

Risk Minimization and the Traditional Ahupua'a in Kahikinui, Island of Maui, Hawai'i



BOYD DIXON, PATTY J. CONTE, VALERIE NAGAHARA,
AND W. KOA HODGINS

THE ARCHAEOLOGICAL RECORD documenting the precocious development of the Hawaiian pre-Contact settlement system, c. A.D. 1450, in Kahikinui is here interpreted as a response to both social and environmental risk in leeward east Maui during the reign of chief Kaka'alaneo (Beckwith 1970:383). The existing system was expanded between A.D. 1575 and 1650 with the formalization of agricultural field boundaries. Spatial distribution of settlement after this time suggests the possible implementation of the *ahupua'a*, or traditional community land unit (Hommon 1986), during the unification of Maui by Chief Pi'ilani (Fornander 1996:94). The rapid abandonment of the *mauka*, or upland, field systems and settlement in the district soon after European contact in 1778 may therefore reflect the dissolving of chiefly control over the productive capacity of the *ahupua'a*, as well as the effects of disease on the human population and of cattle on the natural and cultural environment.

PROJECT BACKGROUND

The archaeological study presented here was based on the results of the 1995–1997 State of Hawai'i Historic Preservation Division (SHPD) inventory survey of cultural remains within the Department of Hawaiian Home Lands (DHHL) Kuleana Homestead development area in Kahikinui, Maui (Fig. 1). Although part of Hāna District today, the *moku*, or ancient district, of Kahikinui included eight *ahupua'a* (Moffat and Fitzpatrick 1995), situated between Kanaio on the west and Nakula on the east (Erkelens 1995; Hammatt and Folk 1994). The district also extended originally from the seacoast to Pōhaku-pālahā on the north rim of the Haleakalā volcano (Hunter 1997; Rosendahl 1978), at an elevation of 2470 m above sea level (masl). Six of these *ahupua'a*, totaling 9,230.6 ha, are today located within Hawaiian Home Lands and are being managed by Ka 'Ohana O Kahikinui, an organization of DHHL beneficiaries.

Boyd Dixon is Project Director for the International Archaeological Research Institute, Inc., Guam; Patty J. Conte, Supervising Archaeologist, and Valerie Nagahara, Archaeologist, are with the Hawai'i State Historic Preservation Division; and W. Koa Hodgins is an Assistant Archaeologist with Cultural Surveys Hawai'i in Kailua, Hawai'i.

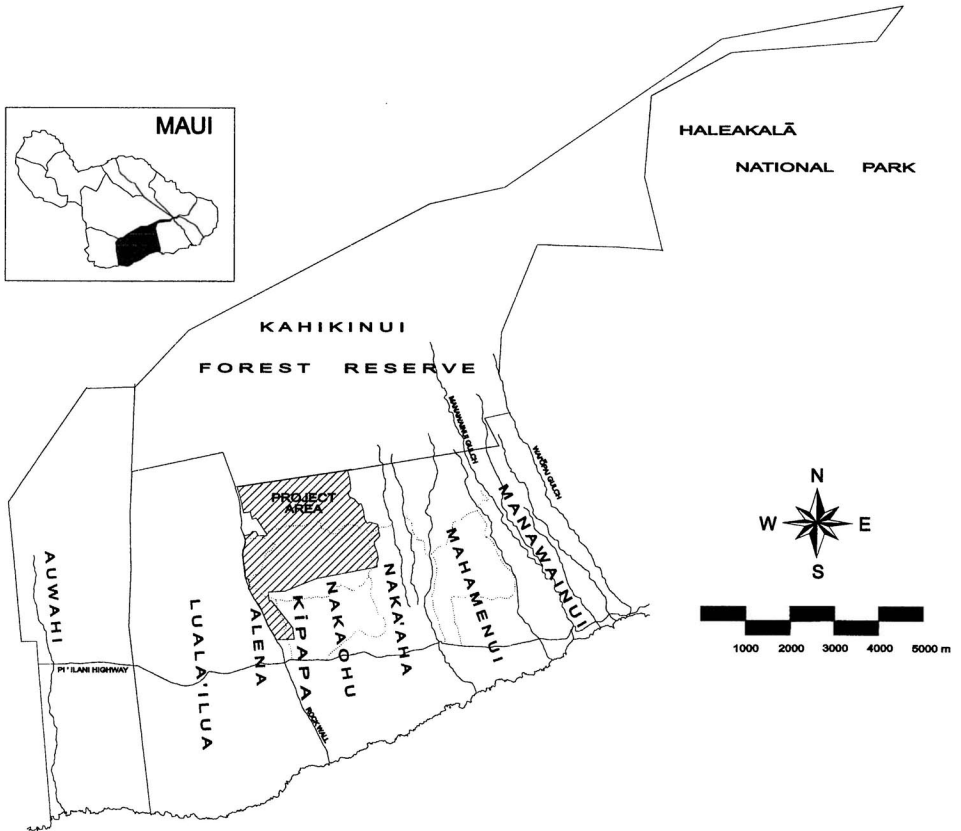


Fig. 1. Location of Kahikinui District and Project Area.

The DHHL archaeological project area surveyed during 1995–1997 covered 809.4 ha located between approximately 640 masl and the Kahikinui Forest Reserve boundary at 1220 masl, with a narrow corridor of nine house lots extending down to 480 masl along the present jeep trail to the modern Pi'ilani Highway. This archaeological inventory survey resulted in the recording of 581 archaeological features grouped into 311 sites (Fig. 2). Ten additional sites defined as agricultural zones (lava or open-soil) were also identified. These sites are distributed across the three *ahupua'a* of Kīpapa, Nakaohu, and Naka'aha within roughly half of the 104 Kuleana Homestead parcels, located below approximately 975 masl. A total of 179 sites (257 individual features) were subjected to subsurface excavations and analysis (291 test units), and these field data are available elsewhere (Dixon et al. 1997, 1998a) and in the four-volume SHPD technical report series (Dixon et al. 2000).

ENVIRONMENTAL BACKGROUND

Because of a lack of early historical documentation for Kahikinui, environmental zones at European contact have been hypothetically reconstructed based on recent

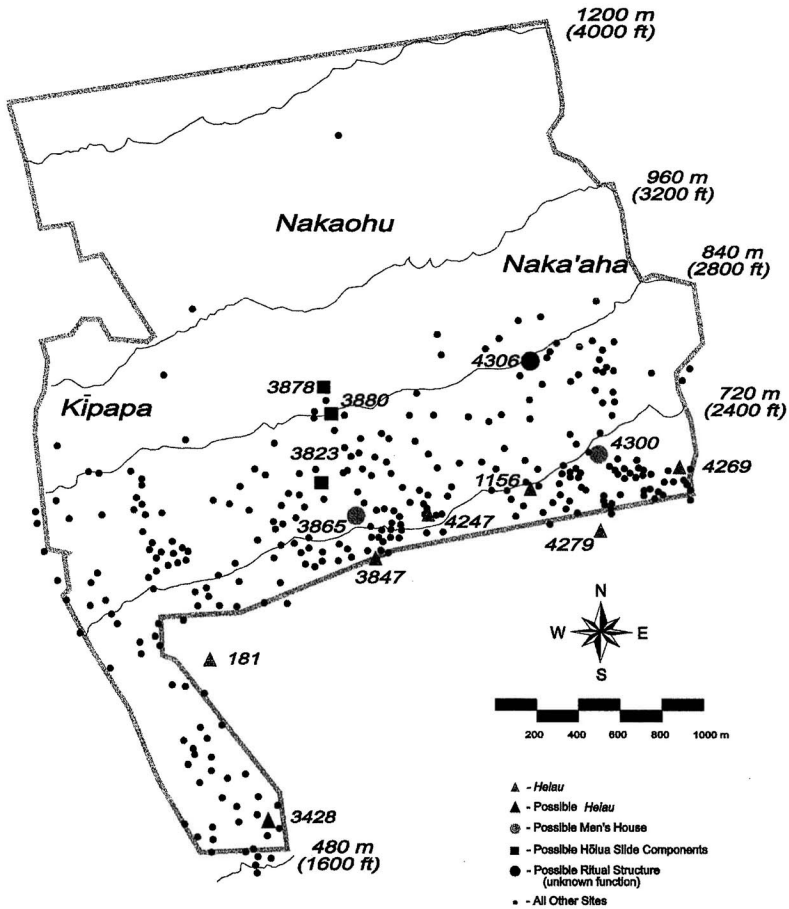


Fig. 2. The distribution of archaeological sites in Kahikinui mauka.

climatic data from nearby 'Ulupalakua Ranch to the west and Wai'ōpai Ranch to the east of the DHHL project area (Kirch & Van Gilder 1996). This reconstruction identifies six environmental regions in east Maui, which are roughly correlated in Figure 3 with previously identified elevation and rainfall statistics (originally reported in inches; Coulter 1931); the actual interface between these zones probably shifted through time due to prehistoric land use.

