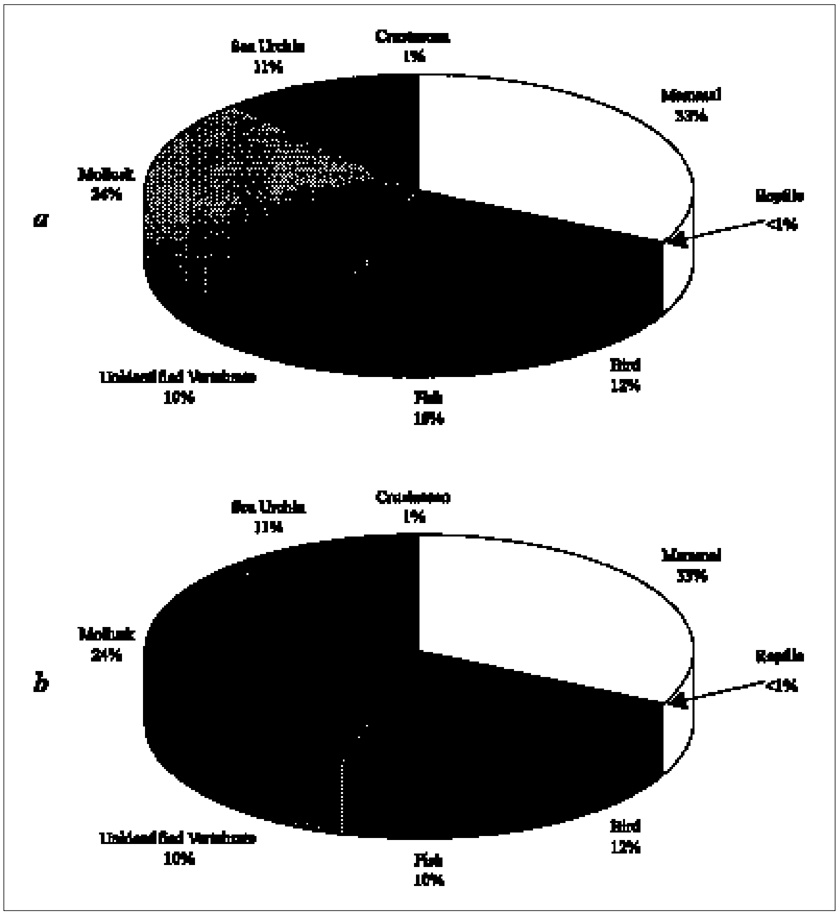

Figure 9. Breakdown of the Kahikinui Mauka Midden Assemblage by NISP (a) and Weight (b).

west of Uma, the three C-shaped enclosures at Site 3478, and the liquor bottle in lava tube Site 3452 also presumably date to the initial roundup of wild cattle in upland Kahikinui, as these features were no longer used extensively by the *paniolo* at Kahikinui Ranch by the 1920s (Rev. David Kelalakea, personal communication 1997). Wooden cattle troughs and above-ground water cisterns recorded within the project area are more likely an innovation of 20th century cattle leases (Bartholomew 1994), as all are connected to a recently abandoned system of metal water pipes and bulldozed access roads.

Judging from the location of early 19th century Native Hawaiian habitation remains within Sites 3426 and 3428 at approximately 1600 fasl (Van Gilder and Kirch 1997) and at Site C/K 335 along the coast (Kirch and Van Gilder 1996), it appears that post-Contact upland inhabitants moved *makai* to be closer to coastal commerce and overland communication routes such as the *mauka* horse trail and the Hoapili Trail/Kings Highway (Burgett et al. 1995; Erkelens 1995; Moore et al. 1994). Another possible center of social and ritual importance may have been located just *mauka* of the Santa Ynez Catholic church, where a network of high-walled habitations, probable corrals, and field boundary walls have been recorded (Kirch and Van Gilder 1996:44). Interestingly, Van Gilder and Kirch (1997) also suggest that Site 3428 was originally a pre-Contact *heiau,* and later rebuilt into a walled yard and house foundation, perhaps by recently converted Catholic native Hawaiians in the 1840s.

Paleoenvironmental Analyses

The identification of discarded food remains (midden), macrobotanical remains, land snails, pollen, phytoliths, and plant and animal residues from radiocarbon dated habitation contexts was undertaken to reconstruct the environment in which native Hawaiian inhabitants of Kahikinui lived and farmed. As will be seen, these results suggest a largely pre-Contact date for settlement within the project area, as few species known to have been introduced to Maui after Euro American Contact in 1778 were present in the subsurface archaeological record.

Food Midden

Marine species were the dominant pre-Contact food source in upland Kahikinui when expressed by the "number of identified specimens" or NISP (Figure 9), while mammals contributed the largest percentage of the assemblage by weight. Splash zone mollusks identified by Valerie Nagahara were the largest single category of marine remains, followed by urchins and shoreline fish species, as might be expected by the generally rough seas and lack of coral reef on the Kahikinui coastline. Among the mammalian species, Alan Ziegler identified taxa introduced in the post-Contact era such as goats and cows primarily from surface contexts; wild dogs, mongoose, and hunters may have played a role in the deposition of these species. Pig and dog remains from subsurface contexts, on the other hand, were interpreted as dating to the

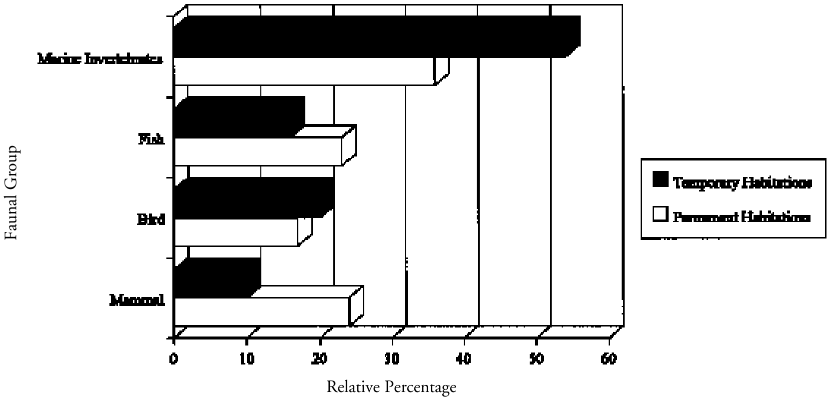

Figure 10. Distribution of Faunal Groups in Kahikinui Mauka Habitations.

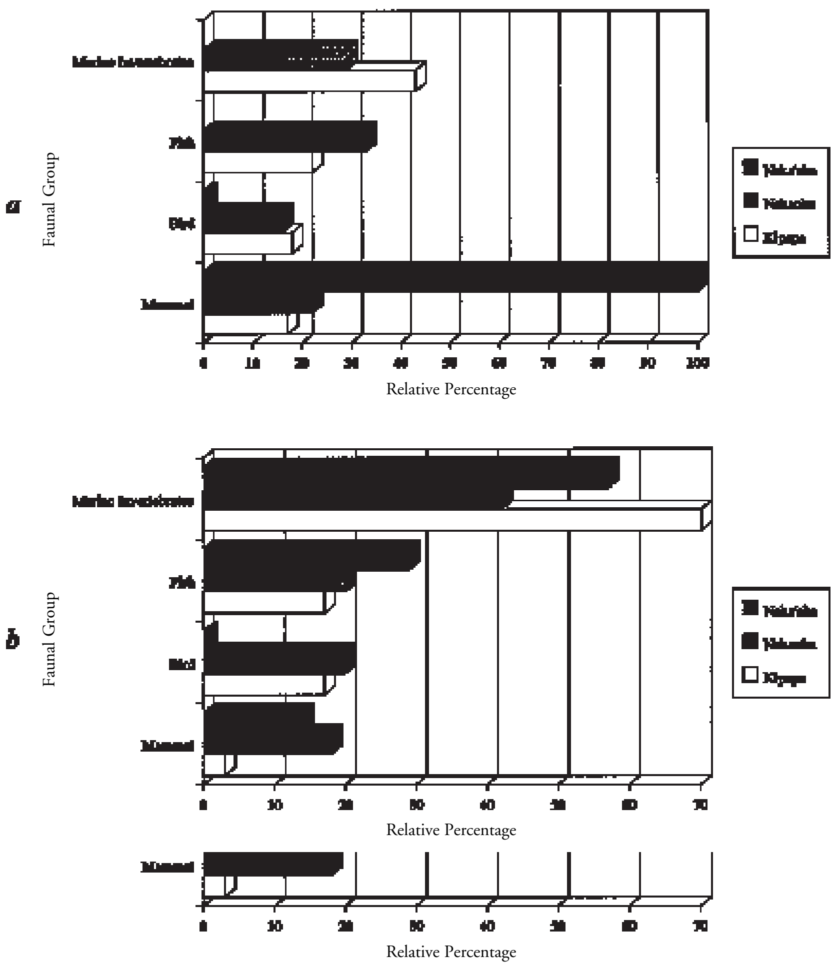

Figure 11. Distribution of Faunal Groups in Kahikinui Mauka Permanent (a) and Temporary (b) Habitations.

pre-Contact era. Several species of endemic birds were identified by Ziegler from subsurface contexts, including the *nēnē* goose, flightless rail, extinct crow, sea birds such as petrels, and forest song birds. The Polynesian-introduced chicken was also found, but in smaller amounts, suggesting a stronger reliance on wild rather than domesticated birds in pre-Contact times. Large domestic fowl such as peacock and pheasant were also found, having been introduced to south Maui in the 1800s (Janion 1976).

A comparison of the social context of these midden remains is intriguing, suggesting several possible patterns of pre-Contact consumption and natural resource distribution. When lumping midden remains by habitation type across the project area for instance (Figure 10), it appears that the permanent domestic household diet was equally dependent on mammals, birds, and marine species. Occupants of temporary field habitations, on the other hand, were more likely to consume marine invertebrates and less likely to consume mammals. When comparing these two habitation types by *ahupuaʻa* (Figure 11), however, it appears that the diet in permanent habitations varied considerably by community, while that of temporary field habitations was more similar. One example is the distribution of native song birds within excavated habitation contexts across all three *ahupuaʻa* (Figure 12), where they were found primarily in the transitional zone between the Lowland Dry and Dry Montane forests in Kīpapa and Nakaohu, with no evidence of avian exploitation (or native forest preservation?) in Nakaʻaha Ahupuaʻa.

Botanical Remains

Gail Murakami identified carbonized wood from three subsurface contexts in the project area (Table 3): at Site 3469 (a habitation terrace floor dated to A.D. 1310–1635), Site 3474 (a rock shelter fire pit dated to A.D. 1650–1950) and Site 3878 (a possible ritual walled terrace floor dated to A.D. 1650–1950). All species were found to be endemic, indigenous, or Polynesian-introduced shrubs and smaller trees, perhaps representing secondary growth or curated plant communities around habitation sites and fields which were also exploited for a variety of domestic uses. There was a noticeable absence of primary forest spe-

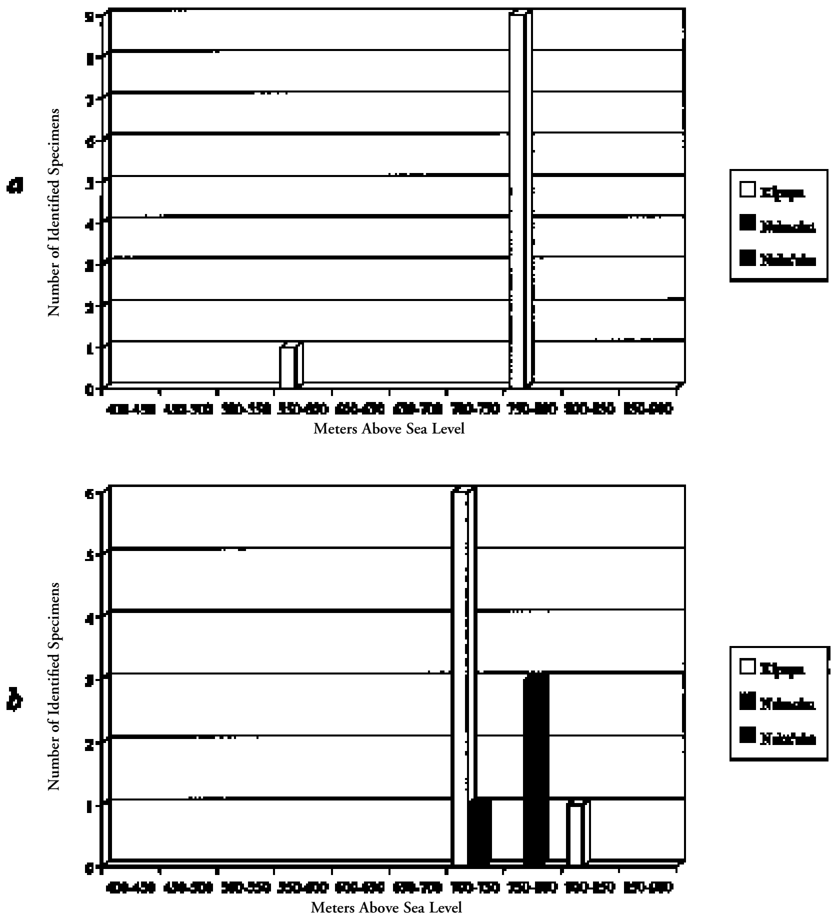

Figure 12. Distribution of Passerine / Small Aves in Kahikinui Mauka Permanent (a) and Temporary (b) Habitations.

cies such a *koa* and *ʻōhiʻa,* although these taxa may have been used in constructing habitations rather than as firewood. Burned *kukui* nutshells were also found in these and many other undated contexts, as might be expected from pre-Contact domestic habitations.

Macrobotanical remains floated from soil samples in six radiocarbon dated contexts by Tanya Lee were identified by Heidi Lennstrom in the hope of isolating other pre-Contact plant food species, but preservation of almost all organics was found to be very poor. The *ʻūlei* shrub was identified from Site 3493 (a habitation terrace floor dated to A.D. 1675–1940), although it is still prevalent in parts of the project area today. The introduced passion flower was also identified in these contexts, but it was most likely introduced in modern times, especially as the number of range cattle has been greatly reduced since 1991. Burned lantana was sometimes found in excavated surface contexts too, but was not collected since it was introduced to south Maui by James Makee at Rose Ranch in the mid-1880s (Janion 1976).

Land Snails

Land snails were recovered from all subsurface archaeological contexts in the project area, and Robert Cowie analyzed samples from two sites: Site 3802 (a habitation enclosure floor dated to A.D. 1410–1625) and Site 3831 (a rock shelter fire pit dated to A.D. 1495–1950). Almost no specimens were identified as being introduced after Euro-American Contact, except for *Gastrocopta servilis.* All remaining species were endemic to the dry and mesic forests on Maui and other Hawaiian islands, indicating little post-Contact contamination of the contexts selected for identification. The presence of *Nesopupa wesleyana* (found under the loose bark of the *ʻōhiʻa* tree) and *Pronesopupa acanthinula* (usually found in *kukui* dominated forests) may mean that remnant primary forest stands were deliberately left intact around pre-Contact habitation zones and field systems, perhaps to be exploited for a variety of domestic uses. On the other hand, some of the species which no longer exist today may have disappeared (at least from the project area) due to post-Contact habitat destruction after the introduction of cattle and the subsequent deforestation of Kahikinui slopes below approximately 4000 fasl.

Pollen Analysis

Linda Scott Commings analyzed pollen samples from two archaeological contexts: Site 3472 (a habitation terrace floor dated to A.D. 1675–1940) and Site 3802 (a habitation enclosure floor dated to A.D. 1410–1625). Pollen evidence for the probable cultivation of sweet potato (*Ipomoea* sp.) was present (Table 4), although the pollen fragments could only be identified to the genus level due to their deteriorated condition. Endemic dry mesic-forest trees including Araliaceae, Myrtaceae, and the *Pritchardia* or *loulu* palm were also present, as were shrubs such

Table 3. Plant Taxa Identified in Carbon Remains from Kahikinui Mauka

Location Material/ScientificName	Hawaiian Name	Origin	Habit	Habitat	Traditional Hawaiian Uses	Radiocarbon Date	Elevation
Site 3469 Feature ST 1							
WOOD							
Cf. *Bobea* sp.	*ʻAhakea*	Endemic	Tree	Dry to Mesic Forests	canoe making, *poi* boards	A.D. 1310–1635	815 m
Chamaesyce spp.	*ʻAkoko*	Endemic	Shrub-Tree	Dry, Mesic Forests	canoe making	A.D. 1310–1635 A.D. 1655–1950	815 m 855 m
Diospyros sandwicensis	*Lama*	Endemic	Shrub-Tree	Dry to Wet Regions	houses, idols, food	A.D. 1310–1635	815 m
Nestegis sandwicensis	*Olopua*	Endemic	Tree	Dry to Mesic Forests	digging sticks, spears, adze handles	A.D. 1310–1635	815 m
Osteomeles anthyllidifolia	*ʻUlei*	Indigenous	Shrub	Dry Regions	fishing tools, digging sticks muscial instruments	A.D. 1310–1635 A.D. 1690–1925	815 m 829 m
Cf. *Pittosporum* sp.	*Hoawa*	Endemic	Shrub-Tree	Dry to Wet Forests	fuel, medicinal	A.D. 1655–1950	855 m
Rauvolfia sandwicensis	*Hao*	Endemic	Tree	Mesic, Dry Forest Dry Shrubland	—	A.D. 1310–1635	815 m
Cf. *Xylosma hawaiiense*	*Maua*	Endemic	Tree	Mesic, Wet Forests Dry Woodland	timber for boards, planks	A.D. 1310–1635	815 m
Site 3474 Feature RS 1							
WOOD							
cf. *Bidens* sp.	*Koʻokoʻolau*	Indigenous	Herb, Shrub	Dry to Wet Regions	medicinal tea	A.D. 1690–1925	829 m
Chamaesyce spp.	*ʻAkoko*	Endemic	Shrub-Tree	Dry, Mesic Forests	canoe making	A.D. 1310–1635 A.D. 1655–1950	815 m 855 m
Osteomeles anthyllidifolia	*ʻUlei*	Indigenous	Shrub	Dry Regions	fishing tools, digging sticks muscial instruments	A.D. 1310–1635 A.D. 1690–1925	815 m 829 m
Site 3878 Feature WT 1							
WOOD							
cf. *Abutilon menziesii*	*Koʻoloa-ʻula*	Indigenous	Shrub	Dry, Leeward Areas	—	A.D. 1655–1950	855 m
Aleurites moluccana	*Kukui*	Polynesian Introduction	Tree	Dry to Wet Regions	canoe making, strengthen tapa	A.D. 1655–1950	855 m
cf. *Antidesma pulvinatum*	*Hame*	Endemic	Tree	Dry to Mesic Forests	tapa making	A.D.1655–1950	855 m
Chamaesyce spp.	*ʻAkoko*	Endemic	Shrub-Tree	Dry, Mesic Forests	canoe making	A.D. 1310–1635 A.D. 1655–1950	815 m 855 m

[Continued on next page]

Table 3. Plant Taxa Identified in Carbon Remains from Kahikinui Mauka (continued)

Location Material/ScientificName	Hawaiian Name	Origin	Habit	Habitat	Traditional Hawaiian Uses	Radiocarbon Date	Elevation
cf. *Cheirodendron trigynum*	*'Olapa*	Indigenous	Tree	Mesic to Wet Forests	bird snares, dye	A.D. 1655–1950	855 m
cf. *Hedyotis* sp.	*Pilo*	Endemic	Shrub	Mesic, Wet Forests	—	A.D. 1655–1950	855 m
Nestegis sandwicensis	*Olopua*	Endemic	Tree	Dry to Mesic Forests	digging sticks, spears, adze handles	A.D. 1310–1635	815 m
cf. *Pittosporum* sp.	*Hoawa*	Endemic	Shrub-Tree	Dry to Wet Forests	fuel, medicinal	A.D. 1655–1950	855 m
cf. *Pouteria sandwicensis*	*'Ala'a*	Endemic	Tree	Dry, Mesic Forest	—	A.D. 1655–1950	855 m
Rauvolfia sandwicensis	*Hao*	Endemic	Tree	Mesic, Dry Forest Dry Shrubland	—	A.D. 1310–1635	815 m
cf. *Xylosma hawaiiense*	*Maua*	Endemic	Tree	Mesic, Wet Forests Dry Woodland	timber for boards, planks	A.D. 1310–1635	815 m
NUTSHELL							
Aleurites moluccana	*Kukui*	Polynesian Introduction	Tree	Dry to Wet Regions	fishing aid, light, food	A.D. 1655–1950	855 m

as Cheno-am, herbs such as Asteraceae, fern spores, and Poaceae or grasses (see Athens and Ward 1997: 46 for similar contexts). It should be noted that windborn pollen found in archaeological contexts may actually reflect plant communities at various elevations to the east, given prevailing trade winds. Thus, dryland forest species such as *Pritchardia* may not have actually been present within the project area. The shallow cultural deposits also precluded any chronological sequence of environmental change, so our picture of the pre-Contact Kahikinui landscape is unrealistically static.

Phytolith Analysis

Cummings also analyzed plant phytoliths samples from two archaeological contexts (Table 5): Site 4310 (a habitation enclosure dated to A.D. 1400–1640) and Site 3452 (a lava tube fire pit dated to A.D. 1470–1950). Phytoliths are considered to be a reflection of plants being used in the excavated habitation context. Evidence was recovered of palm (for matting or senit lashing?), chloridoid short grasses (found beneath matting?), and festucoid and panicoid tall grasses (for roofing?). The absence of Palmae in wood charcoal identifications by Murakami suggests the deliberate introduction of finished palm products from the coast, while the Poaceae or grasses were more likely growing within the immediate project area.

Protein Residue Analysis

Cummings conducted analyses of animal protein residues from six archaeological tools and associated soils found in excavated archaeological contexts: a shark tooth from Site 3445 (a habitation terrace floor dated to A.D. 1685–1930), a bone pick from Site 3867 (an undated habitation floor), a bone pick from Site 4261 (an undated habitation terrace floor), an adze from Site 4300 (a habitation platform floor dated to A.D.