Zone 1. Coastal

This zone below about 60 masl receives no more than 250 mm (10 in.) of annual rainfall and was therefore not the locus of major agricultural pursuits in the past. Unusually wet winters, however, may have encouraged some seasonal or short-term planting in pockets of arable soil near habitations, canoe landings, and seasonal streambeds. Grasses dominate the windswept landscape today, and are joined by salt-tolerant ground cover in sheltered areas. Coconut trees, or *niu* (*Cocos nucifera*), and *noni* (*Morinda citrifolia*) are present at archaeological sites in La Perouse

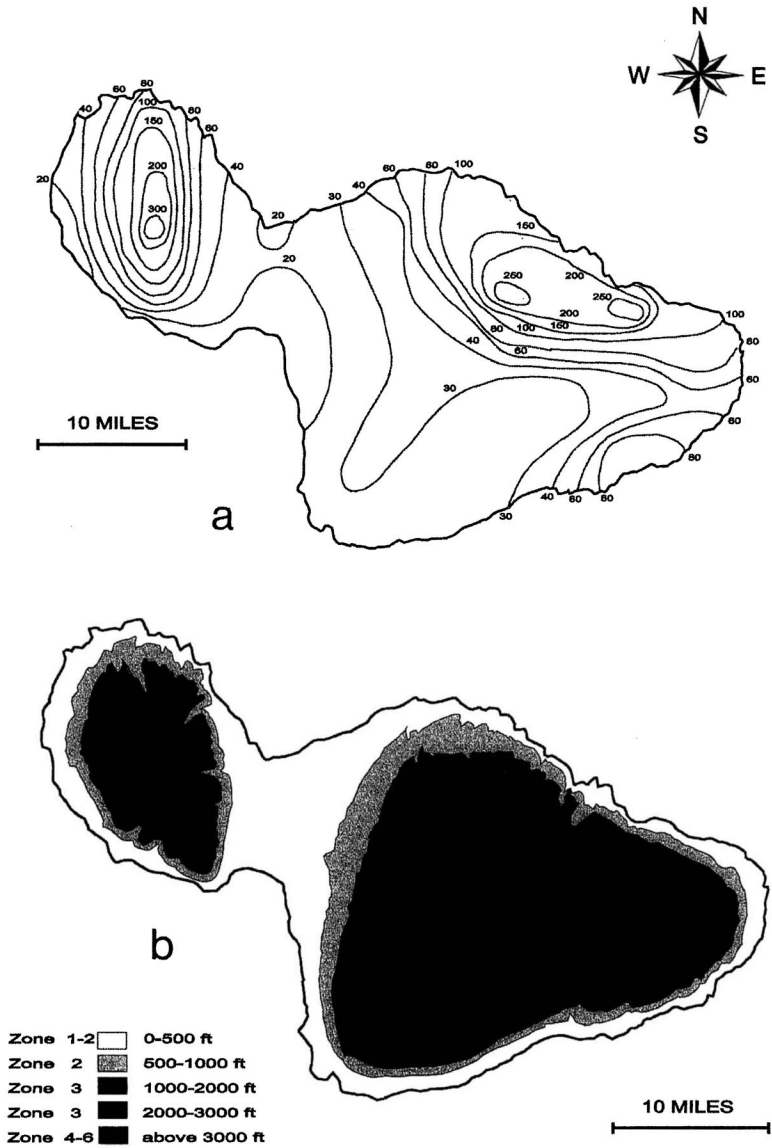


Fig. 3. Maui environmental zones correlated with annual rainfall in inches (a) and elevation zones (b) (after Coulter 1931).

Bay to the west and were presumably planted by coastal inhabitants of Kahikinui as well, although none remain today.

Zone 2. Intermediate Shrubs

This zone from about 60 to 360 masl receives 250–750 mm (10–30 in.) of annual rainfall, depending on elevation, but it did not have dependable levels of precipitation for year-round agriculture because it is situated well below the pre-Contact

cloud line. Small pockets of arable soil do appear to have been farmed, but were rarely loci of large-scale habitation. The vegetation today is characterized by introduced grasses and shrubs, although some remnants of lowland dry-forest species such as 'ōhi'a lehua (*Metrosideros collina*) and kukui (*Aleurites moluccana*) are still present at lower elevations within this zone, diminishing in density and size with proximity to the coast.

Zone 3. Lowland Dry Forest/Dryland Fields

This zone is located at about 360–975 masl and is today characterized by introduced grasses and shrubs, with only small stands of sparse forest vegetation remaining in the project area. The majority of this area is below today's 750–1000 mm (30–40 inches) rainfall zone, although precipitation was presumably higher here before the cloud-line retreat. Much of the area below 900 masl was permanently inhabited and planted in crops such as sweet potato (*Ipomea batatas*); the forest edge at higher elevations may have been planted in dryland taro (*Colocasia esculenta*) using swidden, or slash-and-burn, clearing techniques. Remnants of a diverse forest and shrub community are still scattered about today, including species such as wiliwili (*Erythrina sandwicensis*), 'iliahi (*Santalum sandwicensis*), 'a'ali'i (*Dodonaea eriocarpa*), and kukui.

Zone 4. Dry Montane Forest

This forest was located between about 975 and 1980 masl, once extending considerably lower than its current location well above the project area. Its annual rainfall is suggested to have been 750–1000 mm (30–40 inches) per year, depending on elevation within the cloud line. Species in the forest were dominated by koa (*Acacia koa*), 'ōhi'a lehua, and ferns such as uluhe (*Diacranopteris linearis*) in the gullies. Remnants of a belt of hala pepe (*Dracaena aurea*) are also still present at about 900–950 masl and would have formed part of a transitional forest zone at the lower fringes of the dry montane forest. Limited evidence of pre-Contact agricultural land use within this hala pepe fringe was noted during the survey of the project area, but no such evidence was recorded above approximately 950 masl.

Zone 5. Subalpine Region

This zone, between about 1980 and 2800 masl, lies well above the DHHL project area and is characterized by very low brush and ground cover, gradually diminishing to almost no vegetation within the western end of Haleakalā National Park. Rainfall varies from 750 to 1000 mm (30–40 inches) per year. Plants in existence there today include the silversword (*Argyroxiphium spp.*), found on the flanks of several cinder cones, and a variety of low, endemic bushes on the north face of the south rim, including the 'ohelo (*Vaccinium spp.*), known for its edible berries.

Zone 6. Alpine Region

Very little of this arid zone is present on Haleakalā, unlike the summits on the Big Island of Hawai'i, but the alpine region lies on the rim of the volcano between

about 2800 and 3050 masl. Rainfall rarely exceeds that of the subalpine zone. When vegetation is present, it is characterized by sparse shrubs, including *pūkiawe* (*Styphelia tameiameia*) and *‘ohelo*, plus a few native lichens and mosses.

RISK MINIMIZATION AND THE AHUPUA‘A

The theoretical model presented here is based on one general observation that has been suggested to explain many broad cultural changes—the law of minimization of risk—which stipulates that “. . . when faced by choices, the decision will be to adopt that solution which produces the minimal risk” (Sanders et al. 1979:360). Application of this model to the Kahikinui *mauka* project area refers to the behavior of the lower-ranking and *maka‘āinana*, or commoner, population of Maui rather than to that of high-ranking individuals, because Hawaiian history is replete with the risk-taking actions of the *ali‘i*, or chiefly members of society. It is also recognized here that aspects of risk minimization, as they pertain to the adaptation to leeward environments, were likely to have been understood by the earliest Polynesian colonizers of the Hawaiian Islands (Ross Cordy, personal communication 1999).

In order for this risk-minimization model to have any power in explaining the settlement and eventual implementation of the *ahupua‘a* in Kahikinui, it is first necessary to demonstrate that social and environmental risk was involved in settling the district, and, second, that all the basic components of this risk-minimization system—both settlement and subsistence aspects—were introduced in roughly the same time period, thus functioning in a symbiotic fashion to ensure social reproduction.

Social Risk

Social risk can be defined in many ways for preindustrial human populations, from socioenvironmental contexts that are highly circumscribed (Carneiro 1970, 1981), to societies where warfare is frequent and unpredictable (Redmond 1994), or to where “. . . productive strategies are implemented that have a high likelihood of failure without effective coordination” (Spencer 1993:48). It could be argued that by approximately A.D. 1450 elements of all these scenarios were developing in windward Maui (Kolb 1991, 1992, 1994*a*, 1994*b*), given the unprecedented growth of wetland agriculturally based polities in Wailuku and Hāna spurring expansion into dry leeward areas not previously cultivated to any extent (Cordy 1977; Kirch 1971). This is the same period when Chief Kaka‘alaneo formally partitioned the island of Maui into districts, subdistricts, and smaller divisions for the first time (Beckwith 1970:383). The deliberate occupation of Kahikinui might then have constituted a suitable strategy to minimize new risks in the survival of junior lineages and other factions more distantly related to the powerful windward chiefdoms.

The varied effects of such factional competition in the global archaeological record have recently been recognized (Brumfiel and Fox 1994; Schortman and Urban 1992) and appear to involve the full range of societal components, including religious beliefs, settlement patterns, subsistence strategies, artistic endeavors, burial customs, political institutions, gender relations, social ranking, group eth-

TABLE 1. LEVEL OF AGRONOMIC RISK FOR RAINFED CULTIVATION IN KAHIKINUI

ELEVATION	VEGETATION ZONE	ANNUAL RAINFALL	CULTIVATED CROPS	AGRONOMIC RISK
0–61 m	Coastal zone	<25.4 cm	Coconut, <i>noni</i>	Very high
61–366 m	Intermediate shrub zone	25.4–50.8 cm	Seasonal crops	High
366–732 m	Lowland dry forest	50.8–76.2 cm	Sweet potato, gourds, <i>māmake</i>	Moderate
732–975 m	Lowland dry/dry montane transitional forests	76.2–102 cm	Sweet potato, dryland taro, ti, <i>Awa</i> , banana, sugar cane	Low
>975 m ^a	Dry montane forest	>102 cm	No crops	Low

^a Elevations above 975 m do not appear to have been subject to any permanent cultivation, although soil and rainfall would presumably have supported swidden plots.

nicity, and conflict resolution. This process of political fission has been suggested as one impetus for initial settlement of the coastline elsewhere in Hawai'i: in the Honua'ula District (Donham 1998; Gosser et al. 1993) and in the upland Kula District of leeward east Maui (Kolb et. al 1997) between the late 1200s and the mid-1400s A.D. Political events necessitating the implementation of such a risk-minimization strategy in Honua'ula and Kula would presumably have led to similar attempts in neighboring Kahikinui, although slightly later in Kahikinui because of its greater distance from the windward centers. Later lineage fissioning perhaps then led to a further intensification and expansion of settlement, as has already been identified for leeward east Maui by approximately A.D. 1600 (Cordy 1981; Kirch 1971), after High Chief Pi'ilani and his son Kiha'api'ilani had unified the entire island for the first time (Fornander 1996 : 87; Kolb 1991 : 66).