Table 4. Plant Taxa Identified from Pollen Samples in Kahikinui Mauka

Location Material/ScientificName	Common Name	Radiocarbon Date	Elevation (masl)
Site 3472 Feature LT 1			
TREES			
Araliaceae	Ginseng Family	A.D. 1675–1770 A.D. 1800–1940	835
SHRUBS			
Cheno-am	Goosefoot Family	A.D. 1675–1770 A.D. 1800–1940	835
HERBS			
High-spine Asteraceae	Sunflower Family	A.D. 1675–1770 A.D. 1800–1940	835
Ipomoea	Morning Glory Genus	A.D. 1675–1770 A.D. 1800–1940	835
Site 3802 Feature E1			
TREES			
Myrtaceae	Myrtle Family	A.D. 1410–1515 A.D. 1585–1625	706
PALMS			
Pritchardia	*Pritchardias (loulu)*	A.D. 1410–1515 A.D. 1585–1625	706
SHRUBS			
Cheno-am (D)	Goosefoot Family	A.D. 1410–1515 A.D. 1585–1625	706
HERBS			
Low-spine Asteraceae	Sunflower Family	A.D. 1410–1515 A.D. 1585–1625	706
High-spine Asteraceae	Sunflower Family	A.D. 1410–1515 A.D. 1585–1625	706
Liguliflorae	Sunflower Family	A.D. 1410–1515 A.D. 1585–1625	706
Ipomoea	Morning Glory Genus	A.D. 1410–1515 A.D. 1585–1625	706

(D) = dominant flora in sample.

1670–1945), an adze from Site 3444 (an undated habitation enclosure floor), and a shark tooth from Site 4270 (an undated habitation enclosure floor). Positive reactions to fish, bird, dog, rat, and human antisera on these tools may reflect their use in preparing pre-Contact dietary items, while weak positive soil reactions to goat, sheep, deer, rabbit, and cattle antisera presumably reflect contamination by post-Contact introductions on the landscape. Interestingly, no protein residue evidence was found for the use of pig, although it is known that pigs were a primary offering and tribute item in upland Kula (Kolb, Conte, and Cordy 1997), and are still present in the project area today. Soils from an earth oven at Site 3445 were also analyzed, and produced positive reactions to fish antisera.

Summary

In summarizing these data, it appears that initial native Hawaiian settlement within the Kahikinui *mauka* project area focused on the upper reaches of the Lowland Dry forest by A.D. 1450 (Figure 13), perhaps when chief Kaka'alaneo first divided the island into political subdivisions (Beckwith 1970). Exploitation of dry forest resources and soils then appears to have intensified around A.D. 1575, perhaps when chief Pi'ilani unified the island for the first time (Fornander 1996). Archaeological data suggest that indigenous populations within the project area continued to grow until Contact, spreading down to approximately 1200 fasl as upper elevation soil erosion created new pockets of exploitable alluvium. Within one or two generations after 1778, it appears that the project area above 2100 fasl was virtually abandoned (Figure 14), with very limited evidence of any permanent agricultural habitation. By the mid-1800s, remnant populations had moved down to the *mauka* and *makai* trails, with only temporary overnight camping presumably associated with ranching activities.

Land snail evidence, bird bone identifications, and a preponderance of *kukui* nutshells in excavated habitation contexts suggest that portions of the Lowland Dry forest regime were maintained to some extent throughout the period of native Hawaiian occupation until European contact in 1778. On the other hand, wood charcoal identifications and pollen evidence from dry-forest shrubs, herbs, grasses, and *Ipomoea* sp. suggest that pre-Contact agricultural practices transformed the landscape by creating "... the greatest continuous dry planting area in the Hawaiian Islands" (Handy 1940:161). Food midden and protein residue analyses suggest that the traditional diet was supplemented by a generous reliance on marine life, primarily from coastal species. A study

Table 5. Plant Taxa Identified from Phytolith Samples in Kahikinui Mauka

Location Material/ScientificName	Common Name	Radiocarbon Date	Elevation (masl)
Site 3452 Feature LT 1			
PALMS			
Palmae	Palm Family	A.D. 1470–1950	720
GRASSES			
Festucoid forms	Long Grasses	A.D. 1470–1950	720
Chloridoid forms (D)	Short Grasses	A.D. 1470–1950	720
Panicoid forms	Long Grasses	A.D. 1470–1950	720
Site 4310 Feature E1			
PALMS			
Palmae (D)	Palm Family	A.D. 1400–1640	875
GRASSES			
Chloridoid forms	Short Grasses	A.D. 1400–1640	875

(D) = dominant flora in sample

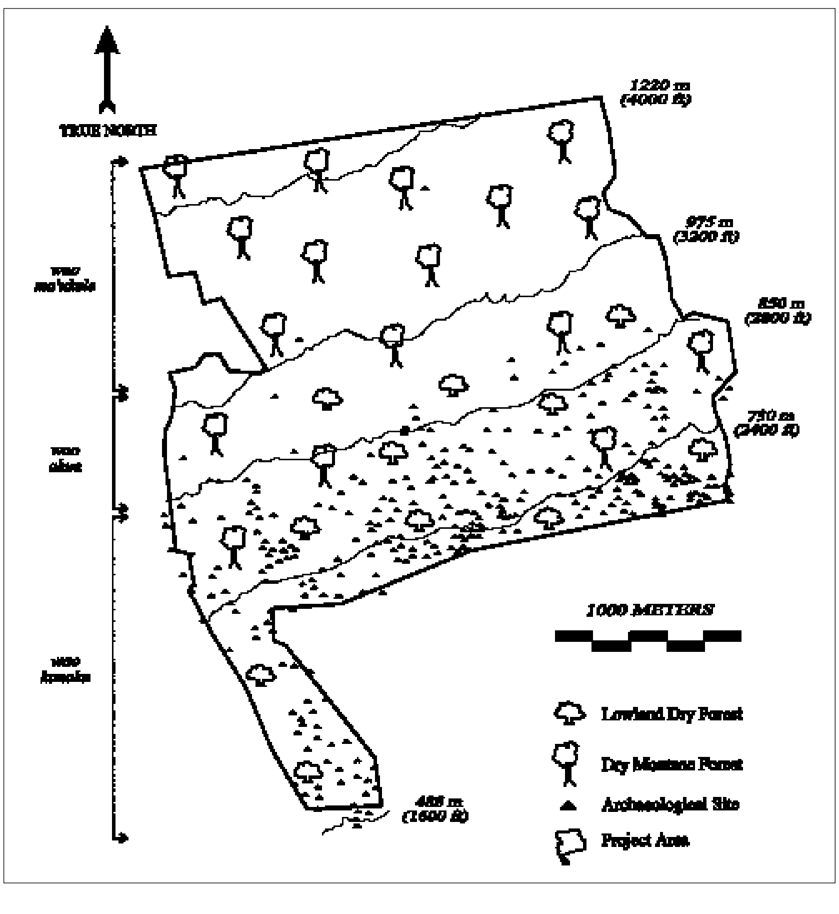

Figure 13. Paleoenvironmental Zones within the Kahikinui Mauka Project Area.

of excavated artifacts and mapped architecture in the project area then indicates that this dryland field system was virtually abandoned not long after contact, leaving only remnants of the once verdant landscape today.

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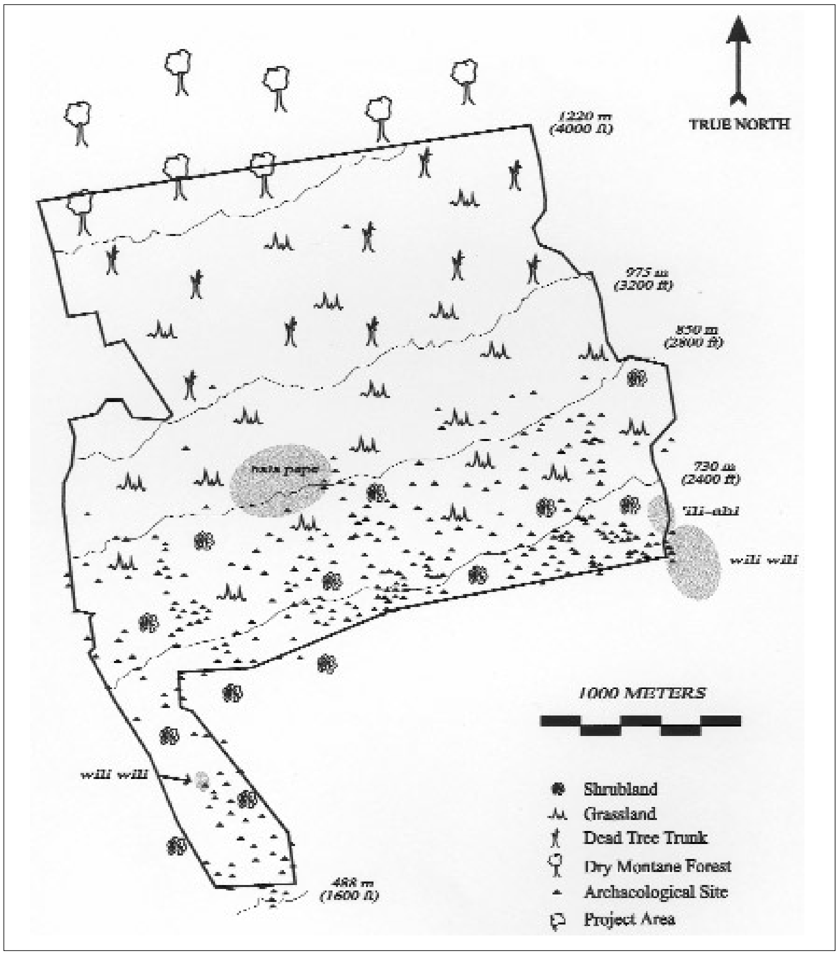

Figure 14. Modern Vegetation Zones within the Kahikinui Mauka Project Area.

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Early Human Activity at a Leeward Coastal Pondfield near Kalepolepo, Maui

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Introduction

This paper presents the results of excavations undertaken near the historic Kalepolepo Church (SHIP #15-10-1587) in Kīhei located in leeward east Maui. This place was an important component of the ancient coastal enclave of Kalepolepo, known for its series of coastal fishponds, and later for, the religious community of David Malo. The goal of excavation was to provide comparative coastal subsistence information for the upland survey conducted in Waiohuli (Kolb, Conte and Cordy 1997). Ethnohistoric records indicate that this area was primarily suited for sweet potato cultivation, although land documents suggest that a number of coastal pondfields in the area provided opportunities for the production of wetland taro. Most studies on Hawaiian dryland agriculture have focused on upland leeward agricultural systems (e.g. Rosendahl 1994) since many leeward coastal ponds have been destroyed by coastal development. Our results indicate human activity at the Kalepolepo church site began around a small inland pond about the same time as intensive permanent upland settlement in Kula.

The Cultural Sequence of Kula

Kalepolepo is located in the district of Kula (Figure 1). Kula was a minor political territory under the jurisdiction of the West Maui chiefs. It is a fairly arid region known for its gentle slopes, upland forest, and intensive sweet potato agriculture and pig husbandry. An archaeological survey in Waiohuli and synthesis of coastal archaeological sites in Kula and Honuaʻula (Kolb, Cordy, and Conte 1997) has

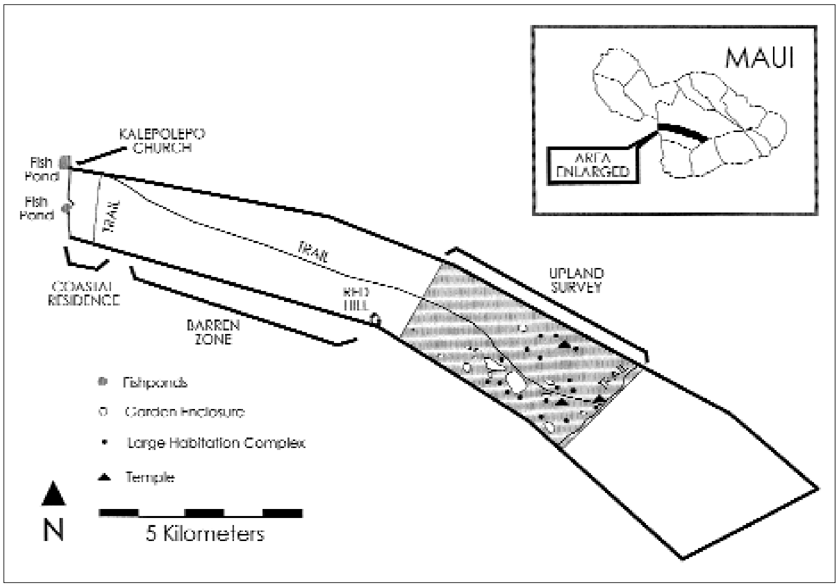

Figure 1. The location of Kalepolepo and the upland community survey of Waiohuli (Kolb, Cordy, and Conte 1997).

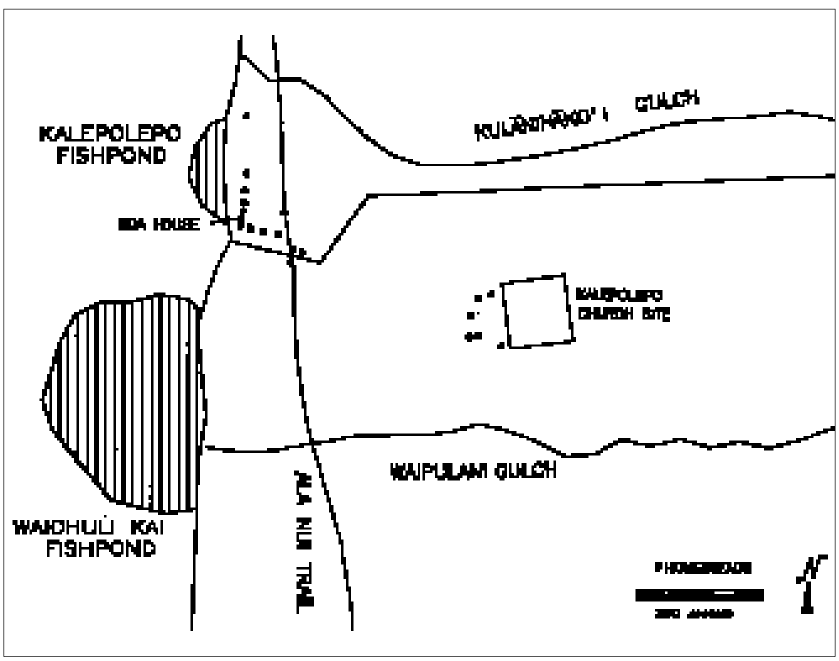

Figure 2. The enclave of Kalepolepo.

shown that the region has a relatively lengthy history. In both the coastal and upland areas, limited agriculture as well permanent residence begins (also see Kolb 1997, Kolb and Snead 1997). Early permanent settlement in both the coast and upland began circa A.D. 1400. Settlement was very low in intensity, most likely focusing upon the exploitation of forest resources such as native birds, wood and coastal resources such as fish. Concentrated upland permanent residence, and intensive dryland agriculture burst onto the landscape after 1400. Permanent habitations with surrounding agricultural terraces were being constructed, as well as small ritual structures. Permanent settlement in the uplands and along the coast continued to intensify during the 1500s. Settlement intensification continued into the 1600s, with more permanent upland and coastal residences, more upland medium-sized *heiau,* and more evidence of upland large garden enclosures for the growing of sweet potatoes.

The Coastal Enclave of Kalepolepo

Kalepolepo is located along a strip of leeward Maui coastline called Kīhei (Figure 2). The history of Kalepolepo is dominated by tales of chiefly privilege as early as the late 1500s A.D. Kalepolepo is known for its ancient royal fishpond, one of several located in Kīhei used for husbanding millet fish prized by the chiefs of Maui (Wilcox 1921). A small ancient village was also located in the area, and its economy was based upon the exploitation of local fishing grounds, fish husbandry, and the planting of wetland taro, sweet potato, and other food crops around the various coastal pools and swamps. The local foodstuffs were plentiful enough that in 1850, Captain John Joseph Halstead built the Koa House at Kalepolepo, a provisioning station for European whaling ships in the area (Jenkins 1983).

Kalepolepo was also the site of a small religious community organized by David Malo, an important Hawaiian chief and retainer of King Kamehameha as well as a Minister in the Congregational Church of Christ. Malo moved to Kalepolepo in 1843, after a renowned career as student, historian, writer, and General School Agent at Lahainaluna Seminary. He preached under the trees in Kalepolepo, summoning the congregation by blowing a huge conch shell horn (Janion 1969). He orchestrated the construction of a stone church at Kalepolepo some 0.5 km inland from Kalepolepo fishpond, along side Waipuʻilani Gulch and a small coastal inland pond. The stone remains of the church are still visible and used for religious worship today. A small cemetery is located on the south side of the church, and the unmarked graves of non-Christians who had the misfortune of dying in Hawaiʻi before they returned home are on the north west side of the church (Rev. Morley Frech, personal communication 1995).

Kalepolepo Church was built inland from the coastal pond and Halstead's provisioning station, and according to oral traditions (Rev. Morley Frech, personal communication 1995), slightly inland of a small pond near the mouth of Waipuʻilani Gulch. The approximate location of this inland pond can be seen in Figure 2, outlined by a crescent shaped alignment of the inland house sites near Kalepolepo Church, indicating the shore of this inland pond. The church itself was located further inland, on the opposite side of the pond than the houses.

Mokuʻula

Archaeological evidence of traditional subsistence leeward coastal ponds is limited. However, excavations at the private residence of King Kamehameha III at Mokuʻula (Clark, 1995), represent an interesting contrast to Kalepolepo. The residence was on the island of Mokuʻula in the Loko o Mokuhinia pond of Lahaina, which was the capitol of the Hawaiian Kingdom at the time of Kamehameha's reign. The excavations included sediment cores which provided stratigraphic evidence of pre-Hawaiian formation of the pond, pre-contact use, and modern deposition. The purpose of the Mokuʻula excavations was to investigate the possibility of early cultural modification of the area and to provide stratigraphic evidence of the chiefly residence of Mokuʻula.

Stratigraphic information came from construction trenches, excavated Test Units, and coring (Clark, 1995, Ch. 5). A sequence of events was established from these data including pond formation of the area and later Hawaiian modifications. The upper eight layers of strata postdate the use of Mokuʻula as chiefly residence. Two major stratigraphic units were associated with early human use. Stratagraphic unit I was associated with the residence of Kamehameha III and consisted of a sequence of silt and high-energy silt loam layers. The deposition of low-energy silty clay layers of stratigraphic unit II predate the use of the island residence by Kamehameha III, but contain material remains. Stratagraphic unit III predates human activity and is comprised of marine sand and terrestrial silts, while IV was made up of olivine sands, fine-textured basalt, and coral. Radiocarbon dates were obtained from both corings and excavations, but all pre- or post-dated early human activity.

The results of the investigations at Mokuʻula found that the area was a naturally formed wetland. The presence of small amounts of faunal remains and high amounts of organic matrix in the deposits of Stratigraphic Unit II suggest an early subsistence use (fresh water fish pond or *loʻi* pondfield) prior to the construction of the King Kamehameha residence which was in use from 1837 to 1845.

Excavations at Kalepolepo

The excavations at Kalepolepo revealed striking similarities to the stratigraphy of Mokuʻula. Following the earlier upland inventory survey (Kolb, Conte and Cordy 1997), excavations were conducted on the grounds of the Kalepolepo Church Site during the spring of 1995 in order to provide comparative data on coastal subsistence. Kalepolepo Church was viewed as an ideal location, given its relatively undisturbed context despite the wake of extensive coastal development that took place in the area since the 1950s. The stone foundation of the church is in good condition, having been reconstructed in the 1960s by the Bishop Museum. The surrounding vegetation consists of introduced trees and flowers, although the drier periphery of the property consists of *kiawe* trees and grass.

Figure 3 shows the area surrounding Kalepolepo Church and cemetery. The overall research scope called for limited test excavations around the periphery of the property in order to avoid the church and cemetery grounds. The church itself was excavated and stabilized by the Bishop Museum in the 1970s. We excavated a total of 5 sq. m in the vicinity of the

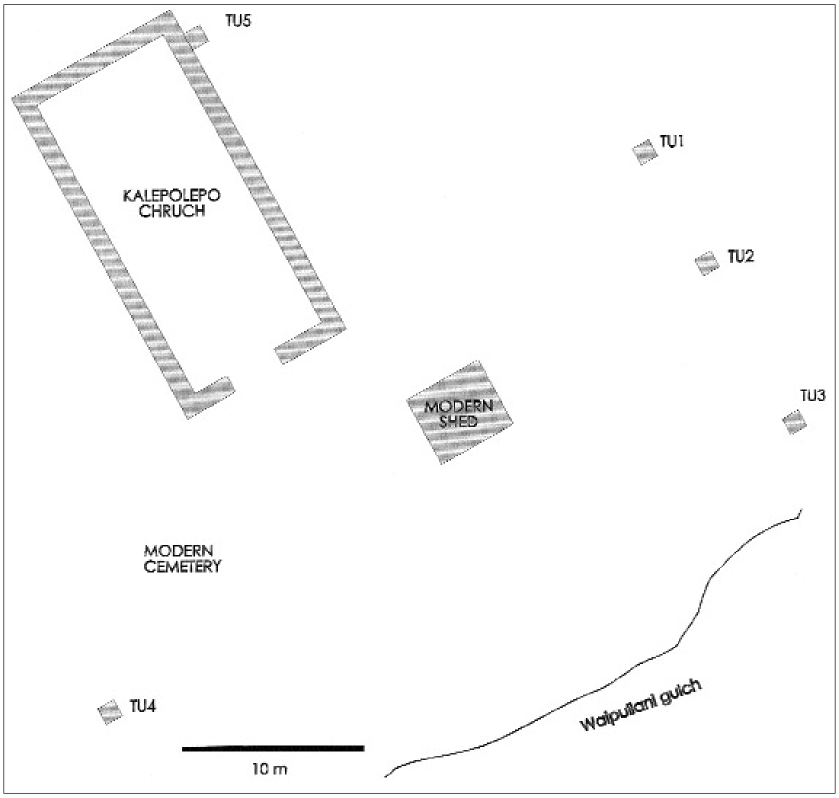

Figure 3. Location of Excavation Units in Relation to Kalepolepo Church.

church. Test units were 1 x 1m in size and their locations were chosen by random and judgmental procedures. Test units 1–3 were placed along a random east-west transect 18.5 m northeast of the church. Test unit 4 was placed south of the cemetery. Test Unit 5 was placed against the north wall of the church, in order to provide some stratigraphic context for the church foundation. The ultimate goal was to find clues about the local subsistence and provide some chronological information as to the occupation of the area.