Environmental Risk

The environmental risk inherent in farming dry leeward Kahikinui was also formidable and is summarized by elevation in Table 1. In reviewing these data in light of the proposed model, it is necessary to bear in mind that "survival in living systems requires effective responses not to average environmental conditions but to risks arising from unpredictability" (Braun and Plog 1982 : 505). Shallow soil cover over much of the district (Foote et al. 1977) was probably not an impediment to early agriculturalists, although the gradual erosion of higher elevation slopes as a result of several centuries of farming may have induced increased planting of naturally redeposited soils in lower elevation swales over time. On the other hand, annual rainfall of under 20–30 inches within the lowland dry forest zone (Kirch and Van Gilder 1996) was only dependable during the winter months, so the cumulative effect of swidden deforestation and more intensive cultivation between 360 and 960 masl across much of leeward south Maui after the 1600s may have contributed to a rising cloud line, hence less ambient moisture over time.

Swidden cultivation may turn maladaptive in three ways: "... by an increase in population which causes old plots to be recultivated too soon; by prodigal or

inept agricultural practices which sacrifice future prospects to present convenience; and by an extension into an insufficiently humid environment in which the more deciduous forests have a much slower recovery rate and in which clearing fires are likely to burn off accidentally great stands of timber" (Geertz 1971:26). All of these scenarios appear to pertain to some extent to upland Kahikinui, especially between 360 and 960 masl during the last three centuries of pre-Contact occupation. However, it could be argued that the "carrying capacity" (Dewar 1984) of the land was never fully realized prior to Contact, at least when considering the agricultural productivity of uncultivated higher elevations or the potential for implementing more intensive land-use practices such as those found on the leeward side of the island of Hawai'i at this same time (Rosendahl 1994).

The most important factor for causing environmental risk in Kahikinui, then, would likely have been extended periods of drought, which were probably frequent and sometimes devastating to agriculturalists, especially at lower elevations and given limited predictability because of fluctuating global climatic conditions such as El Niño. Indeed, recent studies of such phenomena on Maui in the period between 1860 and 1986 (Giambelluca et al. 1991) have reported no fewer than 63 descriptive accounts of droughts lasting from one to 21 months (Table 2). There is no reason to believe this global climatic situation was radically different before European contact, even considering the local effects of deforestation from the post-Contact introduction of cattle. This assertion is also suggested by the fact that droughts recorded during this period were not restricted to the summer months, but sometimes occurred as early as January and then occurred again later in the year. The effects of drought on the island of Maui are not uniform and sometimes appear on the windward side of the island, although stream flow from upper elevations probably moderated these effects at lower elevations. Nevertheless, it is safe to say that leeward east Maui would have been much more susceptible to these fluctuations in global climate because of the rain-shadow effect of the 3050 masl Haleakalā peak and the complete lack of permanent streams.

The Ahupua'a

Notwithstanding these environmental and culturally-induced challenges, agricultural techniques already employed by the first Polynesian settlers in the archipelago were more than adequate to ensure survival of small groups of farmers in such dry leeward settings (Yen 1974). But the challenge after A.D. 1450 was to support larger numbers of people than ever before in such an environment, in a period when population growth and chiefly tribute demands were beginning to tax the existing means of surplus productivity in windward polities. Agricultural intensification is often one response to such situations, especially where settlement nucleation leads to land-use intensification to decrease transportation costs (Chislom 1970) or when population growth puts pressure on agricultural resources (Boserup 1965; Sanders et al. 1979). Expansion of already proven strategies may also be implemented in arid environments without the presence of nucleated settlement or population pressure, with the goal being the creation of "... a series of localized, highly productive, low-risk niches within a generally high-risk environment" (Nichols 1987).

TABLE 2. DESCRIPTIVE ACCOUNTS OF DROUGHT EVENTS IN MAUI, 1860–1986
(AFTER GIAMBELLUCA ET AL. 1991)

DROUGHT PERIOD			DROUGHT PERIOD		
FROM	TO	IMPACT ^a	FROM	TO	IMPACT ^a
1866 Sept			1925 Jan		W
1872 Aug	1872 Sep	W C L	1925 Dec	1926 May	W C L
1873 June	1873 Nov	C L	1928 Mar		W
1875 Sep	1876 Feb		1931 Jan	1931 Mar	W C
1876 July	1876 Oct	W L	1931 June		W
1877 Nov	1878 Apr	W C L	1934 Nov		C
1881 Oct	1881 Nov	W C	1944 Apr		C L
1886 July	1886 Aug	L	1945 Apr		C L
1889 Jan	1889 July	C L	1945 Aug		C
1892 Aug	1892 Sep	C	1949 Apr		C
1893 Aug	1893 Oct	W C L	1950 June		L
1897 Apr	1897 Aug	W C	1951 Dec	1953 Oct	W C L
1898 Apr		C	1957 Jan	1957 Mar	
1901 June	1901 Sep	W C F	1957 June		C L
1905 Jan	1905 Apr	W C L F	1957 Oct		W
1906 Feb			1962 Apr	1963 Dec	W C L
1908 Feb		W	1966 May	1966 June	W C L
1908 May			1969 June	1969 June	W
1908 Dec	1909 Mar	W L	1969 Oct		L F
1909 June	1909 Oct		1971 June	1971 Sep	W C L
1910 Sep			1971 Dec	1972 Mar	W C L F
1911 Aug			1972 June	1972 June	C L
1913 Sep			1972 Nov	1973 Nov	W C L F
1917 Apr	1917 Oct	W C L	1975 Aug	1975 Nov	W C L
1918 Sep	1920 Oct	W C L F	1976 Dec	1977 Mar	W C L
1921 June		W L	1978 Jan	1978 Apr	C L
1921 Aug	1921 Nov	C L	1980 Oct	1981 Aug	W C L F
1922 June	1922 Aug	W C L	1983 Feb	1983 Mar	W C L F
1923 June		C	1983 Nov	1983 Dec	L F
1924 Jan	1924 Feb	W C L	1984 Mar	1984 Oct	W C L F
1924 June	1924 July	W C	1986 Feb	1986 Mar	W C L

^a W = water supply, C = crop, L = livestock, F = fire

This concept of creating exploitable niches in an otherwise harsh environment appears to have been understood by inhabitants of Ka'ū on the island of Hawai'i (Allen and McAnany 1994), given the pre-Contact planting of collapsed lava tubes, or *kīpuka*, as part of a larger regional agricultural system (Ross Cordy, personal communication 1999). However, because these volcanic niches were not present in any quantity or size within the landscape of Kahikinui, a somewhat different "broad spectrum" strategy had to be devised—that of targeting all available environmental zones and microniches (i.e., swales and pockets of older soils) simultaneously to ensure some success at group survival. That the large-scale occupation of Kahikinui would have required some chiefly coordination is likely, especially when "... the survival of individuals was dependent upon the group's ability to adapt quickly to high-risk circumstances" (Spencer 1993:70), such as periodic drought.

Evidence of this chiefly coordination need not be manifest in the construction of large-scale agricultural field systems, such as those in Lapakahi on the island of Hawai'i (Rosendahl 1994), although some pre-Contact walled field systems were present in Kahikinui *mauka* after c. A.D. 1575. Instead, it can be argued that the pattern of substantial *heiau*, or temples, apparently constructed on a systematic "grid" at regular elevations throughout the district below 900 masl (Kolb and Radewagen 1997) attested to a deliberate strategy of settlement and subsistence agriculture supported by periodic religious rituals. Whether this traditional land-use system was institutionalized by Chief Kaka'alaneo c. A.D. 1450 (Beckwith 1970) is probably beyond the realm of archaeological inquiry. But, regional population density and the spatial distribution of settlement in Kahikinui by approximately A.D. 1650 suggest that some *ahupua'a* were probably implemented during the rule of Chief Pi'ilani, with the unification of the island for the first time and the concurrent tribute demands on each district.

RESEARCH DESIGN

To evaluate the power of the risk-minimization model to explain the settlement and eventual implementation of the *ahupua'a* in the Kahikinui DHHL project area (Dixon et al. 1996, 1997, 1998a), it was decided to test those components of the archaeological landscape that were most likely to contain evidence of the interaction between local native Hawaiian society and the environment (both social and ecological). Previous archaeological research in Hawai'i has suggested that habitation sites are more likely to contain evidence of a fuller range of domestic activities (to assess sociopolitical variables) and environmental data (to assess cultural-ecological variables) than special-purpose sites such as those associated with the ritual and agricultural landscapes (Kirch 1985). Primary or permanent family residences and secondary or temporary agricultural habitations were therefore selected as the optimal study units for excavation, especially because they were found to be distributed across almost all of the culturally modified landscape below 900 masl.

Habitation sites from all three *ahupua'a* in the DHHL resettlement area were tested to compare community differences in social adaptation to the local environment; sites from all elevations were selected to evaluate zonal differences in the effects of these responses. An attempt was made to test the full range of features associated with habitation sites (i.e., rock shelters, lava tubes, enclosures, and terraces) to gather functional data, albeit on a regional, not household, scale. A majority of habitation sites in Kīpapa *Ahupua'a* (primary = 66 percent, secondary = 71 percent) and Nakaohu *Ahupua'a* (primary = 55 percent, secondary = 73 percent) were tested between 1995 and 1997; coverage was more uneven in Naka'aha *Ahupua'a* (primary = 55 percent, secondary = 17 percent) because of time constraints.

Sites and features were excluded when they were found to be constructed on bedrock (precluding any depth of deposit), were considered to be redundant (similar to adjacent tested features within a given site), or had been subjected to large amounts of modern erosion or animal damage, or both. Unless precluded by exposed bedrock or severe architectural collapse, most 0.25 m² test units were placed in the northeast corner of habitation enclosures in order to produce repli-

cable data for future investigations outside the DHHL project area. Similarly sized test units were placed near the center floor area of habitation platforms and terraces, and most visible upright slab fire hearths were also tested. Although the depth of cultural deposits in substantial cobble-filled platforms and terraces occasionally exceeded 1 m, the vast majority of excavated floor zones within habitation structures rarely exceeded 40 cm in depth, with minimal stratigraphic complexity. All cultural material (i.e., traditional and foreign-made tools and manufacturing debris) and palaeoenvironmental evidence (i.e., refuse midden, land snails, macrobotanical remains, and soil samples for pollen, phytolith, and protein residue analysis) were retrieved and examined by SHPD archaeologists or technical specialists (Dixon et al. 2000).

Ritual sites in the project area were the target of the Northern Illinois University (NIU) program (Kolb and Radewagen 1997), so only limited SHPD testing was conducted in these features for the study discussed here. Sites in the agricultural landscape were only minimally tested because the University of California at Berkeley (UCB) team had a more regionally oriented palaeoecological focus (Kirch 1997). The primary management focus of the SHPD investigation was also on identifying and evaluating historically significant structures to be avoided by DHHL and Ka 'Ohana O Kahikinui construction plans. SHPD investigations were therefore designed to be complementary to the UCB and NIU programs (Dixon et al. 1998*b*) because the two universities were focusing on large-scale excavations of a few sites considered to be representative of the total settlement pattern, while the SHPD program focused on small-scale testing of a much larger number of sites, thereby conducting an independent test of their interpretations.

Research questions addressed by the subsurface excavation of habitation sites include the following, although these are by no means the only pertinent topics that bear on the risk-minimization model:

1. Was the major pre-Contact settlement of Kahikinui *mauka* “punctuational” or “gradual” in chronological terms? That is, did it occur slowly over a long period of time (with little risk) or did it happen in relatively short intervals of time (greater risk)?

2. Does the initial permanent settlement pattern in Kahikinui *mauka* appear to contain all the elements expected from a fully mature social structure? That is, did it grow accretionally (little risk) or was it implemented virtually intact (greater risk)?

Sampling Strategy

The sampling strategy used to decide which sites were to be tested involved several criteria that were considered in order to make the archaeological data broadly comparable across the project area while addressing the primary research questions listed above. The four criteria used to select the sites to be tested and their specific research goals included:

Criterion 1. Select a comparable number of sites within each 50 m of elevation to assess the nature and intensity of cultural adaptation to different environmental zones through time.

Criterion 2. Select a comparable number of sites from each of the three

ahupua'a to assess differences in community settlement patterns and associated land use over time.

Criterion 3. Select radiocarbon samples from a range of feature types within primary and secondary habitation sites to assess the contemporaneity of different settlement pattern components.

Criterion 4. Select radiocarbon samples from subsurface proveniences that contained a range of artifactual, botanical, and midden remains in order to date specific activities as well as the occupation of the feature and its site.

Although this testing program was not designed as a statistical sampling of the settlement patterns in Kahikinui *mauka*, the coverage was more than adequate to assess the applicability of the risk-minimization model, especially given the restraints of DHHL management expectations. Results of the survey and testing program and summary interpretations are presented below; field and lab data can be found in the four-volume DHHL technical report series on file with the SHPD offices in O'ahu and Maui (Dixon et al. 2000).

RADIOCARBON DATING RESULTS

A total of 28 wood charcoal samples from the DHHL resettlement area were submitted to Beta Analytic Inc. for standard radiometric assays (Tables 3–5). Three of the samples yielded modern dates. As can be seen from the location of radiocarbon-dated sites within the project area (Fig. 4), sampling coverage was fairly even between 700 and 800 masl within the three *ahupua'a*. Coverage above and below these elevations tended to reflect the more uneven distribution of features recorded in the field. The presence of radiocarbon dates below 650 masl only for Kīpapa *Ahupua'a* is due to the testing of a narrow band of sites located along the new access road from Pi'ilani Highway into the DHHL resettlement area above.

These differences in settlement patterns presumably reflect the interaction of pre-Contact social variables (such as population density and perhaps differential tribute expectations) and environmental parameters (such as slope, moisture, temperature, and soil type) that either enabled or inhibited agricultural intensification. A similar density of archaeological remains was also recorded in adjacent Nakaohu and lower Kīpapa *Ahupua'a* down to c. 360 masl (Chapman and Kirch 1979). The nineteenth-century Kahikinui House is located outside the project area at a lower elevation in Nakaohu *Ahupua'a* and was tested as part of a separate program of SHPD investigations (Conte 1998).

CHRONOLOGICAL SEQUENCE

The results of the radiocarbon sampling program within the DHHL project area suggest four basic time periods (Fig. 5) and possible elevational foci of occupation (Fig. 6) in Kahikinui. It should be noted here that period markers used in this sequence were purposefully selected to correlate with the mean intercepts of radiocarbon data rather than the range of calibrated 2 sigma results to approximate a time scale of events occurring within the lifetime of a given historical individual.

Period 1. Initial settlement of the coast and lowland dry forest, with limited farming between 360 and 850 masl from at least A.D. 1300 to 1450.

TABLE 3. SUMMARY OF RADIOCARBON DATA FROM THE KAHIKINUI MAUKA PROJECT AREA: KĪPAPA AHUPUA‘A

SHPD SITE NO. (50-50-15-)	PROVENIENCE	CONTEXT	ELEVATION (meters)	¹⁴ C AGE B.P.	^{13/12} C RATIO	¹³ C ADJUSTED AGE	CALENDRIC RANGE A.D. ^a	MEAN INTERCEPT
3416 U1	TU 156 I/3 20-35 cmbs	Floor zone	491	100 ± 40	-26.2	80 ± 40	1680-1745 1805-1935	None
3445 ST 1	TU 176 I/2 16-30 cmbs	<i>Imu</i> (earth oven)	567	101.8 ± 0.5% MODERN	-11.9	70 ± 40 MODERN		None
3497 E1	TU 180 I/2 10-20 cmbs	Floor zone	668	170 ± 40	-15.0	340 ± 40	1455-1655	A.D. 1573
3452 LT 1	TU 131 II/1 11-20 cmbs	Fire pit	695	290 ± 80	-27.8	240 ± 80	1470-1950	A.D. 1660
3802 E1	TU 188 I/2 10-20 cmbs	Floor zone	716	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	762	40 ± 70	-25.2	40 ± 70	1675-1770 1800-1940	None
3816 WT 1	TU 63 I/4 30-40 cmbs	Floor zone	796	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	814	170 ± 60	-13.3	360 ± 60	1435-1660	A.D. 1573
3469 ST 1	TU 16 I/3 24-33 cmbs	Floor zone	823	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	838	30 ± 60	-25.9	20 ± 60	1690-1735 1815-1925	None
3472 LT 1	TU 41 III/1 23-35 cmbs	Floor zone	847	90 ± 50	-25.7	80 ± 50	1675-1770 1800-1940	None

^a Date ranges calibrated by Beta Analytic using Stuiver and Reimer 1993.

TABLE 4. SUMMARY OF RADIOCARBON DATA FROM THE KAHIKINUI MAUKA PROJECT AREA: NAKAOHU AHUPUA'A

SHPD SITE NO. (50-50-15-)	PROVENIENCE	CONTEXT	ELEVATION (meters)	¹⁴ C AGE B.P.	^{13/12} C RATIO	¹³ C ADJUSTED AGE	CALENDRIC RANGE A.D. ^a	MEAN INTERCEPT
1156	TU 254 I/3 20-30 cmbs	Floor zone	652	110 ± 50	-10.9	340 ± 50	1450-1660	A.D. 1573
4262 PT 1	TU 119 I/2 10-20 cmbs	Floor zone	738	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	747	420 ± 60	-30.7	330 ± 60	1445-1670	A.D. 1571
3831 RS 1	TU 58 I/2 10-20 cmbs	Floor zone	754	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	756	100.6 ± 0.8% MODERN	-14.4	130 ± 70		A.D. 1788
4358 TP 1	TU 225 I/2 10-20 cmbs	Floor zone	768	100.3 ± 0.7% MODERN	-14.2	150 ± 60		A.D. 1791
3871 U1	TU 107 I/2 10-20 cmbs	Floor zone	783	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	812	140 ± 60	-22.4	180 ± 60	1640-1950	A.D. 1796
3878 WT 1	TU 203 I/2 10-20 cmbs	Floor zone	814	190 ± 50	-27.5	150 ± 50	1655-1950	A.D. 1791
3874 L1	TU 99 I/2 8-17 cmbs	Floor zone	817	60 ± 50	-26.7	30 ± 50	1695-1725 1815-1920	None
4253 PT 1	TU 134 II/1 40-50 cmbs	Floor zone	847	370 ± 80	-26.1	360 ± 80	1420-1670 1780-1795 1945-1950	A.D. 1573

^a Date ranges calibrated by Beta Analytic using Stuiver and Reimer 1993.

TABLE 5. SUMMARY OF RADIOCARBON DATA FROM THE KAHIKINUI MAUKA PROJECT AREA: NAKA'AHA AHUPUA'A

SHPD SITE NO. (50-50-15-)	PROVENIENCE	CONTEXT	ELEVATION (meters)	¹⁴ C AGE B.P.	¹³ / ¹² C RATIO	¹³ C ADJUSTED AGE	CALENDRIC RANGE A.D. ^a	MEAN INTERCEPT
4343 WT 1	TU 284 I/1 8-20 cmbs	Floor zone	646	120 ± 60	-20.7	190 ± 60	1640-1950	A.D. 1798
4300 TP 1	TU 283 I/2 10-20 cmbs	Floor zone	674	80 ± 70	-26.3	60 ± 70	1670-1780 1795-1945	None
4338 E1	TU 235 I/2 10-20 cmbs	Floor zone	683	160 ± 60	-14.1	330 ± 60	1445-1670	A.D. 1571
4321 PT 1	TU 291 I/2 10-20 cmbs	Floor zone	768	210 ± 60	-12.2	420 ± 60	1415-1640	A.D. 1455
4315 TP 2	TU 288 I/3 10-20 cmbs	Floor zone	799	120 ± 70	-27.5	80 ± 70	1665-1950	None
4310 E1	TU 45 II/2 20-26 cmbs	Floor zone	860	480 ± 70	-27.8	440 ± 70	1400-1640	None

^a Date ranges calibrated by Beta Analytic using Stuiver and Reimer 1993.