Stratigraphy

Test Unit 1

Test unit 1 provided the most complete and complex stratigraphic profile of the area. Figure 4 illustrates the stratigraphy of Test unit 1 that extended through 23 layers from the surface to the water table (310 cmbs). The overall sedimentary profile consists of loam, humic clay, silty clay, stream gravel, and fine to coarse sands. The gravel of layer XI suggests periodic fluvial disturbances while the patterns of undulating fine sands from layers VII, and IX suggest periodic accumulation of windblown particles as the region filled in.

Two alternating types of sediment are visible in the profile. These types vary in the overall particle size and depositional process. Aside from slight differences in inclusions, the pattern appears to be consistent. Layers I, II, III, IV, VIII, XIII, XIV, XV, XVI, XVII, XVIII, XX, XXI, and XXII are all composed of a fine silty loam or silty clay (Munsell 5YR 3/3, 5YR 3/4, 5YR 4/6, and 5YR 5/8). The lower layers vary from silt to silty clay sediment (7.5 YR 3/4). Deposition of these sediments apparently occurred within the context of relatively slow energy alluvial activity within what was an inland coastal pond at the mouth of an intermittent stream. Layers V, IX, XI, XII, XVI, and XIX, (10 YR 2/2, 10 YR 3/4, and 7.5 YR 2/0) consist primarily of larger grained sands, gravel, and stream worn pebbles. These layers appear to have been laid down in the context of higher energy colluvial action such as the runoff of an intermittent stream.

Test Unit 2

Test Unit 2 was located 6 meters from the southwest corner of Test Unit 1 at 334 degrees. Layer I was a 7 cm deposit of dark brown silt with organic material mix (7.5 YR 3/2). There was a clear boundary between Layer I and Layer II which was sandy silt (5 YR 4/6 with N 2/0 mottling). Layer II extended to 21 cmbs. A 7 cm sand deposit appeared in Layers III & IV with a clear boundary and a Munsell 7.5 YR 4/4. Loose sandy silt began layer V (7.5 YR 3/2) which ended abruptly at 66 cmbs. Layer VI was sometimes sandy mottled, fine silt (5 YR 3/4) and continued down to 102cmbs until it changed to sand at Layer VII. The sand (7.5 YR 2N/0) had a clear basal boundary at 122 cmbs. Layer VIII was a deep deposit of silt (7.5 YR 4/4) with occasional mottling throughout, reaching a depth of 159 cmbs. The final Layer (IX) was sand (7.5 YR 2N/0) that extended to 168 cmbs. The plain horizontal deposition of these layers represents mild alluvial action as seen in the fine sediments of silt found in Layers VI and VII. Periods of heavier colluvial action are evident in the sandy layers sometimes found between silt deposits. The process of deposition found in Test

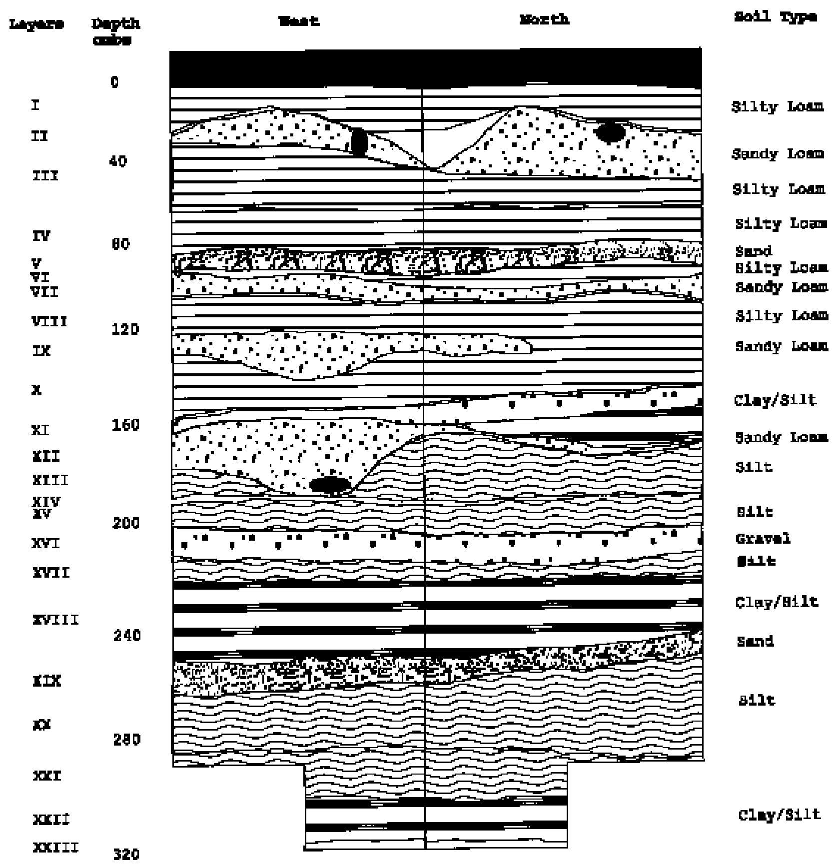

Figure 4. Stratigraphic profile of Test Unit 1.

Unit 2 is similar to that seen at Test Unit 1. The discovery of a piece of metal in Layer VIII indicates the relatively late date of sedimentation at this Level (150 cmbs).

Test Unit 3

Layer I was a hard packed silty loam (10 YR 2/2) that extended to 19 cmbs. Charcoal pieces were collected from this Layer which changed to a more sandy deposit labeled Level II. Level II became a loose sandy loam with no cultural material present. The Munsell code for this Level was 7.5 YR 3/4. The last layer to be excavated was Layer III, comprised of dark black red and olivine gravel (7.5 YR 2/0). Layer III extended from 28 cmbs to 59 cmbs. Although this Test Unit was in the vicinity of Test Unit 1, its lower stratigraphy contained more gravel deposits rather than finer silts, but still laid down in a horizontal fashion. No midden or other cultural materials were found.

Test Unit 4

The first layer extended to 9 cmbs and was a silty loam with sand pockets (10 YR 2/2). Layer II was a silty clay sediment (10 YR 3/4) that was hard packed. Charcoal flecks were collected from this layer that ended at 19 cmbs. Layer III reached a depth of 20 cmbs and was a sandy silt (5 YR 3/1). The layer changed in color to 7.5 YR 7/4 and ended at 57 cmbs. Charcoal was also collected from Layer III. Layer IV produced more charcoal and consisted of silty clay sediment. The Munsell code was 10 YR 2/2 and the unit ended at 75 cmbs. The deposition of soils of Test Unit 4 are very different from the deposits east of the church. The boundaries of the layers were wavy on top of the horizontal Layer IV. It is possible that these upper layers indicate a cyclical nature of the deposits, made up of windblown sand with silt deposits between them.

Test Unit 5

Test Unit 5 was placed on the east wall of the Church building 2 meters from the northeast corner. The purpose of this unit was to determine the depth of the church and to find the extent of disturbance caused by its construction. Two Layers were encountered during the excavation of this unit. Both were comprised of loose fill such as limestone, coral, rubble and some soil. The base of the church extended to 80 cmbs.

Chronology

Three chronological dates were obtained from these excavations, one determined by relative stratigraphy, and two derived from Test unit 1 charcoal samples (Table 1). Stratigraphic evidence from Test unit 5 indicates that layer II (80 cmbs) dates to the mid-1800s. This was the approximate basal depth of the coral and basalt fill upon which the church was constructed. Radiocarbon dates were taken from charcoal concentrations from 224–247 cmbs (Layer XV) and 247 to 286 cmbs (Layers XVI–XVII). The calibrated date range of Layer XV is 450 +/- 50 B.P. (A.D. 1404 to 1629 at the two-sigma range with –25.0 o/oo C12/C13 ratio). The calibrated age for Layer XVI–XVII is 1460+/- 80 BP (A.D. 430 to 695 at the two-sigma range with –25.0 o/oo $^{12}C/^{13}C$ ratio).

Table 1. Radiocarbon date for Test Unit 1.

Laboratory Number	Conventional Age	$^{13}C/^{12}C$ Ratio	Calibrated Results (2 sigma, 95% probability)
Beta-85290	1460 +/- 80 B.P.	-24.0 o/oo	A.D. 430 to 695
Beta-125739	450 +/- 50 B.P.	-25.0 o/oo	A.D. 1404 to 1629

Table 2. Comparison of charcoal between Kalepolepo and Kealia Pond.

Kalepolepo		Kealia Pond	
Depth	Charcoal	Depth	Charcoal
160 cmbs	26.6 mm sq/c	0–19 cmbs	15&9 mm sq/cc
200 cmbs	26.6 mm sq/cc	19–46 cmbs	22 mm sq/cc
240 cmbs	79.7 mm sq/cc	53–55 cmbs	22 mm sq/cc
280 cmbs	21.8 mm sq/cc	62–131 cmbs	31 mm sq/c
		134–135 cmbs	32.4 mm sq/cc

The 1000 year variance between these two dates is mostly likely due to an anomalous piece of old wood, rather than sampling bias or contamination (both samples had excellent $^{12}C/^{13}C$ ratios). The Layer XV date of 1404–1629 is the accepted age of these deep deposits, and chronologically coincides with regional settlement of the area.

Charcoal Analysis

Charcoal was collected from each level using 6 mm mesh screens and standardized collection techniques. High charcoal concentrations were found in layers XIII (200cmbs), XV (240 cmbs), and XVII (280 cmbs) of Test Unit 1. The large amounts of charcoal were accompanied by midden. The charcoal found at the time of excavations increased in concentration at about 230 to 250 cmbs. 130.7 g of charcoal was collected from Test Unit 1. A total of 102.8 g of charcoal was collected from Test Unit 2. Test Unit 3 produced 32.9 g, and only 4.7 g were found in Test Unit 4. Test Unit 5, located at the church wall base produced 63.3 g.

Four soil samples were also collected and analyzed by Jerome Ward for charcoal and pollen trace analysis (Ward 1995). Those samples came from levels X, XIII, XV, and XVII, of Test Unit 1 at depths of 160, 200, 240, and 280 cmbs. The details for each charcoal sample are listed in Table 2. Soil samples used for charcoal analysis were selected using a stratified sampling strategy of 40-cm intervals. The sample from 240 cmbs contained a concentration of 79.9-mm sq./cc (mm squared per cubic centimeter). The other three samples resulted in a concentration of 20-mm sq. /cc.

Pollen Analysis

Pollen and spores were poorly preserved throughout the test unit, most likely due to the fluctuating wet/dry conditions of the intermittent stream bed, and occurred in relatively low concentrations consistent with windblown deposition and soil oxidation. The sample submitted from 160 cmbs (layer X) had the highest concentration (7190/cc) of palynomorphs or organic-walled micro fossils (Ward 1995). The data from this sample suggested a presence of dry mesic forest growth including shrubs and grasses. At 200 cmbs the Cheno-am (shrub) is still present, but the information for other pollen types was simply absent. The last two samples from the lower depths resulted to be inconclusive due to preservation problems. The lack of pollen evidence for agriculture is due to preservation factors; there is no conclusive evidence either way to tell if there was agriculture practiced there or not.

Fauna

A variety of invertebrate faunal material was recovered from Test Unit 1 (see Table 3). Land snails were present in small quantities from the upper strata, while marine fauna were recovered from the lower strata. A mixture of land snail and urchin spines were recovered from 92–127 cmbs (Layer VII). The largest quantity of recovered midden, however, corresponds to the high charcoal concentration located at 247–263 cmbs (Layer XVI). Over 700 fragments (176.6 g) of sea urchin were recovered here, in addition to fragments of *Turbo, Hipponix, Littorina,* and *Nerita.* Two vertebrate bone fragments were also found. A single vertebrae of shark or ray (Chondric-

Table 3. NISP counts (and total weights) of invertebrate midden recovered from Test Unit 1.

Depth cmbs	Class Bivalves	Crustaceans	Urchins	Gastropods	Land Snails	Mollusks
0–25	0	0	0	1 (2.2 g)	1 (0.1 g)	0
25–50	0	0	0	0	5 (0.3 g)	0
50–75	1 (0.1 g)	1 (0.2 g)	1 (0.1 g)	0	1 (0.1 g)	0
75–100	4 (0.3 g)	1 (0.1 g)	6 (0.7 g)	4 (0.5 g)	0	0
100–125	0	0	1 (0.1 g)	1 (0.1 g)	0	0
125–150	0	0	40 (0.7 g)	0	3 (0.1 g)	0
150–175	0	0	0	0	5 (0.2 g)	0
175–200	0	0	0	0	0	0
200–225	0	0	0	0	0	0
225–250	4 (0.8 g)	6 (1.5 g)	702 (176.6 g)	18 (5.4 g)	0	2 (1.1 g)
250–275	1 (0.5 g)	0	28 (7.4 g)	0	0	0
275–300	0	0	1 (0.1 g)	0	0	0

thyes) was found in layer XVII (280 cmbs) among the invertebrate shells. The bone of a plover *(Pluvialis)* was also found in layer XV (240 cmbs). Land snails, urchin remains, and marine mollusks were recovered from Test unit 2. Test Unit 3 did not produce midden. A few historic artifacts came from of Test Unit 4 including glass metal, and ceramic pieces. Test Unit 5 had only land snail and marine shell in small amounts. No historic artifacts were recovered from Test Unit 6. Land snail, urchin, and marine mollusk shell were excavated from all layers of the Test Unit. The presence of midden found in conjunction with high concentrations of charcoal, support the conclusion of human activity in the area.

Discussion

A comparison of the Moku'ula and Kalepolepo excavations reveals a number of similarities. Both areas were natural wetlands that exhibit evidence of precontact cultural modifications for either fishpond or agricultural use. The stratigraphy at Moku'ula presents a sequence of the depositional and erosional forces that took place at the site along with cultural modifications. The silty layers with intermixed deposits of mottled sediments may indicate periods of pond dredging or agricultural use (Clark 1995).

Similar morphology was found at Kalepolepo, including fine silt with organic materials intermixed with more course deposits. Radiocarbon dating reveals early pondfield soils that extend back at least 450 +/-50 BP, comparable in age to other coastal habitation sites. The fine textured sediments at Kalepolepo were deposited horizontally indicating that the recovered midden as most likely primary deposits. The depositional forces of these layers appear to have been mild alluvial action, with periodic high alluvial disturbances caused by flooding and resulting in the deposit of larger gravels and riverine sands.

Comparison of the pollen samples from Kalepolepo and Moku'ula are somewhat more problematic because the lower layers at Kalepolepo did not contain preserved pollen. Perhaps further sampling at Kalepolepo will yield results similar to those found at Moku'ula.

The Kalepolepo site however, had very high charcoal concentrations especially in the lower strata, between 140 and 280 cmbs (79 mm sq./cc). According to Athens, Ward and Tomonari-Tuggle (1996) charcoal found at Kealia Pond, another natural wetland of the island, has been attributed to natural ignition due to volcanic eruptions. The charcoal concentrations from Kealia pond are as follows: the highest ranging from 22–31 mm sq./cc, and the lowest at 0.9–3.1 mm sq./cc. These measurements are much lower than those of Kalepolepo, which had a level of 79.7 mm sq./cc at 240 cmbs. Athens, Ward and Tomonari-Tuggle also state that the amount of 22mm sq./cc would be consistent with agricultural clearing practices. The layers at Kalepolepo with very dense concentrations of microscopic charcoal also had visible charcoal fragments that were large enough to be collected during excavations. Although density comparisons may be problematic when comparing microscopic and macroscopic samples, these collected pieces are approximately three to four times greater in density than that of the microscopic concentrations. The excavated charcoal came from the depths of 92–105 (7.3 g), 147–154 cmbs (30.5 g), 190 to 197 cmbs (5 g), 215–224 cmbs (3.6 g), 224–233 cmbs (12.5 g), and 278–286 (10.9 g). These large amounts represent intensive burning in the area, probably more than simple background levels, and therefore could be the result of burning episodes from periodic agricultural clearing of the area.

The presence of midden deposits, especially from the lower stratigraphy at Kalepolepo, also suggest human activity at the pond. Sea urchin, coral fragments, crustaceans, *Nerita, Littorina,* and *Hipponix* remains were found. A few vertebrate bones and shark or ray vertebra were also present. The midden deposits from Kalepolepo were mostly found in layers of fine silts deposited by mild alluvial action; for this reason they were determined to be primary deposits. The midden composition found at Moku‘ula was very similar to Kalepolepo, there were comparable contents of marine mollusks and urchin remains deposited in a fashion similar to that of Kalepolepo.

Conclusions

We argue for human activity at Kalepolepo as early as A.D. 1400, or about the same time as intense settlement of the upland regions of Kula. Excavation and ethnohistorical data indicate that the environment at the Kalepolepo church site would have been able to support agricultural subsistence in and around a local pond. Oral traditions document the presence of house sites situated around an inland pond, in a region known for fishing, the cultivation of taro, sweet potato, and other crops. The deep and complex stratigraphy of the area east of the church foundation confirms the presence of an inland stream-fed pond that gradually silted in by intermittent alluvial stream action. By the mid-1800s, this region was silted in to the point that the church foundation could have been added with little difficulty. Deeper aolian deposits found west of the church in Test Unit 5 suggests this area was slightly higher and drier.

The primary deposits of large charcoal concentrations and moderate quantities of midden in these deep strata support the idea that this area was used for human activity, particularly where these finds co-occur around 1400 (25 cmbs). Although there is no direct archaeological evidence of stream-fed agriculture, it would not be unlikely given the ethnohistoric descriptions of the area. Nonetheless, the availability of both stream-fed and brackish water, together with its proximity to the ocean, made Kalepolepo an extremely suitable environment for the establishment of an early leeward permanent settlement.

Acknowledgments

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Late Prehistoric Fishing Adaptations at Kawākiu Nui, West Moloka'i

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Introduction

Fishhooks are one of the more common items of material culture found in Polynesian archaeological sites, and sizeable hook assemblages were accumulating in museum and private collections from as early as the 18th century from early explorers such as Bligh and Cook who amassed large ethnological collections from New Zealand and tropical Oceania (Kaeppler 1978). On the basis of the collections available by the early decades of the 20th century, ethnologists became aware that variation in hook form showed strong spatial patterning. Skinner (1924), for example, defined a number of prehistoric culture areas in New Zealand on the basis of hook form and discussed these in terms of alternative migration models. Buck (1927) also saw the potential for using fishhook distributions as a means of tracing, Polynesian migration routes and interpreted Polynesian colonization history on the basis of one-piece hook distributions. Additionally, the distribution of one-piece hooks, *Ruvettus* hooks, and bonito hooks (trolling, lures), were used by Burrows (1938) to differentiate western, central, and marginal Polynesian culture areas.

By the mid 1950's modern archaeological method and theory were being introduced into the Pacific from North America and Europe, and archaeologists sought artifacts for the construction of empirically based culture history sequences. In both Europe and the Americas the dominant artifact class for chronology-building was pottery, but in the near absence of ceramics in East Polynesia, archaeologists turned instead to adzes and fishhooks. The first culture historical sequence in Polynesia—relying, especially, on fishhook and adze forms—was developed by Suggs (1961) and Sinoto (1970) for the Marquesas. The detailed study of fishhook assemblages from stratified sites in tropical Polynesia began with the work of Emory et al. (1959), which produced a detailed descriptive analysis of hooks from sites in Hawaii and an accompanying taxonomic classification system (see also Sinoto 1962). As new "archaic" assemblages were excavated in East Polynesia the hook sequences were compared and used to support various regional settlement models (Emory 1968; Sinoto 1983, 1996).

In a critique of Emory et al. (1959), Green (1961) pointed out the importance of identifying stylistic attributes of hook form in culture history studies. Typology, Green argued, has a strong, functional component while styles change according to cultural criteria (Dunnell 1978). On this basis, Green (1961) argued that stylistic variables were more accurate markers of cultural relationships, and encoded information on prehistoric patterns of interaction, including settlement histories. This point has been reiterated most recently by Allen (1996) who argues, following, Green (1961), that a lashing device might be a stylistic or "adaptively neutral trait" and thus provides a useful measure of cultural relationships.

Notwithstanding a number of functional studies, fishhook analysis in Polynesia has continued to be dominated by the culture historical approach. One of the results of this (and, indeed, most functional studies) is that there has been a bias towards the analysis of whole or near-complete specimens displaying typological attributes. Consequently, archaeologists have concentrated analyses at the level of artifact rather than at the level of *assemblage* which includes whole as well as fragmentary artifacts. While this is appropriate for certain types of problems, it is the assemblage which contains the most complete information on the human behavior surrounding the manufacture, use, and discard of fishhooks in prehistoric Polynesian communities. A fishhook assemblage, more than any other class of material culture from Polynesian sites, contains specimens from the entire use-life of the artifact, typically containing, raw material, unfinished hooks and their manufacturing tools, hooks broken during manufacture, complete specimens, and specimens broken during use. The depositional context also contains the bones of the fish thought to have been caught using those hooks and therefore provides important data for understanding fishing, adaptations.

Polynesian fishing, strategies are broadly similar across most tropical archipelagos but in any given community the fishing adaptation is a product of local cultural, technological, and environmental variables. From the wider set of generic Oceanic fishing strategies (e.g., Dye 1983) each community selects and fine tunes technologies appropriate for the exploitation of the local marine environments (Kirch 1982), number of people involved in a particular strategy, and the availability of manufacturing, skills and materials. Fish species are selected and targeted according, to local pattern of availability, tempered by cultural preferences, values, and prohibitions. In this study we discuss the fishing, adaptation of a small Hawaiian group who occupied the Kawākiu Nui site (50-60-01-38) on the west coast of Moloka'i during late prehistory—that is, after about A.D. 1500.