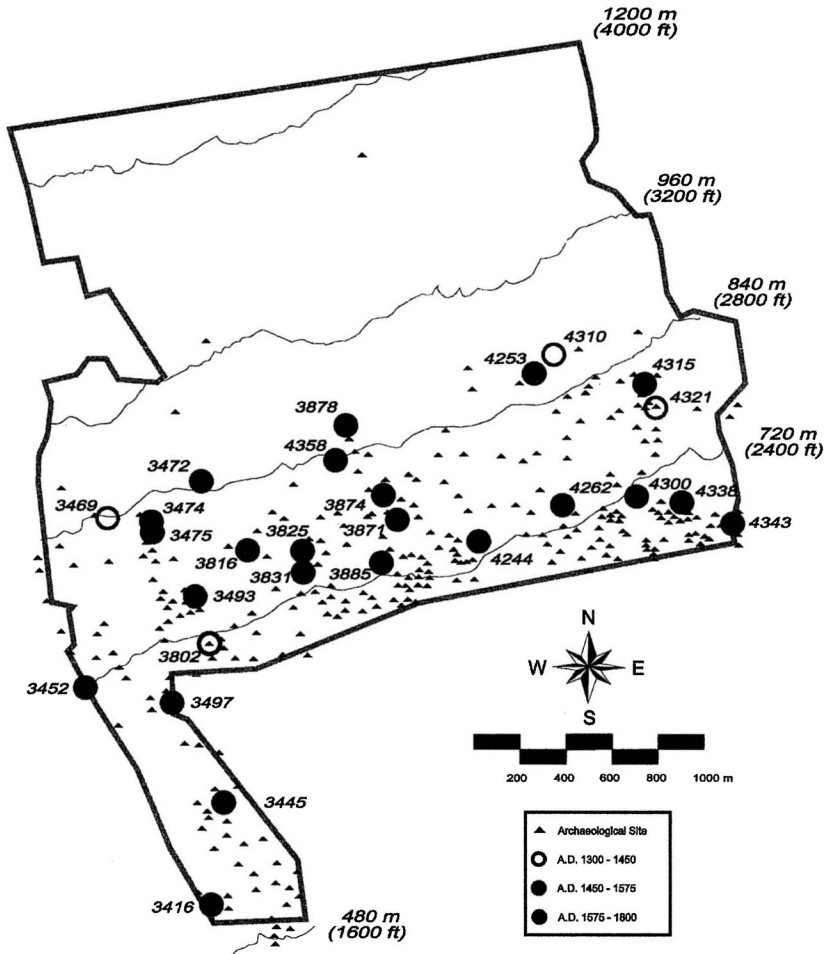


Fig. 4. Location of radiocarbon-dated sites in the Kahikinui *mauka* project area.

Period 2. More extensive settlement and agricultural land use within the low-land dry forest between 360 and 850 masl from A.D. 1450 to 1575.

Period 3. Settlement in-filling and expansion of agricultural zones below 360 masl and above 850 masl from A.D. 1575 until c. A.D. 1800.

Period 4. A less well defined post-Contact occupation suggested by the extension of most Period 3 radiocarbon dates from A.D. 1800 into the modern era.

The precise timing of these four periods in Kahikinui *mauka* does not fit exactly with periods of change proposed in previous chronological schemes for the archipelago (Cordy 1974; Kirch 1985; Sinoto 1968), nor should a perfect congruence be expected. As will be seen below, however, these procedures have not altered the recognition of general settlement and subsistence trends identified elsewhere in Hawai'i, and the mean intercepts in fact correlate very closely with major ethnohistorically recorded events of political importance on the island of Maui (Fornander 1996; Kamakau 1992).

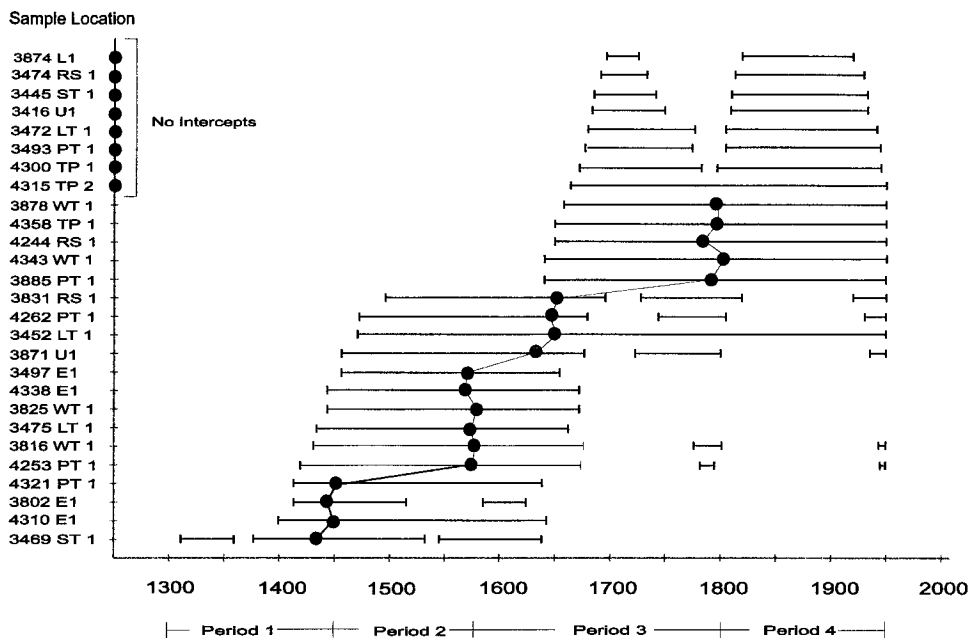


Fig. 5. Chronological sequence of Kahikinui *mauka* settlement by periods (2 sigma, 95 percent probability calibrations plotted against mean intercepts).

Period 1 (A.D. 1300–1450)

The early exploitation of the Kahikinui dry montane forest periphery resources and lowland dry forest soils in the fourteenth and fifteenth centuries appears to have begun relatively late in comparison with similar events radiocarbon dated to the thirteenth century in upland Kula (Kolb et al. 1997). This general time period would be analogous to the middle of the New Adaptation (Cordy 1974: 181) or Expansion Period (Kirch 1985: 303) for the archipelago. If a surplus in Kahikinui *mauka* forest birds and plants for *ali'i*, or chiefly, tribute was not needed in any quantity prior to the partitioning of the island c. A.D. 1450 (Beckwith 1970: 383), then one might expect only small-scale settlement prior to this period, with the population perhaps subsisting initially on swidden agriculture. A 200-year (eight generation) time lag behind upland Kula might not be unreasonable to expect for regions more distant from windward population centers. This time lag may also be explained in part by a series of volcanic events that occurred across the southeast Maui rift zone between approximately A.D. 1170 and 1220 (Eric Bergmanis, personal communication 1998), perhaps discouraging initial settlement of Kahikinui until after these activities subsided.

A shallow fire pit that yielded the earliest calibrated date of A.D. 1310–1365 in Kahikinui *mauka* was found in a rudimentary soil-capped terrace located at approximately 800 masl in Kīpapa *Ahupua'a* (Site 3469). Sparse midden from this feature suggests short-term habitation, presumably associated with the exploitation of a pocket of rich soils located in Uma. The other few feature types asso-

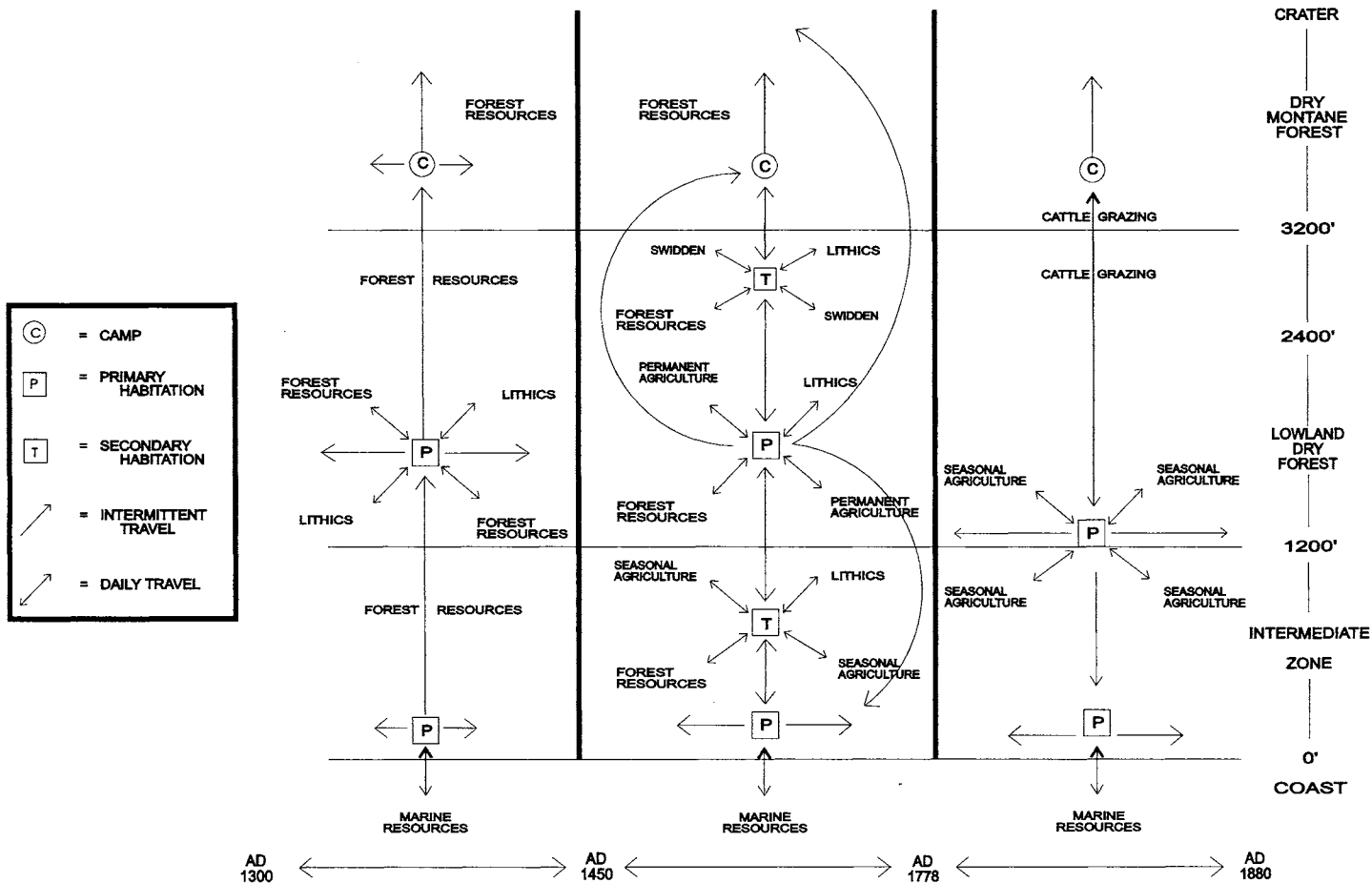


Fig. 6. Hypothetical settlement model for pre- and post-Contact Kahikinui District.

ciated with the Period 1 occupation of the project area were two habitation enclosures (Sites 3802 and 4310) and one paved habitation terrace (Site 4321). These features were also located near small pockets of productive soils in Kīpapa and Naka'aha *Ahupua'a*, suggesting that initial exploitation of Kahikinui *mauka* was on a small scale compared with later periods. However, if the number of radiocarbon dates from this period actually represents the approximate proportion of the total settlement over time ($n = 4$, or 14.2 percent of the 28 dates), then one might expect as many as 90 features to have been constructed within the project area during Period 1.

A slightly earlier date of A.D. 1260–1425 was also recorded for Kahōluapapa *Heiau* (Site 1386) located in Luala'ilua *Ahupua'a* to the west of project area (Kolb and Radewagen 1997), correlating with what is called the Early *Heiau* Expansion Period on Maui (Kolb 1991). This construction epoch suggests that some ritual importance was attributed to the lowland dry forest ecozone of Kahikinui, at least by the time Chief Kaka'alaneo partitioned the island into regional subdivisions (Beckwith 1970:383). Admittedly, the initial clearing and burning of primary forest woods at a slightly later period might account for some of the earliest dates in Kahikinui *mauka*.

Period 2 (A.D. 1450–1575)

During this period of more extensive agricultural settlement in Kahikinui, it would appear that arable land and native forest resources became the target of a much larger group of farmers over a relatively short period of time—by c. A.D. 1575. This general time period would be analogous to the end of the New Adaptation (Cordy 1974:181) or Expansion Period (Kirch 1985:303), and was the period in which High Chief Pi'ilani unified the island of Maui for the first time (Kolb 1991:66). Radiocarbon dates from this period are restricted to an area between 650 and 850 masl, suggesting that pressure (climatic, political, or demographic) to exploit the lowland dry forest below 650 masl was minimal, or gradually accruing at most. The types of features yielding these dates in all three *ahupua'a* were lava tubes and rock shelters (Site 3475), paved terraces (Site 4253), walled terraces (Site 3816 and 3825), and various shaped enclosures (Site 3497 and 4338), reflecting a wider range of habitations presumably associated with midelevation agricultural field systems.

Most of these Period 2 dates fall within areas in all three *ahupua'a* that are located near pockets of older and more agriculturally productive soils. Two *heiau* dates from this same period in Naka'aha (Site 4279) and Luala'ilua (Site 1386) *Ahupua'a* (Kolb and Radewagen 1997) also attest to the formalized ritual importance of this midelevation zone during what is called the Early and Middle *Heiau* Construction Periods on Maui (Kolb 1991). In addition, a calibrated radiocarbon date of A.D. 1454–1648 was recovered from a coastal habitation complex at Site K/V 331 in Nakaohu *Ahupua'a* (Van Gilder and Kirch 1997), indicating that the sites located in Kahikinui *mauka* were part of an extant settlement system exploiting the full range of environmental zones by this time period. If the number of radiocarbon dates from this period actually represents the approximate proportion of the total settlement over time ($n = 6$, or 21.4 percent of the 28 dates), then one might expect as many as 130 new features to have been constructed within

the project area during Period 2, although many earlier structures were probably still being used or modified.

Period 3 (A.D. 1575–1800)

During this period of the most intensive agricultural settlement in Kahikinui *mauka*, between A.D. 1575 and EuroAmerican contact c. 1800, it appears that the need to exploit new arable land within the lowland dry forest may have been increasing. This general time period would be analogous to the beginning of the Complex Chiefdom (Cordy 1974) or Proto-Historic Period (Kirch 1985) and was the period in which Maui polities were involved in an increasing number of interisland conflicts (Kolb 1991), as well as internal struggles. The location and density of the radiocarbon-dated sites suggest that by this time pressure of some sort (climatic, political, or demographic) might have been driving probable swidden farming up into the dry montane forest periphery above 850 masl and down into lower elevations below 360 masl. The types of features yielding these dates were lava tubes and rock shelters (Sites 3452, 3472, 3474, 3831, and 4244), soil-filled terraces (Sites 3445), paved terraces (Site 3493, 3885, and 4262), walled terraces (Sites 3878 and 4343), terraced platforms (Sites 4300, 4315, and 4358), and various shaped enclosures (Sites 3416, 3871, and 3874), all reflecting a broader range of habitations than in the previous period.

The same soil zones appear to have continued to be exploited after A.D. 1575, although many of the Period 3 dated sites are located in newly exploited, more marginal soil pockets and rocky slopes as well. Increasing midelevation settlement density also appears to have necessitated more intensive farming of already existing agricultural field systems, as indicated by the construction of a network of permanent boundary walls in upper Nakaohu *Ahupua'a*. Upper elevation soil depletion is also suggested by the construction of alluvial soil and floodwater entrapment features for agricultural use of swale settings at lower elevations below 660 masl (Kirch 1997). This unintentional creation of seasonally productive microenvironments suitable to agriculture may in turn provide one explanation for why settlement appears to have expanded down slope over time, even as the cloud-line moisture belt presumably moved up slope following the receding lowland dry forests.

Radiocarbon-dated subsurface deposits excavated beneath the Kahikinui House Site 1536 (Conte 1998) and at Site K/V 752 (Van Gilder and Kirch 1997) indicate that permanent settlement had expanded to below 500 masl within Nakaohu *Ahupua'a* by c. A.D. 1650, perhaps extending to the fullest extent enabled by then-existing rainfall. Temporary settlement and seasonal agriculture in the intermediate and coastal zone are also suggested by the presence of small-scale planting modifications of the bedrock landscape (Kirch 1997). In addition, three *heiau* dated to this same period in Naka'aha (Site 4279), Nakaohu (Site 175), and Luala'ilua (Site 1386) *Ahupua'a* attest to the continued ritual importance of this expanded midelevation zone (Kolb and Radewagen 1997:77) during the Late *Heiau* Construction Period (Kolb 1991) on Maui. The construction of a *hōlua*, or sledding complex, in Nakaohu *Ahupua'a* (Site 3878) also suggests large-scale labor investment in the landscape at this time (Dixon et al. 1998a). If the number of radiocarbon dates from this period actually represents the approximate proportion

of the total settlement over time ($n = 17$, or 60.7 percent of the 28 dates), then one might expect as many as 360 new features to have been constructed within the project area during Period 3, although many earlier structures were probably still being used or modified.

Period 4 (A.D. 1800–1950)

Most radiocarbon samples from Period 3 sites in Kahikinui *mauka* had calibrated dates extending into the modern era c. 1950, well after EuroAmerican contact in 1778. Some of these dates can probably be attributed to the contamination expected for such later samples, given the effects of sunspot activities c. A.D. 1650 (Dye 1994) and the fluctuations of ^{14}C creation in the atmosphere since the Industrial Revolution (Kirch 1997). However, a few undated Kahikinui *mauka* sites were occupied into the mid-nineteenth century, as indicated by the construction of high-walled habitations with yards or corrals to keep out introduced domestic animals (Site 3428), the presence of foreign artifacts of nineteenth-century manufacture, and the existence of similarly dated sites at equivalent elevations outside the project area (Van Gilder and Kirch 1997). It should be noted, however, that only seven out of 256 features at 155 sites (or 4.5 percent of the total number) tested in the DHHL project area produced post-Contact artifacts, the majority being located in Kīpapa *Ahupua'a* near cattle-ranching-era sites.

This combination of data therefore indicates that most of the radiocarbon dates from Period 3 habitation sites do indeed reflect late pre-Contact domestic burning events. This, in turn, suggests that the majority of habitation sites (and presumably their agricultural field systems) located between 500 and 850 masl were virtually abandoned at some point not long after EuroAmerican settlement of Maui in the early 1800s. The subsequent construction of cattle walls and corrals in Kīpapa *Ahupua'a* (Dixon et al. 1997) and around Kahikinui House in Nakaohu *Ahupua'a* (Bartholomew 1994; Conte 1998; Janion 1976) may therefore signal the demise (if not the cause) of the traditional settlement and subsistence system in upland Kahikinui by the mid-1800s (Matsuoka et al. 1996), even though a few Native Hawaiian families continued to occupy lower elevations and coastal settings until the turn of the century (Baldwin 1881; Coulter 1931; Sterling 1998; Unknown 1869; Walker 1931).