A wide range of empirical data informs the archaeologist about the prehistoric exploitation of marine resources in any community (e.g., Kirch and Dye 1979). Relevant material culture includes the fishhooks and fragments, unfinished hooks and manufacturing tools, as well as fishing related gear. Examples of the latter include various forms of line and net sinkers, and non-hook components of octopus hooks such as bone toggles and *Cypraea* sp. (cowrie, *leho*) shell lures. Faunal remains provide associated evidence of target species and inferred environmental and ecological information from identified taxa. Site data such as the presence or absence of fishing, related activity areas, food processing and discard patterns, artifact taphonomy, post-depositional alterations, and the context of the site within the wider settlement-subsistence system are also important. The approach taken in this study integrates some of these variables for developing a picture of fishing, behavior as practiced near Kawākiu Nui during late prehistory.

Regional and Site Ecology

The largest of the Hawaiian Islands (Kaua'i, O'ahu, Maui, Moloka'i, and Hawai'i) have terrestrial environments that range from high altitude rain forests,

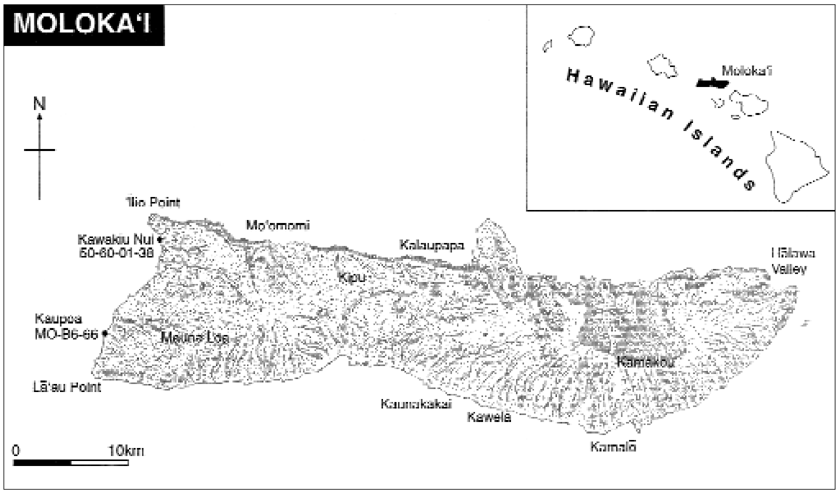

Figure 1. Map of Hawaiian Islands showing Moloka‘i, Kawākiu Nui site 38, Kaupoa site 66, and places mentioned in the text.

bogs, or snowcapped peaks to lowland deserts, lying at extremes of an elevational and rainfall gradient that mirrors a wide range of soils and biotic communities. The sub-tropical marine environments found surrounding Hawaii's shores also display a diverse array of habitats that we divide here into windward vs. leeward and, within this dichotomy, from inshore to benthic zones.

The windward coasts, receiving the full force of storms and high surf, are characterized by sea cliffs interrupted by boulder shores with the occasional embayment and sand beach. The splash-zone and adjacent waters of windward boulder beaches are rich habitats for limpets (*Cellana* spp. or *‘opihi*), other molluscs such as thaidids (e.g., *pūpū‘awa*), and urchins (especially, *Colobocentrotus atratus, hā‘uke-‘uke*). The nearshore waters, with relatively little coral reef development, descend rapidly to the benthic or deep water zone. Conversely, the leeward shores of the oldest main islands, are extensions of the adjacent terrestrial slopes that descend gradually out to sea forming a platform with extensive reef development. As along the south coast of Moloka‘i (from Hālena to Kamalō), the reef platform extends nearly one kilometer offshore and parallels the coast for about 30 km. Besides providing habitat for most fish species found in Hawaiian waters, the reef platform was the foundation for walled fish ponds and traps (Summers 1964, 1971)—an Oceanic innovation taken to extremes in Hawai‘i (Kikuchi 1976). While octopus *(he‘e)* are most plentiful along Moloka‘i's leeward coast, the near inshore waters near sediment-infilled fishponds supported mangrove thickets, habitat for certain crabs, such as *kūhonu* or *haole* crab *(Portunus sanguinolentus).*

East of Kamalō, the island of Moloka‘i turns northeast exposing the coastline to greater swells; here, the reef platform diminishes towards the northeast and coral growth hugs the coast (Fig. 1). The deep, amphitheater-headed valley of Hālawa begins the rugged windward coast-home to the highest sea cliffs found anywhere-which ends at Waikolu Valley, just before the Makanalua Peninsula (Kalaupapa). Fishing along this windward stretch of coastline is normally possible only during the calmer summer months, where trolling for scombrids *(‘ahi, aku,* and *ono)* and *mahimahi (Coryphaena hippurus)* dominates. West of Kalaupapa to ‘Īlio Point, the coastline descends rapidly and is broken only by the shallow embayment at Mo‘omomi and more protected bay at Kawa‘aloa. This area, and west to Mokio Point, is known locally for its *mo‘i* (threadfin, *Polydactylus sexfilis*) and plentiful *‘opihi.* In this latter regard, Weisler, fishing with Moloka‘i resident, Walter Mendes, collected in a few hours more than 50 kilograms of *‘opihi* west of Mokio. During the past few years, commercial boats have targeted the benthic fishery along this coast.

The west coast of Moloka‘i, sheltered by ‘Īlio Point, is protected from the dominant windward swells. Only occasionally do the waves get large enough to attract surfers offshore of Pāpōhaku Beach. Aside from this three km long stretch, the coastline is generally low and rocky, with small embayments along its length. Here, where the waters are shallow and somewhat protected, seine net fishing is possible and a wide range of species is caught. During calm periods, Weisler has also placed long seine nets perpendicular to the shore at various points along, the south half of the west coast. Unlike most regions of the Pacific, where sharks aggressively attack fish caught in seine nets, it is less of a problem in Hawaii, and seine nets—at least on Moloka‘i—are often kept in the water overnight, but are checked routinely. If this practice was similar during prehistory, this may have resulted in the capture of night-active fish such as the holocentrids (squirrelfishes, e.g., *menpachi*), which today are most often speared at night. So while seine net fishing was possible most anywhere along the coast south of Kawākiu Iki, to Lāʻau Point, it was probably most frequently practiced within the bays. Long seine nets are used today for trapping large schools of *akule (Selar crumenophthalmus)* found seasonally along the coast. Pelagic species (e.g., tuna) were occasionally caught in offshore waters around ʻĪlio Point, although this area of Molokaʻi is not favored for trolling like the windward coast. Heavy, grooved lure sinkers, found at many archaeological sites along this coast and south to Hālena, suggest that octopus was an important resource.

The bottom or benthic fishery of west Molokaʻi seems, on archaeological grounds, to have been quite important. We include here not only the snappers or lutjanids *(ʻōpakapaka),* but large carangids *(ulua).* Although it may have differed in the prehistoric past, large carangids are taken today most frequently where relatively deep waters are found close inshore. Using what is known locally as the "slide-bait" technique. a heavy weight with steel prongs is cast by rod as far as possible out to sea. Once anchored to the bottom, a 60 cm (two foot) length of line with a baited rotating hook is slid down the length of the long line. Traditionally, large carangids may have been taken opportunistically by spear or net, but bottom fishing with baited rotating hooks may have been the most frequent capture technique.

The west end of Molokaʻi is typified by gently sloping offshore topography. At 3 km from the coast, the depth, in most places, is only 30 fathoms (about 55 meters or 180 feet), well within bottom fishing depths. Penguin Bank. located about 65 km (40 miles) southwest of Molokaʻi's Lāʻau Point, is delimited by the 30 fathom depth contour which circumscribes a 400 km^2 area (see Macdonald and Abbott 1970: Fig. 230); this is an important benthic fishery today. and may have been during prehistory—although it is quite far from shore and exposed to tradewinds and ocean swells making sorties time-consuming, and relatively hazardous (*contra* Hammatt 1979: 11).

For the small human populations surrounding Kawākiu Nui Bay, a range of fishing techniques were used for specifically-targeted and opportunistically-captured fish species. Inshore fish were speared in shallow waters., poisoned in tide pools (Stokes 1921). and long seine nets were placed in bays and along the coast during calm periods. This resulted in capturing a wide range of herbivorous/omnivorous taxa such as the kyphosids *(nenue),* mullids *(weke, kūmū),* scarids (uhu), and acanthurids (e.g., *manini, palani*), while the occasional large carnivores (e.g., carangids, sharks) and perhaps turtles were also caught. From Kawākiu Nui to Pāpōhaku, large schools of *akule* are still caught with seine nets from March to August. Composite lures with stone weights and cowrie shells were fashioned to trick octopus into canoes and, in deeper waters, snappers and carangids were caught with baited, rotating hooks. Pelagic fish, most notably tunas and *mahimahi,* were occasionally caught by trolling feathered lures behind fast-moving canoes. There is also some archaeological evidence that *mālolo* (flying fish, exocoetids) were also a seasonal prey species caught by cooperative groups of fisherman (Weisler, in prep.). Shellfish were collected along the rocky shores. but from contemporary distributions, molluscs are much more plentiful along the windward coast.

The Archaeological Landscape

Fifth in size and centrally located in the archipelago, the elongate island of Molokaʻi (60 km long, 16 km wide) consists of two broad shield volcanoes that overlap in the central saddle region (Fig. 1). The eastern summit at Kamakou (1244 m) traps moisture-laden tradewinds whose waters descend precipitously carving amphitheater-headed valleys along the north coast, while forming less rugged leeward stream valleys along the south shore. The nutrient-rich alluvial sediments accumulated within these valleys and along the coastal plains of the lee shore supported the earliest and densest, agriculturally-based human populations on the island (Kirch 1985; Weisler 1989a). The concentration of fishponds, temples *(heiau)* and irrigated pondfields (Summers 1971: 241) attests to the importance of east Molokaʻi during prehistory. Traveling west from Kamalō along the south shore, leeward stream valleys are few and rainfall diminishes. greatly reducing the carrying capacity of the landscape and, hence, prehistoric settlements. The stream mouths at Kawela (Weisler and Kirch 1985) and Kaunakakai (Athens 1983; Weisler 1989b) were oases of early settlement along this otherwise barren stretch of coastline, being settled by the mid-13th century (Athens 1983), with the first evidence of burning upland vegetation—presumably for dryland agriculture—also during this time (Weisler 1989b: 64).

West Moloka'i, long known for its fishing and adze rock resources (Dye et al. 1985), lies in a rainshadow where only the higher elevations near the summit of Mauna Loa (421 m) and the upper reaches of Kīpū and Kualapu'u supported productive dryland cultivation of sweet potato during the Early and Late Expansion periods (A.D. 1100–1650, Weisler 1989a: 126–127). It is in these regions of west Moloka'i that more permanent populations could live. The coastal regions, however, were barren, dry, and rocky, and protected embayments were occupied temporarily for exploiting seasonal resources such as fish (especially *akule, mālolo, mo'i*), sea and land birds (Weisler and Gargett 1991), and probably for producing salt.

Despite an early island-wide inventory of major religious sites (e.g., Stokes 1909) and what was one of the first considerations of ecological conditions and prehistoric settlement patterns anywhere in the Pacific (Phelps 1941), most archaeological studies in west Moloka'i were contract or development-driven projects conducted during the past 20 years. Relevant archaeological studies to 1987 are listed in Weisler (1989b: Table 2), while more recent projects include the 2,540 hectare survey of southwest Moloka'i (Dixon and Major 1993; Dixon et al. 1994. Weisler 1984) and inventory surveys of the northwest region (Weisler 1987a), and Kawākiu Nui (Hammatt 1979; Weisler 1987b).

Study Area

Kawākiu Nui Bay is the deepest, most protected embayment on the west coast and it would not be surprising to identify relatively early settlement here, that is, within the west end. However, the only radiocarbon date is from a wave-cut midden exposed on the north side of the bay dated to 170 +/- 60 (calibrated after Stuiver and Reimer 1986), at one sigma, no older than A.D. 1655 (Weisler 1989a: 140). The dominant archaeological features surrounding the bay are dry-laid configurations of boulders and cobbles, stacked to form square and rectangular walled structures that presumably anchored pole-and-thatch constructions. The most substantial residential features are situated along a ridgeline whose seaward portion defines the south side of the bay. Atop this ridge, the inhabitants received the cooling effects of the tradewinds in this otherwise harsh environment. Smaller C-shaped and terrace features are found along the north side of the bay associated with dryland gardening features such as alignments and stone clearing piles. Surrounding the bay, then, are the remnants of a late prehistoric community evidenced by house foundations, a substantial and prominent rectangular enclosure (described below), small shelters, and gardening modifications. That portions of this settlement area were occupied in early history is suggested by what may be a stone-lined cart trail heading inland between Kawākiu Nui and Kawākiu Iki bays (Weisler 1987a: 46; Site 50-60-01-1613, feature E) and numerous fragments of ale, whiskey. wine, cologne, medicine, and food bottles dated as early as 1815, but clustering around the 1870's (Weisler 1987b: 78–98).

During two weeks beginning in December 1978, Hammatt and colleagues excavated two units (total area 1.5 M^2) in the two probable, late prehistoric substantial house features (sites 50-60-01-1606 and -1607), 2 M^2 in an open midden deposit, and about 10 M^2 inside a rectangular enclosure feature (50-60-01-38 hereafter, Site 38). No radiocarbon dating was conducted, but basaltic glass hydration measurements suggested to Hammatt that occupation occurred about A.D. 1749–1805 (Hammatt 1979: Table 8). While Hawaiian basaltic glass "dates" should be viewed with extreme caution, the overall settlement patterns and few radiocarbon dates for west Moloka'i (reviewed in Weisler 1989a; see also Dixon et al. 1994 for additional dates) suggest that Kawākiu Nui was occupied during late prehistory. Aside from Site 38, sparse midden and artifacts were recovered from the excavations consisting of coral file fragments, a bone point of a composite fishhook, basaltic glass flakes and cores, and marine shellfish (Hammatt 1979: 15–17). Excavations at Site 38 produced a large array of bone fishhooks in all stages of manufacture and use and is the subject of this paper.

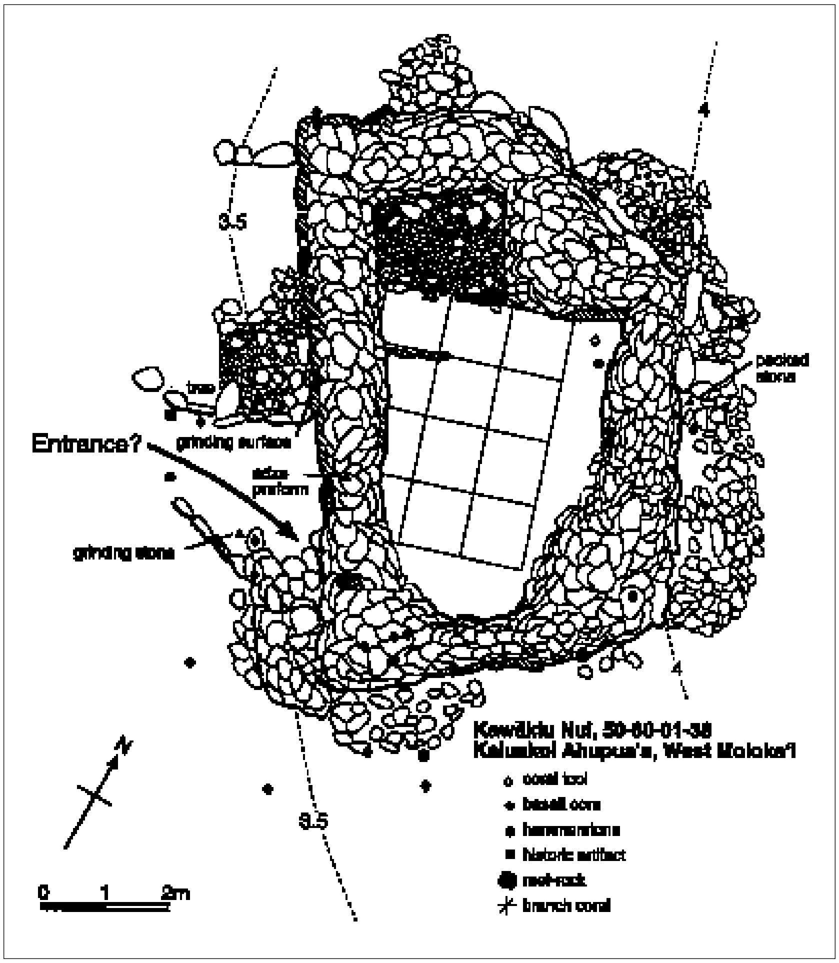

Figure 2. Map of high-walled enclosure site 38 (after Weisler 1987b: 36) with approximate location of excavation units (after Hammatt 1979: 20).

We would like first to describe the site and briefly review the relevant details of the excavations (Hammatt 1979) and interpretations of site function.

Site 38: Description, excavation, interpretation

Situated in the lee of a small hill near the seaward portion of the ridge delimiting the south extent of Kawākiu Nui Bay, this substantial, high-walled rectangular enclosure measures 9.30 by 6.15 m and is the most impressive structure in the area. Upright slabs of basalt and beach rock face portions of the walls which are stacked to 1. 15 m high. The interior north end has a pavement several courses high of water-rounded basalt pebbles and some branch coral —a material associated with religious features (e.g., Weisler and Kirch 1985). The remaining, interior surface was unpaved and filled with soil. It is always uncertain as to the entrance for high-walled enclosures, but an approach is suggested by the short stone alignment and stacked stone step on the exterior southwest comer (see Fig. 2).

Excavations, totaling about 10 M^2, were conducted by Hammatt (1979) where 425 artifacts relating to fishhook manufacture, use, and discard were recovered. Excavations proceeded in arbitrary levels or spits of varying thickness and two cultural strata were identified. Hammatt (1979: 23) describes the cultural strata thus: stratum I, about 20 cm thick, was dark grayish brown (10YR4/2) silt loam with charcoal staining, shell and bone midden, and basalt flakes; stratum II, about 22 cm thick was yellowish red (5YR4/6) silt loam containing charcoal, shell and bone midden with basalt flakes. He reported a "clear stratigraphic separation" between the two cultural layers (Hammatt 1979: 23). Features included a central hearth area found in both cultural layers and a coral filled burial pit.

The deposits were sieved through 1/8" (3.2 mm) screens (Hammatt 1979: 69). Artifacts identified in the field were recorded as to provenance and assigned a number. Some 470 artifacts were recorded and included fishhook manufacturing tools such as coral and urchin abraders, and retouched basalt flakes, as well as cut and worked bone, fishhook tabs, and one piece, two piece, and composite finished fishhooks (described below). Stone sinkers, of unspecified types, were also listed (Hammatt 1979: Table 2). Other non-fishing related artifacts were awls, hammerstones, an adze preform and finished specimens, polished basalt flakes, basaltic glass flakes and cores, and a copper nail.

The midden was not sorted in the field, but the shellfish from two 1 m^2 units were tabulated by lowest taxon and weight revealing a predominance of rocky shore species (Hammatt 1979: 69–73). The overwhelming, majority of bone was of fish with much less mammal and bird bone. The bone is currently being analyzed by Weisler and, at present, the Stratum I material has been identified. We report here the preliminary summary of the fish as it is important for aiding in the interpretation of the associated fishing gear.

More than 63,000 fish bones were recovered from the 1/4" (6.4 mm) size class of stratum I which was rescreened from the total material caught in the 1/8" sieve. Predictably, scarids were the dominant taxon, but within the top ten most common families by number of identified specimens (NISP) were carnivorous species that take baited hooks such as carangids, labrids, lutjanids, serranids, sharks, and cirrhitids. The snappers (lutjanids) ranked 12 out of 25 families and pelagic species, caught by trolling, were represented by the dolphin fish *(mahimahi)* and barracuda *(kaku).* Inshore, coral associated species included ancanthurids, balistids, holocentrids, and pomacentrids. A more comprehensive reporting of all the bone will be presented elsewhere (Weisler, in prep.).

Site 38 is one of only two such structures found along the west coast and is similar to site MO-B6-66 at Kaupoa (Weisler 1984: 39) in the following ways: (1) size, shape, and architectural components (high walls, interior pavement or altar); (2) the most substantial structure in a residential complex consisting of numerous features exhibiting a range of shapes and functions; (3) located near a bay; and (4) distance to the sea. It is interesting to note also that a large, but low-walled, rectangular enclosure is seaward of a major, high-status residential complex in the late-prehistoric settlement of Kawela (Weisler and Kirch 1985: 146). This structure was interpreted as a *hale mua* or men's house within the context of a 7.7 km^2 settlement pattern study and much comparative excavation data (Weisler and Kirch 1985).

From analysis of the artifactual material at Site 38, male activities clearly dominate: fishhook manufacture, use, and discard; and adze manufacture, probable use, and reworking. The coral filled human burial pit and water-rounded pavement with branch coral fragments suggest sacred or religious functions as well. While the site has clear evidence of habitation (combustion features and food remains), we believe it is not possible to discount its religious or sacred functions that, based on comparisons with other similar structures, suggest use as a men's house or *hale mua.* It is well that this site, and many surrounding Kawākiu Nui Bay, have been accorded some measure of protection by listing on the Hawaii and National Registers of Historic Places.

Fishhook Assemblage

The assemblage consists of 48 whole and fragmentary bone hooks divided into five classes based on Emory et al. (1959): (1) one-piece hooks, (2) two-piece hooks; (3) trolling lures; (4) octopus lures; and (5) shark hook points. Approximately 50% of the specimens were fragments. We have included in the two-piece class only those specimens with diagnostic two-piece fishhook features. Specimens d and e (Fig. 3) are designated as one-piece fishhooks because they have inner-shank barbs, a feature not found on two-piece fishhooks at Kawākiu Nui. In Figure 3, specimens a and b could be two-piece fishhooks, while specimen u is indistinct.