SUMMARY DISCUSSION

In summary, it seems likely that by A.D. 1300 the few initial inhabitants of Kahikinui (in the DHHL project area) had selected optimal planting zones in what was an unexploited landscape. By A.D. 1450, however, larger numbers of settlers simultaneously targeted all microenvironmental, or elevational, zones across the landscape below the highland *ōhi'a* and *koa* forests, not only to minimize their dependency on windward polities, but also to minimize the agronomic risk of crop failure in a dry leeward area never before exploited to this extent. This strategy apparently involved the swidden planting of moisture-adapted crops such as dryland taro in the dry montane forest margins, more intensive production of sweet potatoes and a variety of household garden crops in the dry lowland forest, sparse planting of some of these dryland crops at lower elevations, and only sea-

sonal planting along the coast, where marine subsistence activities dominated. This policy was apparently implemented to ensure that some quantity of agricultural produce would be harvested even in the driest of years, necessitating only periodic local settlement shifts instead of wholesale population migration to outside the district.

After A.D. 1575, when Chief Pi'ilani unified the island of Maui for the first time (Fornander 1996), settlement in Kahikinui appears to have expanded into previously unexploited dry lowland forest elevations below and perhaps into the margins of the dry montane forest above. Settlement in-filling is evident, as is the intensification of agricultural production through the establishment of permanently bounded upland field systems in areas that were previously swidden. This trend, in combination with the expansion of existing *heiau* (Kolb and Radewagen 1997), the erection of public recreational facilities such as the *hōlua* slide (Dixon et al. 1998a), and the construction of the Pi'ilani Trail, suggests that this was a period of greater *ali'i* demands for tribute, in exchange for increased *ali'i* involvement in local religious rituals. Such demands were probably met by the chiefly implementation of the *ahupua'a* system, with the east Maui slopes, including Kahikinui, becoming "... the greatest continuous dry planting area in the Hawaiian islands" (Handy 1940:161). There is no indication that this general pattern abated before 1778, because very little archaeological or ethnohistorical evidence was found to suggest that Kahikinui played any major role in this period of inter-island warfare (Kirch 1990). Instead, invasion events and long-term occupations were recorded only for Kaupō and Hāna to the east and Mākena and Honua'ula to the west.

Within the first 50 years after EuroAmerican contact, inhabitants of Hawai'i underwent major changes in settlement density, population distribution, and subsistence practices (Sahlins 1992). By the time of the first census at Kahikinui in the 1830s (Schmitt 1973), it appears that the majority of the upland agricultural field systems above 480 masl had been abandoned, and the remaining inhabitants had moved toward midelevation cattle-ranching features, the Catholic Church at Santa Ynez (Ashdown 1973), and coastal trails. Although the introduction of cattle (McGregor 1989) and foreign diseases (Bushnell 1993; Tam Sing 1993, 1994) undoubtedly precipitated many of these changes before the arrival of the first missionaries in Maui in 1820 (Schoofs 1978), it appears that areas such as Kahikinui, located at the fringes of the pre-Contact sociopolitical structure, may have been among the first to suffer from the breakdown of the traditional *ahupua'a* system. The dissolution of the symbiotic relationship between *maka'āinana* surplus production and *ali'i* religious reciprocity (Kame'elehiwa 1992) may therefore have tipped the delicate balance between the people and their environment in dry leeward settings such as east Maui, thus setting the stage for the final degradation of Kahikinui as we know it today after 150 years of abandonment.

ACKNOWLEDGMENTS

Our work would not have become a reality without the continued support and *mana'o* of all the members of Ka 'Ohana O Kahikinui. In particular, Mo Moler, Donna and Walter Simpson, Aimoku and Lehua Pali, Chad and Harry Newman, Melanie and Norman Abihai, Mahealani Kaiaokamalie, Gordean Bailey, and Toby

Kua have been instrumental in making us feel at home on their 'āina. In the Department of Hawaiian Home Lands, Arick Arakaki, Carolyn Darr, Mike Crozier, Joe Chu, Darrel Yagovich, Mona Kapaku, and the late Dan Awai all demonstrated a personal interest in our undertakings in the field. At the State Historic Preservation Division, Ross Cordy was a sounding board for research ideas and approaches, and Eric Komori and Holly McEldowney provided invaluable assistance over the course of the project. Patrick Kirch, Cindy Van Gilder, Michael Kolb, and Erica Radewagen have been equally helpful in sharing the results of their research within our project area. Michael Graves is also thanked for his patience and editorial wisdom.

REFERENCES

- ALLEN, M., AND P. MCANANY
 1994 Environmental variability and traditional Hawaiian land use patterns: Manuka's cultural islands in seas of lava. *Asian Perspectives* 33(1): 19–56.
- ASHDOWN, I.
 1971 *Ke Alaloe O Maui. Authentic History and Legends of the Valley Isle Told by Maui County's Historian Emeritus*. Wailuku, HI: Kama'aina Historians, Inc.
 1973 Story of Santa Ynez Shrine. Ms. on file, State of Hawai'i Preservation Division—Maui Annex, Wailuku.
- BALDWIN, E.
 1881 Personal recollections of my life written for the benefit of my children. Manuscript cited in E. Sterling, *Sites of Maui*, Wailuku, HI: Bailey House Museum.
- BARTHOLOMEW, G.
 1994 *Maui Remembers: A Local History*. Honolulu: Mutual Publishing.
- BECKWITH, M.
 1970 *Hawaiian Mythology*. Honolulu: University of Hawai'i Press.
- BOSERUP, E.
 1965 *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. Chicago: Aldine Press.
- BRAUN, D., AND S. PLOG
 1982 Evolution of "tribal" social networks: Theory and prehistoric North American evidence. *American Antiquity* 47: 504–525.
- BRUMFIEL, E., AND J. FOX, EDS.
 1994 *Factional Competition and Political Development in the New World*. Cambridge: Cambridge University Press.
- BUSHNELL, O.
 1993 *The Gifts of Civilization: Germs and Genocide in Hawaii*. Honolulu: University of Hawai'i Press.
- CARNEIRO, R.
 1970 A theory of the origin of the state. *Science* 169: 733–738.
 1981 The chiefdom: Precursor of the state, in *The Transition to Statehood in the New World*: 37–79, ed. G. Jones and R. Kautz. Cambridge: Cambridge University Press.
- CHAPMAN, P., AND P. KIRCH
 1979 *Archaeological Excavations at Seven Sites in Southeast Maui, Hawaiian Islands*. Department of Anthropology Report Series 79–1. Honolulu: Bishop Museum.
- CHISOLM, M.
 1970 *Rural Settlement and Land Use: An Essay in Location*. Chicago: Aldine Press.
- CONTE, P.
 1998 'O ka mea hea Paiko o Kahikinui (Which is the Piko of Kahikinui)? A primarily ethno-historical perspective. Master's thesis, Northern Illinois University, DeKalb.
- CORDY, R.
 1974 Cultural adaptation and evolution in Hawaii: A suggested new sequence. *Journal of the Polynesian Society* 83: 180–191.
 1977 Kihei flood control project: Archaeological reconnaissance and literature search. Unpublished report. Submitted to U.S. Army Corps of Engineers, Honolulu.

- 1981 *A Study of Prehistoric Social Change: The Development of Complex Societies in the Hawaiian Islands*. New York: Academic Press.
- COULTER, J.
1931 *Population and Utilization of Land and Sea in Hawaii, 1853*. B. P. Pauahi Bishop Museum Bulletin 88. Honolulu: Bishop Museum.
- DEWAR, R.
1984 Environmental productivity, population regulation, and carrying capacity. *American Anthropologist* 86(3): 601-611.
- DIXON, B., P. CONTE, V. NAGAHARA, AND W. K. HODGINS
1996 An archaeological inventory survey plan for excavations at Sanata Ynez Church and Parsonage, Kahikinui District, Maui, Hawai'i. Unpublished manuscript on file, State of Hawai'i Preservation Division—Maui Annex, Wailuku.
1997 Upland forest periphery subsistence and settlement in the ahupua'a of Kīpapa, Nakaohu and Naka'aha: A preliminary assessment, in *Na Mea Kahiko o Kahikinui: Studies in the Archaeology of Kahikinui, Maui*: 28-43, ed. P. Kirch. Oceanic Archaeology Laboratory, Special Publication No. 1. Berkeley: University of California.
1998a A newly discovered hōlua sledding complex in Kahikinui, Maui, and its context, in *Easter Island in Pacific Context: South Seas Symposium. Proceedings of the Fourth International Conference on Easter Island Research*: 6:260-266. Los Osos, CA: Easter Island Foundation, and Bearsville/Cloud Mountain Press.
- DIXON, BOYD, PATTY J. CONTE, VALERIE NAGAHARA, W. KOA HODGINS, AND ROSS CORDY
2000 *Kahikinui mauka: Archaeological research in the lowland dry forest of leeward east Maui*. 4 vols. Wailuku, HI: State of Hawai'i Preservation Division—Maui Annex.
- DIXON, B., R. CORDY, AND C. VAN GILDER
1998b District-wide research questions for Kahikinui, Maui. Unpublished manuscript on file, State of Hawai'i Preservation Division—Maui Annex, Wailuku.
- DONHAM, T.
1998 Keawala'i Church (SIHP Site 50-50-14-1584), Makena, Honua'ūla, Maui: Archaeological survey and testing of the North Yard area. Submitted to the Board of Trustees, Keawala'i Congregational Church, Makena, Maui.
- DYE, T.
1994 Population trends in Hawai'i before 1778. *The Hawaiian Journal of History* 28:1-20.
- ERKELENS, C.
1995 Phase I archaeological investigation, cultural resources survey, Hawai'i Geothermal Project, Makawao and Hāna Districts, south shore of Maui, Hawai'i. Submitted to Oak Ridge National Laboratory, International Archaeological Research Institute, Honolulu.
- FOOTE, D., E. HILL, S. NAKAMURA, AND F. STEPHENS
1977 *Soil survey of the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*. Washington D.C.: U.S. Department of Agriculture, Soil Conservation Service.
- FORNANDER, A.
1996 *Ancient History of the Hawaiian People to the Times of Kamehameha I*. (Originally published as *An Account of the Polynesian Race: Its Origin and Migrations*, Vol. II). Honolulu: Mutual Publishing.
- GEERTZ, C.
1971 *Agricultural Involution: The Process of Ecological Change in Indonesia*. Berkeley: University of California Press.
- GIAMBELLUCA, T., M. NULLET, M. RIDGLEY, P. EYRE, J. MONCUR, AND S. PRICE
1991 *Drought in Hawaii*. Report R88, Department of Land and Natural Resources, Honolulu.
- GOSSER, D., S. CLARK, B. DIXON, P. KLIEMER, G. HURST, L. ROTUNNA-HAZUKA, AND S. LEBO
1993 *Data Recovery Excavations in Makena Resort's Parcels III and IV, Makena, Maui*. Department of Anthropology Technical Report, Honolulu: Bishop Museum.
- HAMMATT, H., AND W. FOLK
1994 *Archaeological reconnaissance of an 8,300-acre project area, Kahikinui, Maui TMK 1-9-01:3*. Kailua: Cultural Surveys Hawaii.
- HANDY, C.
1940 *The Hawaiian Planter*. Vol. 1, *His Plants, Methods and Areas of Cultivation*. B. P. Bishop Museum Bulletin 161. Honolulu: Bishop Museum Press.

- HOMMON, R.
1986 Social evolution in ancient Hawai'i, in *Island Societies: Archaeological Approaches to Evolution and Transformation*: 55–68, ed. P. Kirch. London: Cambridge University Press.
- HUNTER, C.
1997 *Aerial Remote Sensing and Archaeology in Haleakalā National Park, Maui, Hawaii*. U.S. National Park Service, Department of the Interior.
- JANION, A.
1976 *The Olowalu Massacre and Other Hawaiian Tales*. Norfolk Island, Australia: Island Heritage.
- KAMAKAU, S.
1992 *Ruling Chiefs of Hawaii*. 2d ed. Honolulu: Kamehameha Schools Press.
- KAME'ELEIHIWA, L.
1992 *Native Land and Foreign Desires—Pehea La E Pono Ai?* Honolulu: Bishop Museum Press.
- KIRCH, P.
1971 Archaeological excavations at Palauea, southeast Maui, Hawaiian Islands. *Archaeology and Physical Anthropology in Oceania* 6: 62–86.
1985 *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. Honolulu: University of Hawai'i Press.
1990 The evolution of sociopolitical complexity in prehistoric Hawaii: An assessment of the archaeological evidence. *Journal of World Prehistory* 4(3): 311–345.
1997 *Na Mea Kahiko o Kahikinui, Maui, Hawai'i*. Oceanic Archaeology Laboratory, Special Publication No. 1. Berkeley: University of California.
- KIRCH, P., AND C. VAN GILDER
1996 Pre-contact and early historic cultural landscapes in Kahikinui District, Maui: A progress report. *Hawaiian Archaeology* 5: 38–52.
- KOLB, M.
1991 Social power, chiefly authority, and ceremonial architecture in an island polity, Maui, Hawaii. Ph.D. diss., University of California, Los Angeles.
1992 Diachronic design changes in heiau temple architecture from the island of Maui, Hawai'i. *Asian Perspectives* 31(1): 9–37.
1994a Monumentality and the rise of religious authority in precontact Hawai'i. *Current Anthropology* 34(5): 521–547.
1994b Ritual activity and chiefly economy at an upland religious site on Maui, Hawai'i. *Journal of Field Archaeology* 21(3): 1–21.
- KOLB, M., P. CONTE, AND R. CORDY
1997 *Kula: The Archaeology of Upcountry Maui*. Maui: State Historic Preservation Division.
- KOLB, M., AND E. RADEWAGEN
1997 Na heiau o Kahikinui: The temples of Kahikinui, in *Na Mea Kahiko o Kahikinui, Maui, Hawai'i*: 61–77, ed. P. Kirch. Oceanic Archaeology Laboratory, Special Publication No. 1. Berkeley: University of California.
- MATSUOKA, J., D. MCGREGOR, L. MINERBI, M. KELLY, AND N. BARNEY-CAMPBELL
1996 Native Hawaiian ethnographic study for the Hawai'i Geothermal Project proposed for Puna and southeast Maui. Submitted to Oak Ridge Laboratory, Honolulu, CANDO.
- MCGREGOR, D.
1989 Kupa'a i ka 'aina: Persistence on the land. Ph.D. diss., University of Hawai'i at Mānoa, Honolulu.
- MOFFAT, R., AND G. FITZPATRICK
1995 Surveying the Mahele: Mapping the Hawaiian land revolution. Vol. 2, *Palapala 'Aina*. *American Anthropologist* 89: 596–616.
- NICHOLS, D.
1987 Risk and agricultural intensification during the formative period in the northern basin of Mexico. *American Anthropologist* 89: 596–616.
- REDMOND, E.
1994 External warfare and the internal politics of northern South American tribes and chiefdoms, in *Factional Competition and Political Development in the New World*: 44–56, ed. E. Brumfiel and J. Fox. Cambridge: Cambridge University Press.

- ROSENDAHL, M.
1978 *Preliminary Overview of Archaeological Resources at Haleakalā National Park, Maui*. Department of Anthropology Report. Honolulu: Bishop Museum.
- ROSENDAHL, P.
1994 Aboriginal Hawaiian structural remains and settlement patterns in the upland agricultural zone at Lapakahi, island of Hawai'i. *Hawaiian Archaeology* 3: 14-70.
- SAHLINS, M.
1992 *Anahulu: The Anthropology of History in the Kingdom of Hawaii*. Volume 1, *Historical Ethnography*. Chicago: University of Chicago Press.
- SANDERS, W., J. PARSON, AND R. SANTLEY
1979 *The Basin of Mexico: Ecological Processes in the Evolution of a Civilization*. New York: Academic Press.
- SCHMITT, R.
1973 *The Missionary Censuses of Hawaii*. Pacific Anthropological Records No. 20. Honolulu: Bishop Museum.
- SCHOOF, R.
1978 *Pioneers of the Faith: History of the Catholic Mission in Hawaii (1827-1940)*. Honolulu: Louis Boeynaems.
- SCHORTMAN, E., AND P. URBAN, EDS.
1992 *Resources, Power, and Interregional Interaction*. New York: Plenum Press.
- SINOTO, Y.
1968 Fishhook typology and its significance for establishing prehistoric culture sequences in Oceania. *Proceedings of the VIIIth International Congress of Anthropological and Ethnological Sciences*. Tokyo: Science Council of Japan.
- SPENCER, C.
1993 Human agency, biased transmission, and the cultural evolution of chiefly authority. *Journal of Anthropological Archaeology* 12: 41-74.
- STANNARD, D.
1989 *Before the Horror: The Population of Hawai'i on the Eve of Western Contact*. Honolulu: Social Science Research Institute, University of Hawaii.
- STERLING, E.
1998 *Sites of Maui*. Honolulu: Bishop Museum Press.
- STUIVER, M., AND P. J. REIMER
1993 Extended ¹⁴C data base and revised calib 3.0 ¹⁴C age calibration program. *Radiocarbon* 35: 215-230.
- TAM SING, T.
1993 Hawaii: A paradise or not? An account of disease according to Captain James Cook and Captain M. de La Perouse. Unpublished report. Honolulu: University of Hawai'i at Mānoa.
1994 Maui's La Perouse Bay: A comparative study of ethnohistorical and archaeological evidence. Unpublished report. Honolulu: University of Hawai'i at Mānoa.
- UNKNOWN
1869 Letter written in Hāna, 27 May 1869, to A. Fornander Esq., Superintendent General of Schools, Honolulu. Signature illegible.
- VAN GILDER, C., AND P. KIRCH
1997 Household archaeology in the ahupua'a of Kīpapa and Nakaohu, in *Na Mea Kahiko o Kahikinui, Maui, Hawai'i*: 45-59, ed. P. Kirch. Oceanic Archaeology Laboratory, Special Publication No. 1. Berkeley: University of California.
- WALKER, W.
1931 Archaeology of Maui. S. on file, Bishop Museum Library, Honolulu.
- YEN, D.
1974 *The Sweet Potato and Oceania*. B. P. Bishop Museum Bulletin No. 236. Honolulu: Bishop Museum Press.

ABSTRACT

Rather than viewing the culture history of Kahikinui, Maui, as a process of gradual population growth and ecological adaptation, this article proposes that the settlement and subsistence system found in the district at European contact was implemented virtually intact in the mid-fifteenth century as a deliberate and conscious chiefly strategy—both to avoid the social risks inherent in increasingly factionalized windward polities and to minimize the environmental risks involved in settling this dry leeward district. By approximately A.D. 1650, the spatial distribution of settlement and the formalization of agricultural field systems suggest the implementation of the *ahupua'a*, or traditional Hawaiian community land unit. Kahikinui, located at the fringes of the pre-Contact sociopolitical structure, may have been among the first areas to suffer from the breakdown of the traditional *ahupua'a* system after European contact in A.D. 1778. KEYWORDS: Hawaiian archaeology, leeward environments, Maui, risk.