One-piece hooks

Polynesian one-piece hooks are generally divided into either jabbing or rotating forms. The distinction between these two classes has recently been redefined by Sinoto (1991) who describes the rotating hook as one in which an extension of the point will result intersection with the shank—in other words, any hook in which the shank and point are converging. The rotating aspect of the hook can be achieved by shaping a curve either into the shank or the point, or by offsetting the point tip. Although there are few complete hooks present in the Kawākiu Nui assemblage, most specimens are rotating forms, while there were no unambiguous examples of jabbing hooks represented. In the Kawākiu Nui assemblage the shanks are straight and the bends tend to be gently curved giving the point an obtuse (or diverging) aspect in relation to the shank (Figs. 3 and 4). The rotating feature is then achieved by shaping the point with a sharply incurved tip. The result is a form similar to the acute recurved point or point-tip-at-angle forms described by Suggs (1961) from the Marquesas (see also Rolett 1989). In the Emory et al. (1959) classification the complete hooks group most closely with the IB2 class (Sinoto, pers. comm. 1997).

A number of the Kawākiu Nui one-piece fragments contained barbs which are a common feature of Hawaiian hooks (Goto 1986: 221–229), but which are less common throughout the rest of tropical Polynesia. The Kawākiu Nui assemblage contains examples of barbs on both the inner and outer aspects of the hook (Fig. 3). Inner barbs on Polynesian hooks may be located on either the inner aspects of the shank or the point (see, for example, Fig. 3g). However, at Kawākiu Nui, all examples of inner barbed hooks containing intact shank and point sections, exhibited barbs in both locations. Although a number of fragments contained only single barbs, it is probable that all inner barbed hooks at Site 38 were formed with two opposing barbs. A total of 13 barbed shanks and four barbed points were recovered. Barbs were also located at the distal end of the point (Fig. 3q, r, v, and w). Outer point barbs occurred as single features and were never associated with inner barbs.

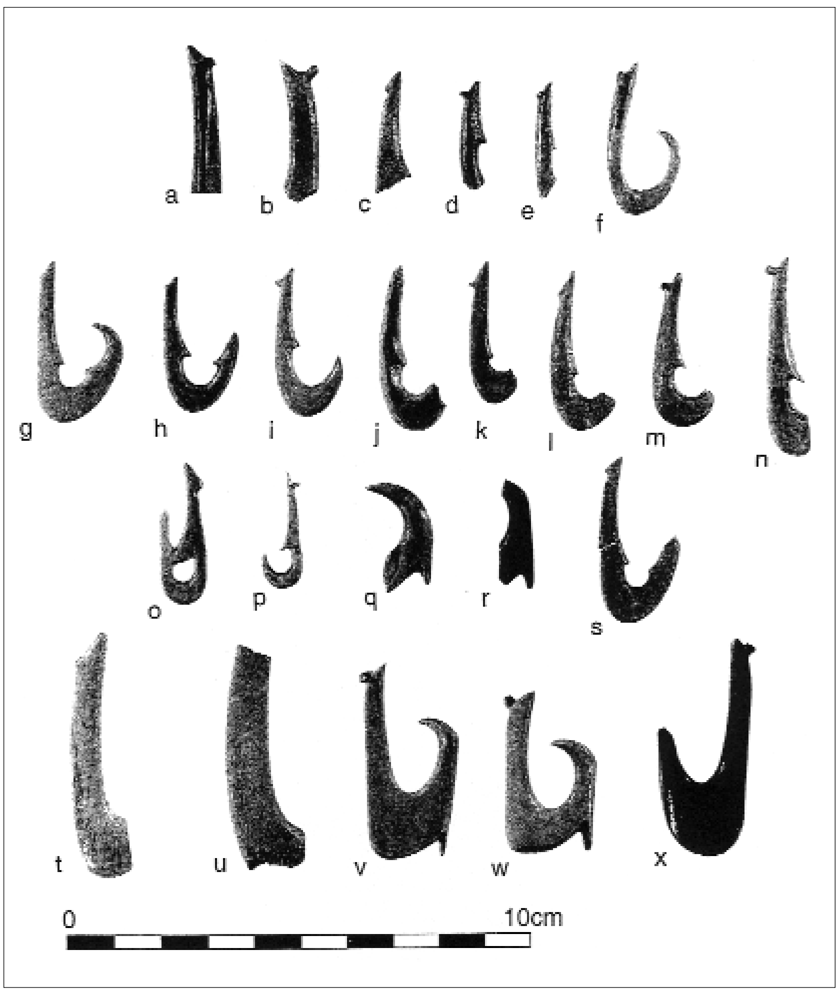

Figure 3. Complete and fragmentary one-piece fishhooks from Kawākiu Nui site 38.

The lashing devices show little variation and are dominated by the HT4 form of Sinoto (1962) with three examples classified as HT1a, where reduction occurs under the top of the shank. The HT4 form is characterized by a knobbed projection on the outer shank face and neither has a reduction of the inner shank face.

The hooks were measured using digital calipers following the procedure illustrated in Figure 5. Because most of the hooks are broken it is difficult to provide assessments of hook sizes, but the indication is that the assemblage is dominated by forms in which the point is shorter than shank and, on this basis, shank length alone provides a reasonable measure of hook size. The one-piece hooks range in size from 8.7 to 53.8 mm with a mean length of 32.5 +/-10.2 mm (Table 1).

Two-piece hooks

The two-piece hook assemblage consists of three shanks and nine points of which two shanks (Fig,. 6d and g) and five points (Fig. 6a, c, e, i, and j) are

Figure 4. Small one-piece fishhooks from Kawākiu Nui site 38.

Table 1. One-piece fishhooks from Kawākiu Nui *

Hook ID	SL	G	PL	W	T	B	Fragment Class
416	46.0				7.0		Point
216	53.8				5.4	12.4	Shank
73a			49.3		5.0		Point, no tip
414	48.0		28.0	19.7	5.9	16.0	Complete, no tip
357	43.0				4.4	9.4	Shank
411	42.9		31.9	21.2	6.2	14.5	Complete
Reconstructed	36.6		22.3	19.0	3.4	8.3	n/a
76	36.2				4.4	8.0	Point
57	35.7		26.4	19.6	4.5	9.1	Complete
56	34.5	8.0	22.9	17.9	4.4	7.8	Complete
435	34.3				4.5	7.0	Shank
199	33.1				4.0	7.0	Shank
13	32.8	6.5	18.7	16.2	4.7	5.1	Complete
416	32.3			7.4			Shank
82	32.3			14.7	3.3	6.6	Complete, no tip
341c	31.0		21.3	9.8	2.2	5.0	Complete
354	30.9			7.4			Shank
379c	30.8				3.7	7.0	Shank
5	29.6			16.5	3.0		Tip
70	26.8			3.6			Shank
318	25.5		8.5	8.9	2.7	3.5	Complete, no tip
114	25.0			3.7			Shank
308d	23.3			4.0			Shank
107	20.5		10.8	12.5	3.3	5.4	Complete, no tip
25	14.9	4	11.4	9.1	1.7	3.4	Complete, no tip
165	8.7	2.5	7.1	6.1	1.6	2.4	Complete
363			24.4		4		Shank
351			23.7		4.5		Point
341b							Bend
?							Point, no tip

*see figure 5, above right, for key to column heads

complete specimens. The two-piece hooks contained similar head lashing devices to the one-piece forms with single examples of both the HT1a (Fig,. 6g) and HT4 (Fig. 6d and h) forms present. The shanks ranged in length from 37.8 to 55 mm with an average of 46.3 mm (see Table 2).

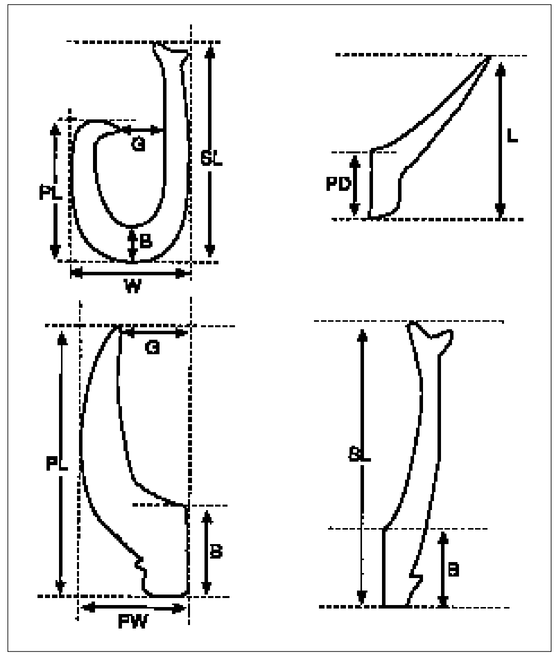

Figure 5. Dimensions taken from one-piece, octopus/trolling lure points, and two-piece fishhooks. One-piece fishhooks (upper left): SL=shank length; PL=point length; W=width; B=bend depth; and G=gape. Octopus/trolling lure points (upper right): PD=proximal depth and L=length. Two-piece fishhook points (lower left): PL=point length; PW=point width; B=bend depth; and G=gape. Two-piece fishhook shanks (lower right): SL=shank length and B=bend depth. Thickness (T) measured at midpoint of specimen, not shown.

Trolling Lure Points

In this assemblage, it was not possible to clearly differentiate trolling lure points from octopus lure points in all examples (see Fig.6s). Five trolling lure points (Fig. 6r, s, t, u, and v) were recovered from Kawākiu Nui. The five specimens include two perforated forms (Fig. 6t and u) which clearly group with the bonito lure category, while the other three could be interpreted as extreme examples of either the octopus lure points or two-piece hook categories (Fig. 6q, r, and v). The lure points displayed more variation in form than that found in either the one- or two-piece assemblages. Two points contained single perforations and all five contained distal lashing projections, although this feature was minimized in one specimen (Fig. 6t).

Table 2.*

Hook ID	SL/PL	G	T	PW	B	Part	Fragment Class
73b	56.2	14.4	4.1	5.9	14.3	Point	Complete
71	45.8	20	7.2	6.2	15.3	Point	Complete
129	40.3	12.7	4.8	6.8	9.7	Point	Complete
403	49.2			11.3	23.2	Point	Complete, no tip
359a	48.8		8.2	11	19.1	Point	Complete, no tip
99	48.8		6.2	9.7	23.4	Point	Complete, no tip
48	40		3.8	6.4	16.1	Point	Complete, no tip
38	34.8		6.5	11.3	15.5	Point	Complete, no tip
335a	34.8		4	10.8	13.2	Point	Complete, no tip
221	55.2		7.4		16.9	Shank	Complete
376	37.8		3.1		6.4	Shank	Complete

*see figure 5, page 56, for key to column heads

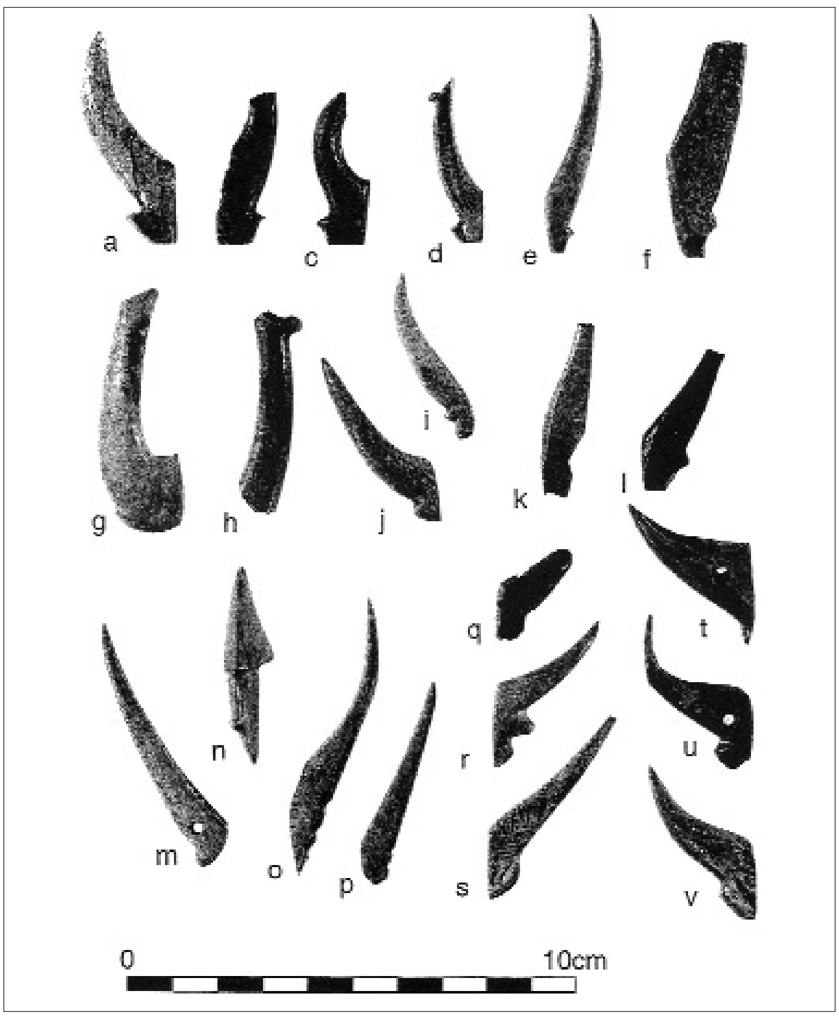

Figure 6. Two-piece hooks and lures from Kawākiu Nui site 38.

Table 3.*

Hook ID	L	T	PD	Fragment Class
3086	60	3.3	11.8	Complete
145	48	2.9	11.5	Complete
4	65.3	4.1	15.1	Complete
379a	49.7	4.6	16.8	Complete, no tip

*see figure 5, page 56, for key to column heads

Octopus Lure Points

Octopus lure points are longer and more narrow than trolling, lure points and differ from one-piece hook points in the wider gape implied from the lashing angle. Of the four lure points recovered, all were complete and each displayed different lashing forms. One specimen contained double grooves on the outer distal surface (Fig. 6p), one specimen had a triple groove (Fig. 6o), one had a single perforation (Fig. 6m), and the remaining specimen had a single distal projection similar to that found on trolling lure points (Table 3). No lure shanks were recovered although these are rare in Hawaiian assemblages.

Shark Hook Point

Shark hook points (or crescent points, following Emory et al. 1959: 38) are inserted into large wooden hooks. Our single example, specimen 355, is complete with a total length of 45.9 mm comprised of a 23.7 mm shank and a 22.2 mm point, with a maximum width of 11.5 mm (Fig. 6n).

Manufacture, Function, and Adaptation

We discuss here the three interrelated terms of manufacture, function, and adaptation in reference to the Kawākiu Nui assemblage. We consider the hooks in local Moloka'i and regional Polynesian contexts, hook function in relation to fish size and raw material constraints, and the influence of specific ecological zones targeted by the prehistoric fishers. Given mammal bone as the hook raw material, and environmental zones off west Moloka'i, how did the prehistoric fishers design their hooks for fishing, effectively in the local waters?

The Kawākiu Nui one-piece hooks are similar in basic form to those found in assemblages across central East Polynesia. In particular, unbarbed varieties of the incurved point types are well distributed throughout the Marquesas and the Cook Islands (Chikamori and Yoshida 1988; Rolett 1989; Suggs 1961, Walter 1989). One of the major differences between the Kawākiu Nui hooks and those in other East Polynesian assemblages is that the latter are predominantly manufactured in pearlshell. Pearlshell has a number of advantages for fishhook use; where it occurs, it is usually accessible in quantity, its lamination and molecular structure provide superior structural strength, and its surface sheen attracts fish. In a recent trial, Weisler caught bottom fish (serranids) with unbaited, traditionally-styled single-piece hooks off Henderson Island, Pitcairn group; in the Cook Islands, Walter (1988) has used similar hooks for catching surface swimming scombrids. Wherever it is available in East Polynesia pearlshell is the material of choice for one-piece hooks (Sinoto 1995: 152). Unfortunately, the distribution of pearlshell (specifically, *Pinctada*) in Polynesia is patchy and where its availability is limited, as for example in Hawai'i, Polynesians adopted alternative technologies The Kawākiu Nui assemblage displays manufacturing attributes which reflect the adaptation of a shell one-piece technology to an environment where the supply of suitable shell is absent or limited.

In the absence of pearlshell a range of alternative manufacturing materials have been adopted in Polynesia. In the Cook Islands, for example, Walter and Campbell (1996) have documented the transition from pearlshell to the less satisfactory *Turbo* sp. during a period of decreasing availability of pearlshell (see also Kirch et al. 1995). In Rapa Nui, Pitcairn, and New Zealand, bone. stone, and wood were used (e.g., Buck 1971, Green 1959). At Kawākiu Nui, mammal bone (probably including human, pig, and dog) was the preferred raw material, and its advantages are its availability and its capacity to be easily worked into hook forms. The Kawākiu Nui bone hooks were manufactured from tabs of long, bone which were first grooved and snapped into rectangular or sub-rectangular tabs (Fig. 7). Next, one hole was drilled through the tab thus beginning the formation of the hook interior (Fig. 8). The rest of the hook was then shaped using a combination of *Porites* sp. coral and echinoid abraders. In those hooks with inner shank and point barbs, a second hole drilled above the first formed the barbs. The intervening bridge of bone was removed through sawing, or abrading (Fig. 3o). The practice of using long-bone tabs resulted in most hooks having a lateral curvature inherited from the rounded cross section of the original bone. The convex side of the hooks also displayed a pitted, cortical bone surface, as seen on the tabs in Figures 7 and 8.

The characteristics of mammal bone impose severe limitations on a one-piece hook technology. The lateral curvature is not ideal because it removes the hook from a single plane. Thus a direct downward pressure, for example, will contain a shear component that would be absent or minimal in a pearlshell hook. Furthermore, since bone has grain, there are inher-

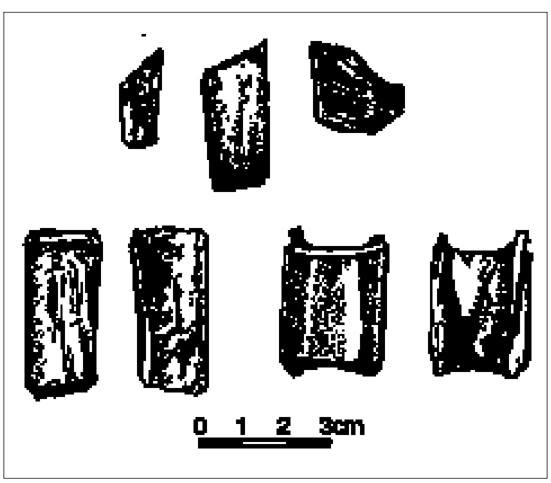

Figure 7. Examples of fishhook tabs.

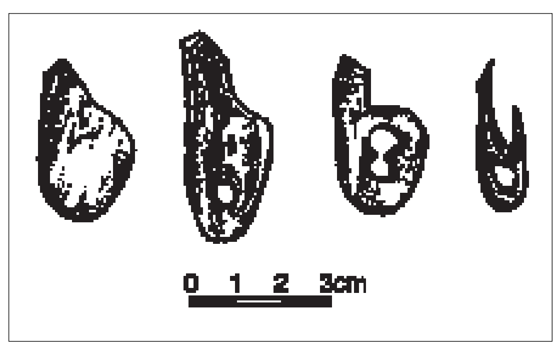

Figure 8. Some stages in the manufacturing process of one-piece bone fishhooks.

ent weaknesses present in the form of natural fracture lines. The Kawākiu Nui assemblage compensates for these disadvantages in a number of ways.

To minimize the problems created by the natural grain, the hooks have been formed so that the grain runs parallel to the length of the shank. If the grain ran at right angles to the shank this would make the shank and point highly susceptible to snapping and impose a fatal limit on one-piece hooks. The bend, which is already part of the hook exposed to major stresses, is potentially weakened by having a longitudinal grain line run through it. But whereas it is impractical to reinforce the shank by significantly widening its cross-section. There is less limitation to the extent to which the bend depth can be increased and, as an aid to strengthening the hook bend—where breaks often occur—the bend depths are much greater in some of the Kawākiu Nui specimens than is usual in pearlshell hooks (see Fig. 3v, w, and x). Weakness in the shank can be compensated by the use of an elaborate snood (line attachment) for strengthening, the upper shank. This is suggested by the shank tapering, towards the head of many Kawākiu Nui examples (see Fig. 3c, g, i, j, m, and n), which creates space for the snood.

Barbs are also an uncommon feature of many Polynesian one-piece hooks and while they are not unknown in pearlshell varieties, they do have a strong correlation with bone specimens and are particularly common in Hawai'i (Goto 1986). This is undoubtedly because pearlshell hooks, with their natural luster, can attract fish without the need for bait. Bone hooks, however, require bait and inner and outer barb function, in part, to hold the flesh securely. It is clear that barbs inhibit the fish from working free and may also be an adaptation to the specific feeding behavior of certain species. Mechanical stress tests comparing pearlshell and bone may also elucidate whether barbs reduce the weakness of bone as a raw material. Finally, barbs may be a functional adaptation to deep water fishing as practiced by the Kawākiu Nui fishers. To see this more clearly, it is necessary to understand the practical aspects of fishing inshore versus in deeper, offshore waters.

In clear, shallow tropical waters, it is often possible to actually see the fish you are trying to catch. Baited jabbing hooks on a relatively short line are often thrown from the shore, while standing at the reef edge, or from a canoe. Light line weights are sometimes used. Once a fish is hooked—which is readily felt by a jerk of the line—a steady even tension is kept on the line and the fish is landed quickly. Fishing for benthic species in deeper waters offshore presents a different set of challenges: (1) away from the shore and the protected embayment, the current is usually stronger and the fisher's position is no longer stationary; (2) unlike a sand bottom which reflects light, making it easier to see fish which appear dark against a white background, a hard bottom of rock, coral rubble, and sediment is present off Kawākiu Nui (Manoa Mapworks 1984), making it difficult to see fish in the water column; (3) heavier line weights are necessary to sink baited hook(s) before they drift laterally and remain close to the surface, far from the bottom-dwelling target species; and (4) the canoe rises and falls with the ocean swells which constantly puts varying tensions on the weighted line which can make it difficult to feel when a fish strikes the hook. It may be that using jabbing hooks or barbless, rotating hooks for benthic fishing would result in an inordinate loss of fish that struck the hook, removed the bait, and managed to get free from the hook—all this taking place without the benthic fisherman ever seeing or feeling, what was happening.

We suggest that rotating hooks in general, and barbed hooks specifically, are an adaptation to the specific conditions of offshore benthic fishing, and in shallower inshore water where seeing the prey and feeling it strike the bait are unlikely. It is also important to make the distinction between inner and outer barbs. Unlike shiny pearlshell hooks that naturally attract fish, all bone hooks need to be baited. Inner barbs may help secure the bait and probably make it more difficult for a hooked fish to remove the bait and release the hook (see Fig. 3g-n). However, we believe that the outer barb may be an ingenious adaptation for benthic fishing (see Fig. 3q, r, v. and w). After a fish bites the baited hook, the lower jaw comes in contact with the outer barb on the bend and this pressure helps rotate the hook, facilitating the point to pierce the mouth and secure the fish. Since benthic fishers may not feel the fish strike, it is not possible to apply an even pressure at the opportune time to successfully land the fish. The functional and technological properties of barbs in the Polynesian context is an issue that needs to be more fully addressed by looking at hook assemblages from sites of different time periods and located in a range of marine environments, and identifying fish bone stratigraphically associated with fishhooks.

Finally, the manufacture of two-piece hooks in Polynesia's strongly associated with the use of bone as a manufacturing material. In fact, two-piece hooks are only found in the peripheries of East Polynesia (Hawaii, New Zealand, and Rapa Nui), where pearlshell is either absent or in very limited supply. The adaptive properties of the two-piece hook relate to the structural weakness of the one-piece bend which is further increased with the use of bone (see above). In two-piece hooks the solid bend is eliminated by lashing independent shank and point sections. Some of the stress in the two-piece bend is absorbed by the lashing. The cylindrical shape of bone precludes the manufacture of large one-piece hooks. This is in marked contrast to large, flat pearlshell valves—essentially a canvas free of most restrictions. By fashioning two relatively straight pieces of bone that meet at a lashed bend. larger and thicker hooks can be made (see Fig. 6a and e). These hooks are flat, unlike the one-piece hooks that follow the natural concave-convex curve of the mammal long bone. It is uncertain if flat hooks are better adapted since many steel rotating hooks made today are slightly offset in the lateral plane. At any rate, the success of the two-piece hook is reflected in the breakage patterns discussed below.

Taphonomy

One aim of our study is to reconstruct the use life (Schiller 1987) of the individual hooks. Earlier studies of Polynesian fishhooks have discussed the relationship between form and function in respect to complete hook specimens, but many of these studies have overlooked the potential information contained in hook fragments, which usually comprise the bulk of the assemblage. Yet the form of these fragments and their breakage patterns directly reflect the set of behaviors involved in their manufacture, use, and discard. In this study we first consider the taphonomy of the assemblage in terms of identifying the process or processes which were responsible for assemblage formation. Second, the patterns of hook, breakage are examined in relation to the technology of manufacture and use.

In respect to taphonomy and site formation processes, there are a number of potential explanations for the Kawākiu Nui assemblage. The basic alternative hypotheses are that the hooks either accumulated through deliberate discard because they were broken during manufacture or use, or else that whole hooks were accidentally lost and then broken through post-depositional processes such as human trampling (see McBrearty et al. 1998). Accidental loss of complete hooks can account for some of the specimens since the site matrix is loose silt loam where hooks can be easily buried, and at least six whole hooks are included in the assemblage. But no fragments could be matched to reconstruct whole hooks or larger specimens (except specimens broken during excavation, see Table I) and this suggests that at least some hooks were broken away from the site, perhaps during use. In order to investigate assemblage formation processes, hook breakage patterns are examined.

Fragment classes

On the basis of the descriptive criteria of Sinoto (1991, see also Fig. 9) seven fragment classes of one-piece hook were defined (Table 4). Fragment classes

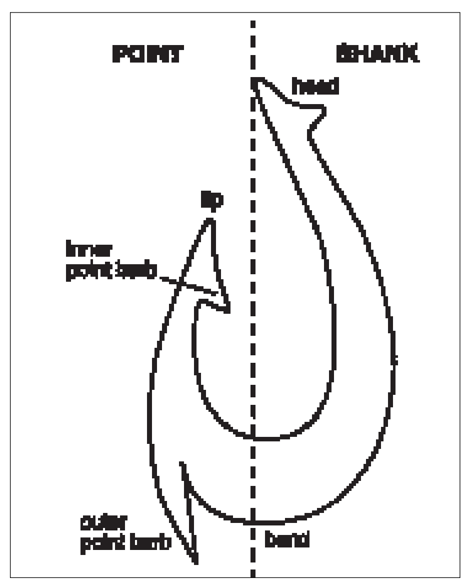

Figure 9. Parts of a one-piece fishhook.

Table 4.

Fragment Classes	No.
Shank	11
Complete	6
Complete, no tip	5
Point	3
Point, no tip	2
Bend	1
Tip	1
Total	29

Table 5.

No. of Breaks	Breakage Zone			
	None	Bend	Tip	Both
None	Complete	—		—
One break	—	Shank	Tip	
		Point	Complete, no tip	
Two breaks		Bend		Point, no tip
		Shank		Shank
		Point		Point

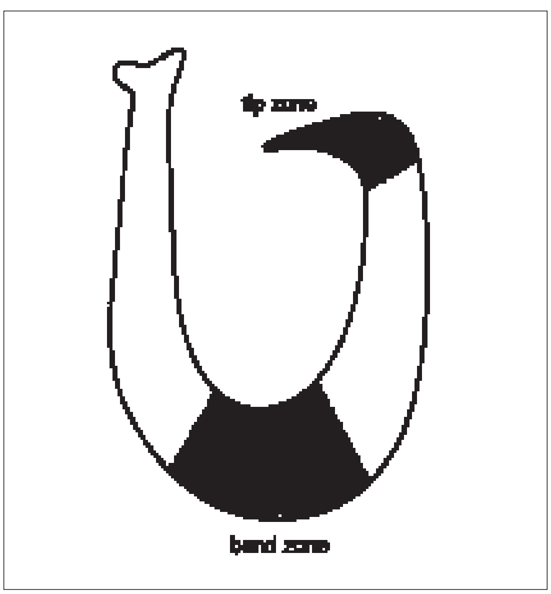

Figure 10. Break zones (bend zone, tip).

were interpreted in terms of the intersection of two modes of breakage: the location of the break or "breakage zone," and the number of breaks present. The breakage of one-piece hooks was restricted to two break zones on the original artifact, the bend and the point tip (Fig. 10). and each specimen results from either one, two, or no breaks in these zones. One break implies the presence of a terminal hook feature (tip or lashing device), two breaks implies no terminal features, and no breaks implies a complete hook. As Table 5 indicates, some fragment classes can result from different breakage patterns, but all fragments can be described in terms of just two modes of variation. The restricted range of variation in breakage is highlighted by the absence of a number of potential fragment classes (e.g., lashing device. shank without lashing, device, or mid-shank segments).

The two-piece and composite hooks showed less variability in patterns of fragmentation than the one-piece forms. Two-piece hook shanks were all complete and, like the one-piece hook, there is no example of breakage occurring in the shank section. The two-piece and octopus lure points were either complete or broken near the tip. Again, this is similar to the patterns of breakage seen in the one- and two-piece points.

In considering fragment class in reference to the use and discard history of the assemblage, a number of observations are significant. First, the range of breaks in the one-piece assemblage was limited to the bend and tip which are the hook portions where maximum stress occurs during use. The tip is the thinnest part of the hook and is subject to direct pressure from the mouth of the fish. The bend connects two lines of force which diverge and accumulate stress under a variety of conditions. The distribution of variation in fragment classes suggests that man of the hooks were broken during use and discarded later. There were no examples of hooks broken midway through the shank and no specimens consisting solely of the head or lashing, device. These two forms of breakage are likely to be found in assemblages in which significant post-depositional damage has occurred. In the few examples from Kawākiu Nui where the shank contained no bend section, the break occurred at the distal end of the shank on the edge of the bend zone (see Fig. 3a–e).

The high relative proportion of shanks to points in the one-piece hook assemblage suggests a similar conclusion. There were 11 shank specimens in the site but only six containing portions of points only (Table 4). The most probable explanation is that most of the hooks broke under stress during fishing and the points were lost at sea.

Polynesian hooks are lashed to the line and can not be as quickly detached and replaced as their steel counterparts. The lines were probably brought ashore and the shank fragments untied and discarded on the site.

Breakage patterns

The form of the breaks on the hook fragments is informative about manufacture and use. The hooks were all manufactured of mammal long bone which displays certain characteristic patterns of breakage. When "green" or fresh mammal bone is put under tension it tends to break creating a spiral fracture (see Agenbroad 1989). When the bone ages, moisture loss, microcracking, and incipient split-line features all facilitate fracture fronts that produce diagonal, perpendicular, or parallel breaks (Johnson 1989: 4361). The Kawākiu Nui assemblage exhibited 29 examples of both spiral fracture (fresh) and nonspiral breakage or old breaks (Fig. 11f). Fractures were described as "fresh" only when they exhibited clear stepped or spiral fractures (see Fig. 11g & h); all other hooks were described as "old breaks." The results of this analysis of one-piece. two-piece, and octopus lure points are shown in Table 6.

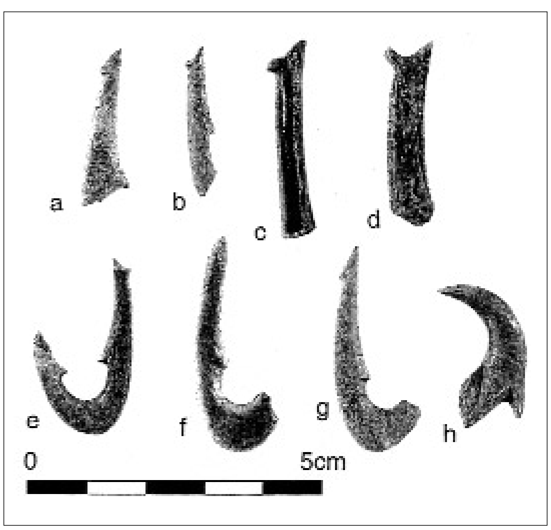

Figure 11. Fracture of bone fishhooks from Kawākiu Nui site 38.

As Table 6 indicates spiral fractures were found only on the one-piece hooks while all breaks on two-piece and octopus lure points were old breaks. The one-piece hooks had 10 examples of old breaks and 12 examples of fresh fractures. The fresh fractures were evenly distributed between shank and point fragments. The distribution of spiral fracture lines in the Kawākiu Nui assemblage suggests that a number of the one-piece hooks broke while the bone was still fresh (probably by use within days of manufacture when the bone was still "green"), the other hook classes broke when the bone was older and drier. Assuming that all hooks were manufactured of fresh bone this suggests a longer average use life for the two piece hooks.

Summary and Conclusions

We wanted to know the late prehistoric fishing adaptation of a small group of people occupying Kawākiu Nui Bay situated along, the rugged leeward coast of Moloka'i. We have advocated the analysis of fishhooks as part of an assemblage where whole specimens as well as fragments provide useful information for understanding, the manufacture, function, breakage patterns or taphonomy, and discard of these artifacts. In addition to artifactual information, fishing strategies are the product of the local culture in as much as group size, specific strategies based on kinship-based cooperation, and manufacturing skills provide opportunities and limitations. For example, in traditional societies. not all members had adequate skills for manufacturing pottery or stone adzes. By the same token, we can assume that not all members of the Kawākiu Nui community could manufacture bone fishhooks and fishing line, and weave nets as well as have the detailed knowledge of fish capture strategies, availability of seasonal fish species. kinds and preparation of bait, and knowledge of sea and weather conditions. In other words, fishing is a socially complex endeavor requiring, detailed knowledge and a range of skills. Although we may never be able to empirically assess certain human skills and knowledge directly, nonetheless, it is part of the equation to understanding, overall fishing strategies during prehistory.

We can make certain predictions about the kinds of fish caught from a general knowledge of the marine environments believed to be exploited by the Kawākiu Nui community. The low rocky shores washed within the splash-zone provided habitat for limpets *(ʻopihi)* and other molluscs. Although there are no extensive reefs in the vicinity, coral growth hugs the coastline and is home to the coral-dwelling, scarids *(uhu)* and seaweed *(limu)* browsers such as the abundant acanthurids (e.g., *kala, kole, manini, palani*) and kyphosids *(nenue)* that could be taken by seine net. Fishing inshore with baited jabbing or rotating hooks may yield such carnivorous species as the jacks (*ulua,* carangids), hawkfish (e.g., *poʻopaʻa,* cirrhitids), serranids. as well as eels and sharks. In shallow waters, spearing for *uhu,* spiny puffers (diodontids), and tetradontids would be possible.

Seasonally plentiful species that are often taken by seine nets include *akule (Selar crumenophthalmus)* and the threadfin *(moʻi, Polydactylus sexfilis),* while flying fish *(mālolo)* can be captured by dip nets. Trolling in the pelagic grounds may catch scombrids *(ahi, aku, ono),* dolphinfish *(mahimahi),* and barracuda (*kaku,* sphyraenids). Snappers (*ʻopakapaka,* lutjanids) would be the dominant bottom or benthic fish targeted by baited rotating hooks on long lines. Kawākiu Nui Site 38 produced fish bone from most of these taxa which suggests a diverse range of fishing strategies.

The hooks from Site 38 represent an assemblage designed primarily for inshore exploitation with a specialization for targeting, benthic fish communities. The one-piece hooks were dominated by rotating forms which may be more suitable for bottom and mid-water feeders, and were almost certainly cast from canoes stationed offshore, probably over a reef or coral rubble surface. The fishhook sizes were in the mid-range for one-piece varieties which suggests that the fishers were targeting medium to large benthic predators such as serranids, carangids, and lutjanids. These families come in a range of sizes, but specimens in the 30–60 cm range are commonly taken with baited hooks on dropped lines on west Molokaʻi today. No jabbing hooks were positively identified and this is consistent with the interpretation that the Kawākiu Nui people were fishing deep inshore waters. Jabbing hooks are more appropriate for fishing shallow reef edges where the fisher sets the hook by putting the line under even tension once the fish. Jabbing hooks are probably not as effective in deeper waters where the fisher is less likely to feel the fish strike. Instead. rotating hooks are designed to be set by the feeding or striking actions of the fish.

The two-piece hooks are slightly larger in size than the one-piece varieties but functionally similar and designed to exploit the same environments and fish genera as one-piece hooks. In our view, the use of two-piece hooks at Kawākiu Nui is a direct adaptation to the technological limitations imposed by the use of mammal bone as a manufacturing material. The narrow cross-sectional width of mammal long bones places a lower limit on the size range of one-piece as opposed to two-piece hooks. The structural weaknesses inherent in mammal bone are also minimized in the two-piece forms.

Like most Polynesian fishing communities the Kawākiu Nui people possessed the technology to exploit a range of fish species and habitats. Trolling lure points were used for catching surface swimming pelagic predators such as bonito and *mahimahi* and a single shark hook point was also recovered. Both these devices are part of composite hook forms although the complementary components were missing from the assemblage. Shark hook points are generally fitted to wooden shanks and the absence of these at Kawākiu Nui is not unexpected. It is interesting to note. however, the rarity of trolling, lure shanks in Hawaiian assemblages given the relatively widespread occurrence of lure points.

The Kawākiu Nui fishing assemblage also reflects aspects of the invertebrate fishing economy. Octopus lures are composite fishing devices of which only the points and toggles were found at the site. A cowrie shell is attached to a stone sinker and both are lashed to the end of a wooden shank. A long sharp point is lashed distal of the lure component (Sinoto 1991). The whole device is then suspended from a line over a reef or section of rocky sea floor. Octopus lures are a common Polynesian fishing device (Pfeffer 1995) but it is important to note that octopus can be caught in many different ways including simple foraging strategies along the exposed reefs and rock pools. Octopus are plentiful in most Polynesian waters, they are easy to catch, and individuals have a high proportion of meat weight to non-edible portions. It is likely that octopus made up a sizeable component of the marine food intake of many Pacific communities but they are virtually invisible in the middens. Reconstructions of prehistoric Hawaiian marine diets should take this missing component into account.

An examination of fragment types and breakage patterns suggests that most of the hook specimens recovered from the site were broken during use. This is reflected in the location of breaks on the original hook, which were restricted to the bend and tip in the one- and two-piece forms. This is the part of the hook which is most highly stressed during use. The fracture lines on the one- and two-piece hooks contained examples what we suggest are green breaks plus older, clean-line fractures. (Straight fractures may also occur at the bend of new hooks.) The green breaks were more common on the one-piece hooks implying a longer average use-life for the two-piece forms. This agrees with our view that the use of two-piece hooks is intended to eliminate some of the structural problems of mammal bone which are most apparent in the one-piece varieties.

The fishing kits of the Kawākiu Nui people were manufactured on site, probably by specialists. The site contained examples of hooks in various stages of manufacture and the process for making one-piece forms could be reconstructed (Hammatt 1979: 64). An examination of the fishing assemblage goes some way towards illuminating the fishing adaptation of this west Moloka‘i community. It is important to understand, however, that what we have seen in the site represents only a sub-set of the fishing technology of these people. In addition to the hooks, the fishing, kits would have included nets—in a range of lengths, heights, and mesh sizes—spears, traps, and poisons. In addition, a part of the dally marine catch, including vertebrates, was probably taken using simple opportunistic foraging strategies along the strandline or from rocky promontories. For these and other reasons discussed above, any study of prehistoric Oceanic fishing should take careful account of oral tradition, ethnographic and historic observations, contemporary fishing practices, fish bones associated with the hook assemblage, hook and site taphonomy, and coastal ecology.

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A Beach, a Lava Flow, and an Old Road: Archaeological Research on the Island of Hawai'i, 1995-1997

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Introduction

Between 1995 and 1997, the author and students at the University of Hawai'i-Hilo (UHH) carried out three field projects on Hawai'i Island. In 1995, we conducted test excavations at a habitation site at 'Anaeho'omalu Bay. In 1996, we conducted a reconnaissance survey around the perimeters of two anchialine ponds near Pueo Bay in the *ahupua'a* of Pu'uanahulu in North Kona. In 1997, we carried out a reconnaissance survey along a portion of the Old Government Road in the *ahupua'a* of Kea'au in Puna. All of these projects consisted of preliminary field investigations of historic properties coupled with accompanying historical and documentary research. While detailed site descriptions will not be presented here (due to landowners' and agencies' concerns over site security), we offer some preliminary findings and make suggestions for future research in each case. More detailed site information may be obtained from project reports on file at the State Historic Preservation Division (Lass 1995, 1996 & 1997).

Test Excavations at Site 50-10-10-19838 at 'Anaeho'omalu Bay

'Anaeho'omalu and the Site Vicinity

After a local resident, David Ka'apu, discovered cultural materials eroding from beach deposits near the south end of 'Anaeho'omalu Beach Park in 1994, the landowner, Waikoloa Land Company, had the site evaluated by archaeological consultant Paul H. Rosendahl, Inc. (PHRI). In March 1995, a UHH team and representatives of PHRI conducted excavations at Site 19838.

An *ʻili* or land division within the *ahupuaʻa* of Waikaloa in South Kohala District on the leeward coast of Hawaiʻi Island, ʻAnaehoʻomalu is a relatively narrow piece of land which extends for approximately three kilometers (km) along the coast and covers an area of approximately 300 hectares (ha) or 800 acres. Annual rainfall averages less than 10 inches (22 cm) per year (Armstrong 1983:63); there is little to no soil and virtually no naturally occurring vegetation except along the shoreline and near brackish ponds.

At the south end of ʻAnaehoʻomalu in the vicinity of site 19838 are *pāhoehoe* and *ʻaʻā* flows which originated from Mauna Loa in pre-Contact times (MacDonald, Abbott, and Peterson 1986:350-351). Many collapsed lava bubbles and tubes form caves and rockshelters. Relief is quite low so that in places where it dips below sea level brackish ponds occur, and several kinds of fish and shrimp are found in such ponds (Maciolek and Brock 1974). The large, crescent-shaped beach at ʻAnaehoʻomalu Beach Park is the only beach of any extent in ʻAnaehoʻomalu. The two fishponds lie immediately behind the beach; the smaller Kahapapa pond is on the north, and the larger Kuʻualiʻi pond is on the south. Site 19838 is located near the south end of the Kuʻualiʻi pond (Figure 1).

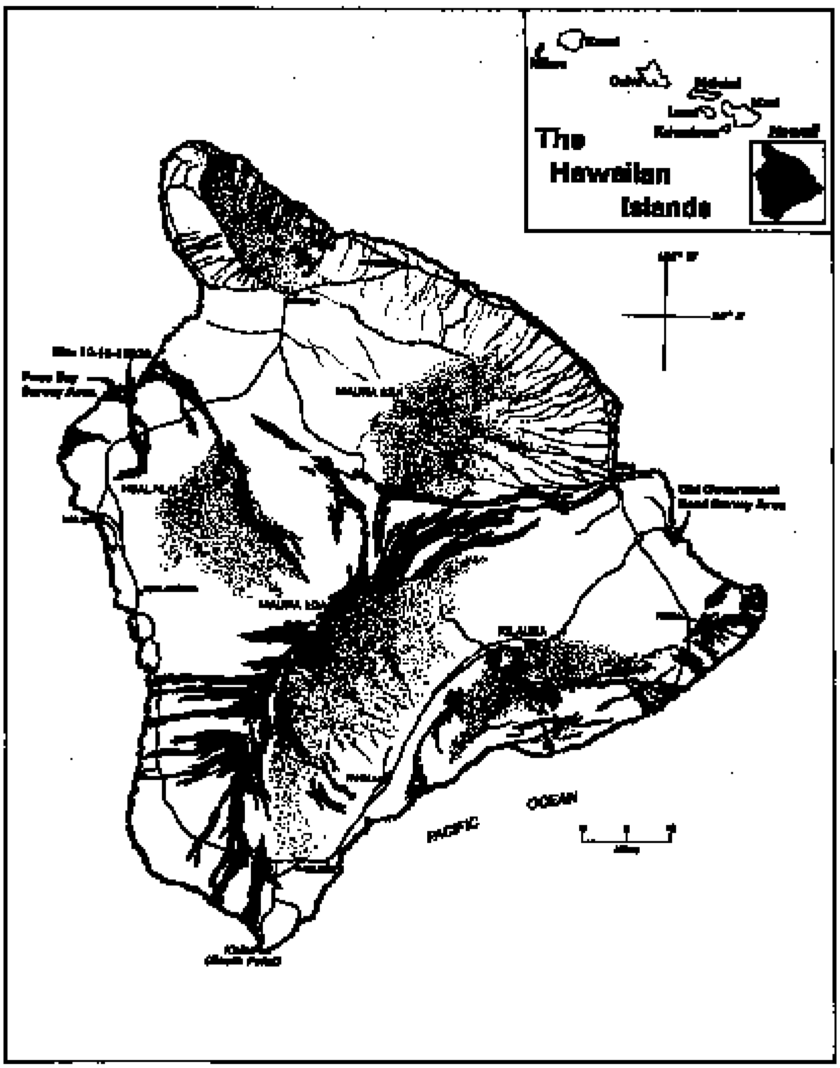

Figure 1. Project locations

Historical Background at ʻAnaehoʻomalu

When William Ellis made his journey along the coast of Hawaiʻi Island in 1823 he did not mention any settlement at ʻAnaehoʻomalu. In the *Mahele* of 1848, Kamehameha III claimed ʻAnaehoʻomalu as crown land. According to Barrère (1971), ʻAnaehoʻomalu was passed from Kamehameha I to Kamehameha II, then to Kamehameha III, and finally upon his death in 1854 to Queen Kalama Kapakuhaili Hakaleleponi. Barrère suggests that ʻAnaehoʻomalu was valued primarily for its marine resources and that "in the days of the Kamehamehas" groups of people periodically visited the area to obtain and dry supplies of fish for *aliʻi* households. Barrère further suggests that, on the basis of boundary testimony given in 1873, ʻAnaehoʻomalu was largely devoid of traditional Hawaiian settlement by that time, and she attributes this abandonment to the disruptions of the new cash economy as well as the lava flow of 1859 which damaged fishing. Queen Kalama died in 1871, and in 1878 John Parker (the grandson of Samuel Parker, founder of Parker Ranch) purchased ʻAnaehoʻomalu. Parker Ranch then used the coastal areas of ʻAnaehoʻomalu to obtain fish for the Ranch, and for recreation (Barrère 1971:111-113).

Caretakers for the fishponds lived at ʻAnaehoʻomalu from at least 1878 into the twentieth century, and an 1880 map shows a hut in the vicinity of archaeological site 303 which may have been the caretaker's residence (Barrera 1973: 5, 21; Barrère 1971:113). Parker Ranch rebuilt the fishponds at ʻAnaehoʻomalu Bay after they were damaged by tsunamis in 1946 and 1960, but did not maintain them after the mid 1960s when the last fishpond caretaker died (Barrera 1971:111-113). The beach park facilities at ʻAnaehoʻomalu Bay were constructed in 1974, and the first resort construction at ʻAnaehoʻomalu took place in 1981 (Cobb 1995).

Archaeological Background at ʻAnaehoʻomalu

William Barrera conducted a reconnaissance survey in 1969 and located several post-Contact sites at the south end of the Kuʻualiʻi pond, including "historic walls and foundations at the beach" and a rectangular structure (Barrera 1970:14-15) built of "concrete mortar and lava rocks" (Barrera 1971:46). Several other sites excavated by Barrera in 1969 and 1970 Barrera yielded evidence of post-Contact activity in the vicinity of Site 19838. Site 197C, a cave, contained shell midden along with post-Contact artifacts of metal and glass (Barrera 1971:44-46). In addition, Barrera's excavations at Sites 153 (a complex of nine rock walls and two small caves), Site 194 (a complex of stone walls and two small caves), and Site 195 (a complex of historic walls and terraces associated with Parker Ranch) yielded both traditional midden and historic materials such as metal, wire, and glass (Barrera 1971:42-46).

Site 303, mentioned above, is a stone pavement with associated midden and artifact deposits on the beach at ʻAnaehoʻomalu Bay, just a few meters north and east of Site 19838. In 1972 Barrera supervised excavations at Site 303 and recovered historic materials including crockery and rusted metal, in addition to a rich traditional deposit including midden, adze fragments, fishhooks, and other artifacts (Barrera 1973).

Excavations at Site 19838

In 1995, we excavated a portion of a stone floor or platform measuring approximately 3 m north-south and 2 m east-west. We excavated two one meter by one meter test units within the paved area, and systematically tested areas adjacent to the excavation units with a soil probe in order to define the extent of the site. Excavated by trowel, all deposits were screened using 1/4 inch mesh, and all artifacts and all midden material were saved and analyzed.

Test Unit 1 was excavated to a depth of approximately 30 cm at which a layer of large paving stones (up to 60 centimeters in length) was encountered. Below the pavement, we recovered a quantity of shell, bone, and sea urchin remains, and a single artifact, a green glass fragment. A matrix of sand, gravel, and cobbles composed the deposit found in Unit 1. The presence of a glass fragment and midden material below the pavement layer may indicate that incidental garbage made its way through the stone floor to the sand below.

Test Unit 2, located to the south of Unit 1, contained less evidence of the pavement or floor, but yielded more artifacts—both traditional and post-Contact—and midden in the first 10 cm. While a few cobbles were recovered along the east margin of the excavation unit, they did not seem to form a pavement. Between 10 and 20 cmbs in depth, additional artifacts, traditional and post-Contact, were recovered together with midden in the sandy matrix. No artifacts or midden material were recovered from below 20 cm in depth, and excavation ended at a depth of 30 cm where several large (up to 50 cm in length) flat stones were encountered. These stones did not appear to form part of a pavement.

Neither test unit contained evidence of distinct occupation levels. Instead, post-Contact materials such as glass and iron were found throughout the cultural deposit mixed with traditional artifacts and midden material. The only concentration of artifacts (or midden material) consisted of three octopus lures and an octopus-lure sinker which were all found in close proximity in Level 1 (0-10 cm) in the northeast quadrant of Test Unit 2.

Two series of soil probes were made in the vicinity of the excavation units. The first series of seven probes tested a portion of the beach inland or *mauka* of the test units, and no cultural material was found. In the first probe, located only one meter east (*mauka*) of Test Unit 1, rock was encountered at a depth of 15 cm, and may be a continuation of the stone pavement.

We conducted the second series of nine probes between the excavation units and the ocean, and in areas to the south of the excavation units along the beach face where erosion exposed some midden material. No midden was recovered from the two probes made between the excavation units and the ocean, but the remaining probes all yielded charcoal and/or concentrations of shell. Site 19838 may thus extend south of the test units although it is not clear whether the midden materials found in the probes are primary deposits or secondary, due to erosion or slumping sand further inland.

Summary of Artifact and Midden Analyses

Site 19838 yielded clearly post-Contact items, including iron nails with square heads, iron fragments, glass fragments, and glass beads. The square nails and glass beads date to the late nineteenth or early twentieth centuries. The other artifacts from the site are typical Hawaiian artifacts used in the pre-Contact as well as post-Contact periods. The traditional artifacts include coral and echinoid abraders, a *poi* pounder fragment, and several items associated with fishing for octopus: an octopus-lure sinker and four octopus lures (all from Unit 2). The sinker (ca 9 cm long and weighing approximately 220 g) is of the "coffee bean" type (Kirch 1985:204), and made of a material commonly called beachrock, a soft and easily broken breccia made up of sand, coral, and shell (MacDonald, Abbott, and Peterson 1986:291, 293). The largest of the four lures (ca 7 cm long) is made of the shell of *leho* (*Cypraea mauritiana* or cowrie), often used for octopus lures (Titcomb 1978:340). The other three lures, all smaller (mean length 6 cm), were made of shell from another species of cowrie, *Cypraea maculifera.*

Marine shell comprises the bulk of midden recovered from Site 19838. Most identified shell comes from taxa such as *'opihi* (genus *Cellana*), *leho* (genus *Cypraea*), and *pipipi* (*Nerita picea*), used in pre and post-Contact times for food, tool, and ornament manufacture (Kay 1979: 43-46, 63, 188-202; Titcomb 1979: 338-344). Pearl shell (genus *Isognomon*) was also recovered in small amounts, and possibly used in the manufacture of fishhooks (Kay 1979:520-521; Titcomb 1979: 349-350). Most of the recovered bone midden is too fragmentary to identify although both mammal and fish bone are clearly present. Sea urchin (family Echinoidea) remains were recovered, and consist almost entirely of fragments of spines, often used for abraders. We refer the reader to the 1995 excavation report for a complete inventory of midden material (Lass 1995).

Summary of Findings at Site 19838 and Suggestions for Further Research

An apparent habitation site with a pavement and associated midden and artifacts, Site 19838 resembles Site 303 nearby. The pavement at Site 19838 is comparable in size to the pavement recorded at Site 303 (Barrera 1972). Similarly, Site 19838 yielded glass and iron items as well as traditional artifacts associated with marine exploitation, and, like Site 303, Site 19838 probably dates from the late nineteenth century or early twentieth century. At Site 19838, shellfish were used for food as well as for artifacts, including the manufacture of fishing gear. Fish and other vertebrate animals were part of the diet, and sea urchin spines were gathered, presumably for use as abraders. The caretakers of the fishpond may have occupied Sites 303 and 19838 as may have others who used the pond or fished in the area in post-Contact times.

We recommend that further excavations be conducted to further define the extent of Site 19838, particularly the extent of the pavement and the midden deposits. Further laboratory work should include detailed comparison of the post-Contact artifacts with the similar materials recovered from nearby sites, with the goal of dating them more specifically. Finally, more documentary research on the acquisition and use of the area by Parker Ranch could assist in dating and determining the use(s) of Site 19838 as well as other post-Contact sites at 'Anaeho'omalu Bay.

Archaeological Reconnaissance Survey at Pueo Bay

In 1996, a team from UHH conducted a reconnaissance survey near Pueo Bay, on behalf of the State Division of Forestry and Wildlife. The Division plans to develop for public access a portion of the Ala Kahakai, a trail within the survey area, as part of the statewide Na Ala Hele Program. Consequently, in order to prepare a cultural resource management plan for trail development, the Division needed to have an inventory of historic sites in the area.

The Survey Area and Anchialine Ponds at Pueo Bay

Approximately three and a half hectares (eight-nine acres) in size, the survey area extended around the perimeter of two anchialine ponds located just inland of Pueo Bay in the *ahupuaʻa* of Puʻuanahulu in North Kona (Figure 1). Puʻuanahulu is the northernmost *ahupuaʻa* in North Kona, and has a hot, dry climate in this coastal portion of the *ahupuaʻa*, with an average annual temperature of 75-80 degrees F and average annual rainfall of only 5-10 inches (11-22 cm) (Armstrong 1983: 63, 64). The terrain in the survey area consists of rough *ʻaʻā* lava which supports virtually no vegetation. The ponds lie east-west along the margin of the 1859 lava flow from Mauna Loa; the other lava flows around the ponds are much older at more than 4,000 years old (Trusdell 1995:328).

The two ponds at Pueo Bay can be described as the *mauka* (east) pond and the *makai* (west) pond, but are essentially a series of pools of water dispersed over a distance of 300-400 m. The largest and deepest pool is at the *makai* end; it is 90 m long, 10-15 m wide, and up to 3 m deep. Formed by rainfall collecting in a collapsed lava tube or other trench-like volcanic feature, sea water penetrates the volcanic basin, causing brackish or anchialine ponds to form. Vegetation growing along the margins of the ponds includes grasses and sedges, *noni* (Indian mulberry), *hala* (pandanus), and introduced kiawe. Small, endemic red shrimp (*ʻōpaeʻula* or *H. rubra*) live in some pools, and tilapia, an introduced fish, are found in others.

About seventy-five percent of the anchialine ponds of Hawaiʻi Island are found in Kona (Maciolek and Brock 1974:4). In the barren environment of the Kona coast, the ponds were oases, often modified in pre-Contact times, and perhaps used for aquaculture, soaking or treating vegetation, washing, bathing, and swimming (Barrera 1971; Walker and Rosendahl 1990). People may have been especially attracted to the ponds of Pueo Bay because they are relatively large and deep. The ponds at Pueo Bay also have unusually low salinity levels in comparison to other anchialine ponds. Most of the brackish ponds have water salinities of less than 10 parts per thousand (ppt), but only water with a salinity of 5 ppt can be consumed without ill effect (Maciolek and Brock 1974:6-7). The salinity of the water in the ponds at Pueo Bay is only 2-3 ppt (Maciolek and Brock 1974:28) making the ponds a suitable source of drinking water and agriculture in addition to other uses.

Knowledge of the Pre-Contact Period

Fairly dense clusters of archaeological sites are found along the coast of Puʻuanahulu at Kapalaoa, Weliweli, Pueo Bay, Keawaiki, and possibly other locations as well (Barrera 1980; Cordy 1981; Emory, Bonk, and Sinoto 1959:7; Kelly 1973: 96; Reinecke 1930: 29, map; Walker and Rosendahl 1990). While Cordy suggested that the entire North Kona coast from Kaloko north to ʻAnaehoʻomalu (including Puʻuanahulu) was not occupied on any permanent basis prior to A.D. 1400-1450 (Cordy 1981: 136-142, 176), Barrera proposed, based on his work at ʻAnaehoʻomalu, that significant habitation occurred at quite an early date (around A.D. 900) at environmentally favorable locations such as Pueo Bay. Later, less favorable areas were occupied, with some abandonment occurring in the A.D. 1600s and significant abandonment occurring by A.D. 1850 (Barrera 1971:100-108).

Regardless of when and what sort of settlement occurred along the North Kona coast, archaeological evidence clearly reveals a subsistence focused on marine exploitation and fishponds (Kirch 1985: 167, 169-170). At least nineteen fishponds once existed along the coast between Honokōhau and Kawaihae, including one at Weliweli and another at Keawaiki in Puʻuanahulu, and all of them may have supported relatively dense, even permanent populations (Ching 1971:37, 49, 245-247). Oral traditions place the construction of most Hawaiian fishponds in the 15th through 17th centuries A.D. (Kirch 1985:214), a fact that supports Cordy's idea of relatively late, permanent occupation of the Kona coast in the pre-Contact period. It is interesting to consider, however, when and to what extent the construction of fishponds may have been preceded by the use of naturally occurring brackish ponds for aquaculture and perhaps agriculture as well.

Limited agriculture may have been carried out in pre-Contact times. Citing his Hawaiian informants in the 1930s, Handy claimed that, "Whenever a little soil could be heaped together along the dry lava coast of North Kona, a few sweet potatoes were planted by fishermen at such places as . . . Kiholo, Keawaiki, and Kapalaoa" (Handy 1940:163). Water from suitable brackish ponds could have been used in this sort of cultivation by carrying water to crops and/or by digging planting pits which intersected the source of brackish water. Archaeological research in other arid zones of Hawai'i Island indicates that crops were sometimes grown in quarried agricultural features which utilized water found in nearby caves or lava tubes (Stone *et al.* 1994).

Knowledge of the Post-Contact Period

The survey area at Pueo Bay is most probably the former location of the village called Wainānāli'i, referred to by the missionary Lorenzo Lyons in an account of the 1859 Mauna Loa lava flow. He described the village as "near the northern boundary of North Kona, and about fourteen miles from Kawaihae" (Lyons 1872:224) which corresponds with the location of the survey area. Two maps made prior to 1859, one by William Ellis and the other by John Arrowsmith, also indicate a place called Wainānāli'i at Pueo Bay (Kelly 1973: 96-97). William Ellis visited the village in 1823. He stopped first at Kapalaoa where he noted twenty-two houses as well as "curiously carved wooden idols" associated with a *heiau*. Ellis then traveled south to Wainānāli'i where he "repaired to the house of Waipio, the chief" (Ellis 1963:294). Interestingly, the name Wainānāli'i means "water belonging to the chiefs" (Maguire 1926:49) or "chief-protected water" (Pukui, Elbert, and Mo'okini 1974:226).

In 1859, Lyons recorded the destruction of Wainānāli'i by a lava flow which originated high on Mauna Loa. Lyons wrote that on January 23rd of 1859 smoke and lava were seen from Waimea, and on January 31st the lava reached the sea at Wainānāli'i. The eruption lasted 300 days and also destroyed sites at Kīholo Bay (Brigham 1909: 78; Hitchcock 1911: 101, 103-104; Kelly 1973: 92-93; Lyons 1872:223-224). At Pueo Bay today, it is clear that the 1859 lava flow formed the bay's southern shore. In addition, habitation sites and portions of a trail overrun by recent lava are readily observable within the survey area along the south edge of the anchialine ponds..

No land commission awards were made at Pueo Bay or in the entire *ahupua'a* of Pu'uanahulu as a result of the *Mahele* of 1848 nor does any land claims testimony pertaining to the survey area appear to exist (Indices of Awards 1929). This suggests little occupation of the area by the mid 1800s which was probably followed by even sparser occupation after the 1859 lava flow damaged area fishing (Barrère 1971:111). The area near Pueo Bay became government land, then state land, which it remains today. After the *Mahele* a few people apparently continued to live at Kapalaoa which was not overrun by the 1859 lava flow. Informants homesteading at Kapalaoa after the Land Act of 1895 knew of residents who had lived there before 1895; those people depended on fishing for survival, and when fishing was poor, there was little other means of subsistence. Between 1896 and 1916 no more than twenty people homesteaded at Kapalaoa, suggesting that late 19th century occupation of the region was temporary. The residents of Kapalaoa visited Weliweli, Keawaiki, and Kīholo by using the area's trails, but no mention was made of visiting at Pueo Bay, suggesting that Wainānāli'i had been abandoned (Kimura 1968).

Reconnaissance Survey

We surveyed the area on the south side of the ponds covered by the 1859 lava flow by walking in transects approximately ten meters apart extending 50 meters from the ponds. The only site present was a trail, crossing the flow in a north-south direction. The trail must date to after 1859, and is very narrow and rough, having probably been constructed hastily after the lava flow to reconnect other trails in the area.

We conducted intensive survey in areas not completely covered with recent lava, particularly the area north and west of the ponds, and some small areas on the south side of the ponds along the edge of the 1859 flow. Nine survey units (A-I) each measuring approximately 50 m by 50 m were laid out in reference to a semi-permanent datum, and all sites were recorded on standardized site forms developed specifically for the project. A site was defined as a structure or cave with evidence of human use or habitation. The location of each site was measured with tape and compass from the southeast corner of the survey unit, and each site placed on a master map of the project area. Black and white photographs of each site were taken. No artifacts were noted or collected, and no midden material was collected.

Sites at Pueo Bay

Sites located as a result of the reconnaissance survey include walled shelters, caves, religious structures, agricultural and aquacultural features, and modifications to the ponds. Each of these types of sites is discussed below. More complete information is available in the 1996 report on the Pueo Bay project (Lass 1996).

Eighteen walled shelters were found concentrated near trails on both the north and south side of the ponds. They occur in basically three shapes or forms: circular or enclosed on all sides, u-shaped in having one open side, and c-shaped, consisting of an arc of rock without clearly defined sides. The method of construction is similar to that observed on other *ʻaʻā* lava flows at ʻAnaehoʻomalu (Barrera 1971:21). The typical shelter covers an area of 5 to 6 sq m, and the height of the walls varies from 50 cm to 1 m. Midden, usually shell fragments, is scattered on the floor at approximately half of these sites.

Five caves were recorded, four of which had been modified by the construction of stone walls at the entrance. Most are found in spaces beneath overhanging rocks or in spaces between blocky pieces of lava. All are relatively small, the largest having a surface area of 8 sq m. Shell midden was found at some of the cave sites.

Six sites may be *heiau*, shrines, or associated sites. We recorded a *heiau* near the *makai* pond, a *heiau* with three associated *ahu* near the *mauka* pond, and a smaller shrine near the *mauka* pond. The *heiau* near the *makai* pond is a low and somewhat irregularly shaped platform built as a terrace on sloping ground; the total area covered by the terrace is 20 m x 15 m. Low walls delineate u-shaped or semicircular areas on the platform each covering an area of 3–4 sq m and containing marine shell and sea urchin spine. Coral fragments are scattered on the surface of the platform and incorporated into the walls.

The *heiau* near the *mauka* pond is also a platform constructed as a terrace on sloping ground. It is 23 m long, 6 m wide, and 1 m high. Irregularly shaped piles of stone and some low semicircular walls are on the platform with shell, coral, and charcoal fragments scattered throughout. Near this *heiau* are three probable *ahu* or altars consisting of piled rock measuring 2 m in diameter and 1 m in height; in each case a pit (possibly the source of the piled rock) is located adjacent to the base. The shrine near the *mauka* pond resembles a c-shaped shelter approximately 3 m across with walls 1 m high, but, within the walls, has a smooth upright stone with coral offerings placed at its base.

One site may have been used for agricultural purposes, and consisted of six adjoining circular depressions, each less than 1 m deep and enclosed by a rock wall approximately 1 m high. One of the depressions contained coral, shell, charcoal fragments, and sand. Another apparently contained enough moisture to support vegetation as a large and healthy plant was observed growing from it. It is possible that these are agricultural features in which plants (probably sweet potato) were planted in sand and watered with brackish water brought from the nearby ponds, or obtained by intersecting the subterranean source of water at the bottom of the pits themselves. Mulching to retain moisture may have been carried out.

An L-shaped wall (17 m east-west by 11 m north-south) located adjacent to the *mauka* pond, may also have been associated with agriculture and/or aquaculture. The wall may have originally enclosed a larger, perhaps rectangular, area, but this part of the *mauka* pond was overrun by the 1859 lava flow, and portions of the site may have been obliterated. The wall is 1 m high and 1 m thick, with some shell fragments and sand found within the enclosed area. Well-constructed of several courses of rocks, the wall resembles a fishpond in its manner of construction or may possibly represent a water control feature originally used to impound or contain this portion of the *mauka* pond.

Other modifications to the anchialine ponds were observed. At the *makai* pond, stones had been placed at the end of a trail leading to the water, augmenting naturally occurring stones to extend the trail across the pond and effectively dividing the pond with a low dam. This modification resembles one noted at ʻAnaehoʻomalu where a wall constructed across an anchialine pond formed two pools with a trail passing across the pond on top of the wall (Barrera 1971:21). Such modifications in which ponds were divided, enlarged, contained, or otherwise altered in shape with walls are commonly found on the Kona coast (Maciolek and Brock 1974:3) and have been noted nearby at Kapalaoa (Walker and Rosendahl 1990). Another possible modification of the ponds at Pueo Bay consists of small irregularly shaped depressions excavated in the floor of both ponds in several locations. The purpose of these depressions is not known although it is possible that they were excavated in an effort to obtain water at times when the water level in the ponds was unusually low.

Summary and Suggestions for Further Research

The sites recorded at Pueo Bay resemble those found nearby at Kapalaoa (Walker and Rosendahl 1990) and ʻAnaehoʻomalu (Barrera 1971). Previous studies have suggested that walled shelters and modified caves like those at Pueo Bay typify the short-term or temporary habitations of people who made only periodic visits to the leeward coast of Hawaiʻi Island for fishing (e.g., Kirch 1979: 186). The agricultural and aquacultural features at Pueo Bay, however, in combination with the anchialine ponds, the habitation features, and the *heiau* suggest significant investment in time and labor by and for more than a small, impermanent population. The area's significance in the post-Contact era, as indicated by the name Wainānāliʻi, may be a continuation of its earlier importance, due to the presence of the ponds.

Clearly, site excavation and dating should be carried out to reconstruct the nature, date, and duration of settlement at Pueo Bay. In addition, we suggest further comparative research on the use of anchialine ponds on the leeward coast by examining the ponds and associated features with those recorded at Pueo Bay. Finally, further work focused on clarifying the definitions of permanent and temporary habitation would enhance our understanding of the settlement of Pueo Bay and of the leeward coast in general.

Reconnaissance Survey Along the Old Government Road

After the successful completion of the field work at Pueo Bay (above), the Division of Forestry and Wildlife sponsored another field project which provided UHH students with an opportunity to participate in archaeological field work and at the same time assist the Division of Forestry and Wildlife (Na Ala Hele program) with cultural resource management planning. Originally a nineteenth century horse trail which extended from Hilo south along the Puna coast and into Kaʻū, the three mile (5 km) portion of the Old Government Road surveyed in 1997 is the longest and best preserved portion of the road remaining today (Figure 1).

Environment of the Project Area

The Old Government Road is adjacent to the shoreline throughout much of the survey area although near the southern end it is up to 1/2 mile (.8 km) inland. In this area, low sea cliffs form the shoreline from which fish and shellfish are obtained today. There is a boulder beach at Pākī Bay and a sand beach at the north end of the survey area at Hāʻena. Fresh water is available at Hāʻena in the form of springs which can be seen bubbling out of the beach at low tide as well as a stream which flows to the sea from a large freshwater pond. The pond was originally a pre-Contact fishpond, but it has been modified in recent times (Cahill 1996:229; Hudson 1932:306; McEldowney 1979b:14; United States Army Corps of Engineers 1979:86). It and an adjoining marshy area cover about eight acres (3 ha) (United States Army Corps of Engineers 1979:86), and there are also smaller wetland areas closer to Pākī Bay.

Rainfall in the area is plentiful at 125 to 150 inches (275-330 cm) per year, and the average temperature is in the 80s (Fahrenheit) (Armstrong 1983:63, 64) making a wet, warm climate. Today the vegetation of the area is classified as open guava forest with shrubs (Armstrong 1983:71; United States Army Corps of Engineers 1979:3, 21), but prior to alteration of the native forest it was probably submontane rain forest, once extending from sea level to an elevation of two thousand feet (600 m) (McEldowney 1979a:3). In the survey area, the Old Government Road passes through open areas where only grasses and wild orchid (*Arundia bambusifolia*) grow on *pāhoehoe* as well as more densely forested areas with developed soils. These soils are histosols or organic soils which here consist of two to eight inches (4-18 cm) of highly organic material on top of lava rock (Armstrong 1983:47). It is possible that agricultural activities including composting and mulching for taro, sweet potato, sugar cane, and yam cultivation (Handy 1940:47, 147, 169-170) contributed to soil development in some areas.

In the pre- and post-Contact periods, coastal settlement in Puna would have been focused where there was fresh water as well as ponds, streams, or wetlands for aquaculture and taro cultivation, agricultural soils, and opportunities for marine exploitation (McEldowney 1979a:15). Clearly, the project area along the Old Government Road provided ideal conditions for Hawaiian habitation.

Kea'au in the Post-Contact Period

William Ellis first recorded information about the native inhabitants of the Puna coast, and he described a village at Hā'ena (then called Kea'au) which was "extensive and populous with well-cultivated plantations of taro, sweet potatoes, and sugarcane . . ." (Ellis 1963:212). Charles Wilkes also visited the Puna coast with the U.S. Exploring Expedition of 1840-41. The expedition party visited the village at Hā'ena where they noted a schoolhouse in addition to the freshwater springs (Wilkes 1970:190). For Puna in general, Wilkes noted abundant breadfruit, bananas, sugar cane, taro, and sweet potatoes under cultivation (Wilkes 1970:188).

Puna was traditionally regarded as a rich agricultural area, with taro grown all along the coast in areas with appropriate soil, including the wet, marshy forest of the survey area (Handy 1940:128). It was grown in small mounds of soil in swampy areas and by mulching in cleared patches of forest (Handy 1940:126-127). Like taro, sweet potatoes were sometimes planted in mounds of soil and organic matter in wet or swampy areas, but in areas without soil, earth for sweet potato mounds could be made by composting. Sometimes the compost was used to fill hollows and fissures in lava rock where the sweet potatoes were grown (Handy 1940:146-147). Yams were planted in composted material as well (Handy 1940:169-170, 172).

Residents of the Puna coast maintained a largely traditional lifestyle well into the nineteenth century (Crozier and Barrère 1971:9). After the *Mahele* of 1848 only two land claim awards were made in Puna, and many Hawaiians continued to live as tenants on government lands or chiefs' lands (Barrera and Barrère 1971:8; Crozier and Barrère 1971:17-18). In the *Mahele*, Prince William Lunalilo, who died in 1874, acquired the *ahupua'a* of Kea'au, within which lies the survey area. Lunalilo's will directed that his lands be sold to finance the establishment of the Lunalilo Home for elderly Hawaiians, and in 1882, the 65,000 acres of Kea'au *ahupua'a* were sold to William H. Shipman, Johannes Elderts, and Samuel Damon. Shipman, the son of local missionaries, eventually became the sole owner (Cahill 1996:122-127, 163-167). Tax assessment records at the Hawai'i State Archives show that in the 1870s Shipman and three others had already established the Kea'au Ranch on leased land in the Kea'au *ahupua'a* (Interior Department Tax Assessment Records; see further discussion in Lass 1997:11). By 1900 this ranch was among the largest on the Big Island (Cahill 1996:189, 201). Cattle ranching encroached on native agriculture, and a visitor to Puna in 1874 noted that people fenced in their "small holdings" with "lava blocks" in an attempt to keep cattle out (Nordhoff 1974:49).

In the early 1900s thirty people, mostly ranch hands, were on the Shipman payroll (Cahill 1996:210). Ranch hands were commonly Hawaiians who lived in the area. A local informant, Agnes Auwae, was born in Puna and lived there near Kapoho for parts of her childhood which was probably in the 1910s-1920s. Before his marriage, Agnes Auwae's father had been a "cowboy" for the Shipman ranch (Akoi 1989:58-59). In 1997, we interviewed other members of Agnes Auwae's family who stated that her father was born and raised in Maku'u, just south of the survey area and continued to live there after being employed by the ranch. The family described former Hawaiian settlements at Pākī Bay and

Hāʻena; they also stated that taro was grown between Pākī and Hāʻena, and fishponds were used in the area. It is not clear when these things occurred, but a few Hawaiians were reportedly living at Hāʻena until the construction of the Shipman residences there. The main house was constructed in 1908 (Cahill 1996:202) so this means that Hawaiians were probably living at Hāʻena at the end of the nineteenth century and perhaps into the early twentieth century as well.

During World War II, the Shipman ranch lands were the temporary homes of soldiers in infantry, artillery, and searchlight (coastal defense) battalions. A local informant claims that much of the area near Hāʻena was "destroyed" by Army engineers when machine gun bunkers and other defensive facilities were constructed and manned near the beach (Cahill 1996:212, 214, 238). Today, most of the Shipman property in Keaʻau has been sold or donated (Hawaiʻi Tribune Herald 1981:10), but 104 acres at and near Hāʻena are still owned by the Shipman family (Cahill 1996:266).

Documentary Information on the Old Government Road

Many Hawaiian roads were originally pedestrian trails (Kuykendall 1966:23-25) so even though the Old Government Road was constructed, maintained, and used as a horse trail in the mid to late nineteenth century, it probably followed the general route of an older foot trail from the pre-Contact and early post-Contact periods (Hudson 1932:247). Apple maintains that this trail, sometimes called the "Beach Trail," was the only route through Puna from Hilo to Kaʻū because the inland areas near ʻŌlaʻa (the present town of Keaʻau) were sacred lands devoted to bird catching. A more direct route from Hilo to Kīlauea was established only after the *kapu* system was abolished in 1819 (Apple 1965:10; 1994:79; 1997). There is some indirect support for Apple's suggestion. Formerly called Laʻa—consecrated or holy (Emerson 1972:268; Pukui, Elbert, and Moʻokini 1974:126, 169)—ʻŌlaʻa was a legendary area for collecting feathers. The well-known legend of Pele and Hiʻiaka refers to "the restful groves of Laʻa" (Emerson 1978:34), and in possible reference to a bird with red feathers, another chant mentions the "darting flame-bird of Laʻa" (Emerson 1972:41). In the early nineteenth century, areas north of ʻŌlaʻa including the current Panaʻewa Forest Reserve were one of the few forested areas in the region because other areas had been cleared for agricultural use (McEldowney 1979a: 18-24). The forest may have still existed because it had been reserved for bird catching in the past. Into the 1870s, travelers noted that the forest north of Hāʻena (at the north end of the survey area) stretched from the ocean to the high elevations of Mauna Loa, and among the many forest birds seen there was the native ʻōʻō "whose wings hid the rare, yellow feathers used for the royal mantles of the ancient chiefs" (Whitney 1875:79).

Citing local informants, Hudson suggested that the Old Government Road was constructed just before the visit of the Wilkes Expedition of 1840-41 (Hudson 1932:2476-249). Wilkes provided the earliest known description of the Old Government Road when his party traveled north to Hilo along the Puna Coast (Wilkes 1970:179-188). However, it is not clear from his description whether they traveled over an improved road or whether they simply followed a foot trail of long-standing use. Wilkes said, "In some places they have taken great pains to secure a good road or walking path; thus, there is a part of the road from Nanavalie [Nānāwale] to Hilo which is built of pieces of lava. . . . " He went on to say that "the road is exceedingly fatiguing to the stranger, as the lumps are so arranged that he is obliged to take a long and a short step alternatively, but this the natives do not seem to mind, and they pass over the road with great facility. . . ." (Wilkes 1970:191).

Wilkes may possibly have traveled along the Old Government Road when it was what is sometimes called an AB trail. These were originally pedestrian trails (or A trails) which were remade for horses simply by (1) removing paving stones so that horses would not step between them and fall, and (2) adding curbstones along the sides of the path so that horses could follow the route without constant guidance. The Hawaiian chiefs directed the construction of such trails between 1820 and 1840, and they were used for foot and horseback travel. Some B trails designed specifically for horses were also constructed during this time, and they had straighter, more direct routes than either the pedestrian or AB trails (Apple 1965:34-35, 64).

By the mid to late 1870s the Old Government Road was definitely used for horse travel. William H. Shipman and his wife traveled along this coastal road (Cahill 1996:153), and visitors to Hawai‘i were advised to visit Kīlauea Volcano via the "Puna Road" (Nordhoff 1974:41; Whitney 1875:78-79). At this time the Old Government Road probably looked much as it does today, and it was apparently a C trail, a type of road or trail constructed in Hawai‘i between 1840 and 1918. Wide enough to accommodate two horses side by side, the C trails tended to be very straight as they were designed to connect two points in as straight a line as possible. Like the AB and B trails, they lacked paving stones, made use of curbstones, and were used for both horse and foot travel (Apple 1965: 34-37, 64-65).

Hired laborers, prisoners, people who paid fines through labor, and citizens who paid their taxes in labor built the government roads, under the direction of district road supervisors (Apple 1965:45, 47-48). First elected, later appointed by the Minister of the Interior, and finally replaced in 1887 with district road boards of three members each, the road supervisors (and later heads of the road boards) made annual reports and submitted other correspondence to the Department of the Interior in Honolulu (Apple 1965: 47-49; Kuykendall 1966:26; 1967:514). For the Old Government Road project, the author examined all road documents from 1855-1895 at the Hawai‘i State Archives (Interior Department Records - Roads, Hawai‘i Island) which pertained to the district of Puna. Nine letters were translated from Hawaiian while three letters were illegible and could not be used.

The earliest known reference to the section of the Old Government Road within the survey area is 1869 (Interior Department Records 1869), but some sort of trail or road already existed at this date. Prior to 1875, road work consisted of major construction, and it is likely that the Old Government Road was constructed as a C trail/road in the late 1860s and/or early 1870s. From 1869 into the 1890s, crews worked on the Old Government Road, including the section within the survey area, but after 1875 this work apparently consisted almost entirely of repair and maintenance. Until 1880 the Old Government Road may have been the main transportation route through and within the district of Puna, but beginning in 1880, the Volcano Road (the present Volcano Highway) began to surpass the coastal road in importance. By 1900 the construction of other roads which connected the Volcano Road with the coast caused large sections of the Old Government Road, including the portion in the survey area, to become obsolete. Most other sections of the Old Government Road between Hilo and Kaimū, and the portion within the project area, were never modified for vehicle use (see Lass 1997:18-24 for a more detailed discussion of archival information).

Reconnaissance Survey

In 1997 we conducted a pedestrian survey along a portion of the Old Government Road itself, and recorded of sites within view of the road. The UHH crew described and measured the length and width of visibly distinct sections of the road (e.g., sections on *pāhoehoe* with curbstones vs. sections on rougher lava with curbstones and stone fill or surfacing). They noted also the current condition of the road since four-wheel drive vehicles use some sections and vegetation obscures others. Because the primary goal of the survey was to ascertain whether and how the Old Government Road could be developed as a hiking trail, we only recorded sites which could actually be seen by people walking on the road. We mapped sites with tape and compass, and then plotted them in on a map of the road corridor using the reference points laid out by the Division of Forestry and Wildlife's surveyor. Measurements and descriptions of sites were recorded on standardized site forms, and black and white photographs were taken.

The Old Government Road

Within the survey area the Old Government Road crosses both open relatively unvegetated areas on *pāhoehoe* lava and forested areas with soil. Curbstones from the original road can sometimes be observed on the *pāhoehoe*. These are loose, isolated blocks of lava rock simply resting on the surface of the ground at irregular intervals along the edge of the road. The curbstones are relatively small, measuring approximately 30-45 cm by 30-45 cm. Other than curbstones there are no indications of road construction in the *pāhoehoe* areas.

Curbstones in forested areas usually adjoin to form low walls which extend along one or both sides of the road for distances of up to several meters. And, instead of simply being placed on the surface of the ground, the curbstones are partially buried or embedded in soil. In areas with soil the road bed also contains concentrations of cobblestones or rounded, waterworn rocks along with smaller rounded pebbles and gravel (*ʻiliʻili*). Transported to the road from beach areas, the waterworn rocks were apparently placed on the road to form a rough sort of pavement in an attempt to prevent or ameliorate muddy road conditions. In some places cobblestones were used to build up or cross low places, and these built-up areas sometimes have low curbstone walls.

The *pāhoehoe* sections and the forested sections of the Old Government Road are interspersed at varying intervals. Some portions of the road extend over *pāhoehoe* lava or through forest for several hundred meters at a time, but other portions consist of short, alternating stretches a few meters long, first on *pāhoehoe*, then of cobblestones, and so on. In addition, in some areas *pāhoehoe* and cobblestones are interspersed across the width of the road. For example, the *mauka* side of the road may be on *pāhoehoe* but the *makai* side may contain cobblestones.

The width of the road varies from 2.5 to 3.5 m with an average width of 3 m or approximately 10 feet, a typical feature of Type C roads and consistent with early twentieth century maps identifying the Old Government Road as the "10 Foot Government Road" (County of Hawaiʻi 1933). As a C road, the Old Government Road is relatively straight, but it passes over many dips and rises in the lava terrain. Nineteenth century road builders did not level the roadway in high places although they filled or built up low places with cobblestones (Apple 1965:51). There is a relatively deep depression in the swampy area just south of Hāʻena, and the Old Government Road once crossed the stream at Hāʻena as well. There is no evidence of how these obstacles were crossed and certainly no evidence of bridges; travelers may simply have waded across.

Sites Along the Old Government Road

Sites recorded along the Old Government Road include agricultural features, stone walls of varied age and function, and sites associated with World War II. These sites are briefly discussed below, and more detailed information can be found in the 1997 project report (Lass 1997).

The five rock wall enclosures were immediately adjacent to the Old Government Road, and parallel or perpendicular to it. The enclosures range from square to rectangular to simply irregular in shape, the largest enclosure measuring approximately 100 m x 50 m and the smallest approximately 50 m x 35 m. The walls are approximately .5 m wide and 1 m high. Inside the enclosures rock was collected and then thrown or piled on and against *pāhoehoe* outcrops. The enclosures also contain interior features such as retaining walls or small sub-enclosures. Located in forested areas with soil, all enclosures had cleared soil areas within them (from which it appears the rocks have been removed and piled) containing three to six inches of moist dark organic material. Probably constructed after European contact, in the first half of the 1800s, the structures functioned as cattle exclosures.

Another site found along the Old Government Road was probably associated with horticulture as well. This site is a modified depression or *kīpuka* also located adjacent to the road in a forested area with soil. It is roughly oval in shape and measures approximately 11 m x 10 m with a depth of 1.5 m. Portions of the interior are lined with rock, and one end contains a possible rampway or entrance constructed with rock. This site could have been a gardening and/or composting area.

One wall recorded in the survey area is parallel to and immediately adjacent to the Old Government Road and appears to have been a retaining wall associated with construction or maintenance of the road itself. Another particularly massive wall extends over a distance of 425 m, varies from 1.2 to 1.8 m in height, and is .8 m wide or thick. It contains a metal gate clearly intended to regulate access to Shipman property at Hāʻena, and is probably of relatively recent origin. While some walls located near the agricultural enclosures may be associated with them, others near Hāʻena in locations without soil may have functioned to confine cattle or mark property boundaries in the post-Contact period.

Two sites of relatively recent origin probably date to World War II. A concrete bunker measuring 3.5 m on each side, with a covered attached entrance and a viewing slit 1.1 m from the ground, is identical to the many bunkers found elsewhere throughout Hawai'i. It was probably intended to defend the potential landing site at the nearby beach at Hā'ena. The second site includes two trenches located on a relatively high lava formation. The trenches are approximately 15 m long, 1.5 m wide, and 1 m deep and one is divided into sections with stone walls. Their proximity to the shoreline and their location on a hill suggests that they were intended for use in coastal surveillance or defense although similar trenches were also constructed throughout Hawai'i as places of refuge in case of attack (Dod 1966:441).

Summary and Suggestions for Further Research

Archaeological sites, tax records, historic accounts, and information from oral history all indicate that Hawaiians continued to live in and near the survey area in the nineteenth and twentieth centuries. The fertile soil, ample rainfall, natural wetlands, and fresh water made this portion of the Puna coast exceptionally well-suited for agriculture, aquaculture, and general habitation in Pre- and Post-Contact times. A dispersed settlement which included Hā'ena, Pākī, and virtually the entire survey area may have existed at one time, but today only agricultural enclosures are still visible, primarily near Pākī Bay where there have been fewer recent impacts on the landscape.

Originally a pedestrian trail in the pre-Contact period, the coastal trail was modified in the 1870s to become the Old Government Road as it appears today. The construction of the Old Government Road accompanied many other local changes in the post-Contact period, including the establishment of the Shipman ranch and land acquisition by the Shipman family. At some point, gardens in the survey area were enclosed to prevent cattle from encroaching on native agriculture. Hawaiians in the area probably continued to live at Pākī and other nearby places, and maintained a largely traditional lifestyle into at least the late nineteenth century, but they also worked on the Shipman ranch. Some Hawaiians may have lived at Pākī until the advent of World War II, marked by its own historic sites in the survey area.

We have limited archaeological data on windward Hawai'i Island, and little is known about northern Puna. The survey area along the Old Government Road is one of the very few locations in northern Puna where a concentration of archaeological sites still remains intact. The sites exemplify several important events and changes of the post-Contact period, and the area provides excellent potential for combining archaeological and documentary information as well as information from living informants to reconstruct culture history. Future work could include additional survey of areas outside the road corridor, and excavation at selected sites (such as the apparent agricultural enclosures) with the goal of establishing site function and chronology. More comprehensive documentary research on the Shipman ranch and on other aspects of post-Contact occupation in the area should also be done, and additional and more detailed information should be obtained from ethnographic informants. As of late 1998, further archival and ethnographic research on the Old Government Road is being conducted by other researchers under the sponsorship of the Division of Forestry and Wildlife.

Conclusions

The three research projects described here—at 'Anaeho'omalu, at Pueo Bay, and along the Old Government Road in Puna—were relatively small in scope, but they yielded interesting information and profitable avenues for further research. Furthermore, the three projects demonstrate the value of cooperative work in which students gain archaeological field experience, assist state and private agencies with cultural resource management activities, and contribute to knowledge of Hawaiian history and prehistory in an efficient and cost-effective manner. Such projects can also, as these will, assist in future public interpretation of sites, trails, and other culturally important locations.

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Cover image

A Man of the Sandwich Islands, Dancing, 1779. Engraving by Charles Grignion after a drawing by John Webber. Courtesy of Barbara Pope.