Prehistoric Bird Hunters: High Altitude Resource Exploitation on Hawai'i Island

J. Stephen Athens,[1] Michael W. Kaschko,[1] and Helen F. James[2]

ABSTRACT

Intensive archaeological survey and test excavations in a 730 hectare forested parcel in the upland saddle area of Hawai'i Island disclosed 16 sites in lava tubes and a bubble. All but 1 are inferred to have been temporary prehistoric Hawaiian shelter sites; the exception is known to contain only paleontological bird bones. Prehistoric avian faunal remains, clearly the result of Hawaiian exploitation, were associated with most shelters. Radiocarbon dates indicate there was a sudden increase in use of the area by about A.D. 1400. The archaeological remains are discussed, and it is suggested that exploitation of the brightly colored passerine birds for feathers and juvenile petrels for chiefly food may have been the primary focus of activities. This is despite the dominance of adult petrel bones, and to a lesser extent, the bones of the Hawaiian Goose and other species, which presumably served as subsistence foods for the collectors. The date for the emergence of large chiefdom polities is presumed to correlate with the initial surge in demand for specialty foods and the use of feathers as adornments and emblems. Both served to define and publicly identify the rank and status of chiefly individuals and social groups.

INTRODUCTION

This article presents the results of an archaeological inventory survey with subsurface testing conducted within the proposed Multi-Purpose Range Complex (MPRC) of the Pōhakuloa Training Area on Hawai'i Island. The recovery of a large sample of avian faunal remains dating to the prehistoric Hawaiian period is of particular interest for the data it provides on such subjects as the impact of prehistoric Hawaiians on a pristine natural environment, changes following Western contact, patterns of resource exploitation by prehistoric Hawaiians, and the development of a complex society on Hawai'i Island. It is our contention that these remains, besides informing us about an heretofore poorly documented aspect of highland land use, provide a significant new line of evidence concerning the chronology of the development of large chiefdoms on Hawai'i Island.

This research was conducted by International Archaeological Research Institute, Inc. under contract to the U.S. Army Corps of Engineers, Pacific Ocean Division. Fieldwork was performed during a 2½ month period between August and October 1987 by a field crew of 4 to

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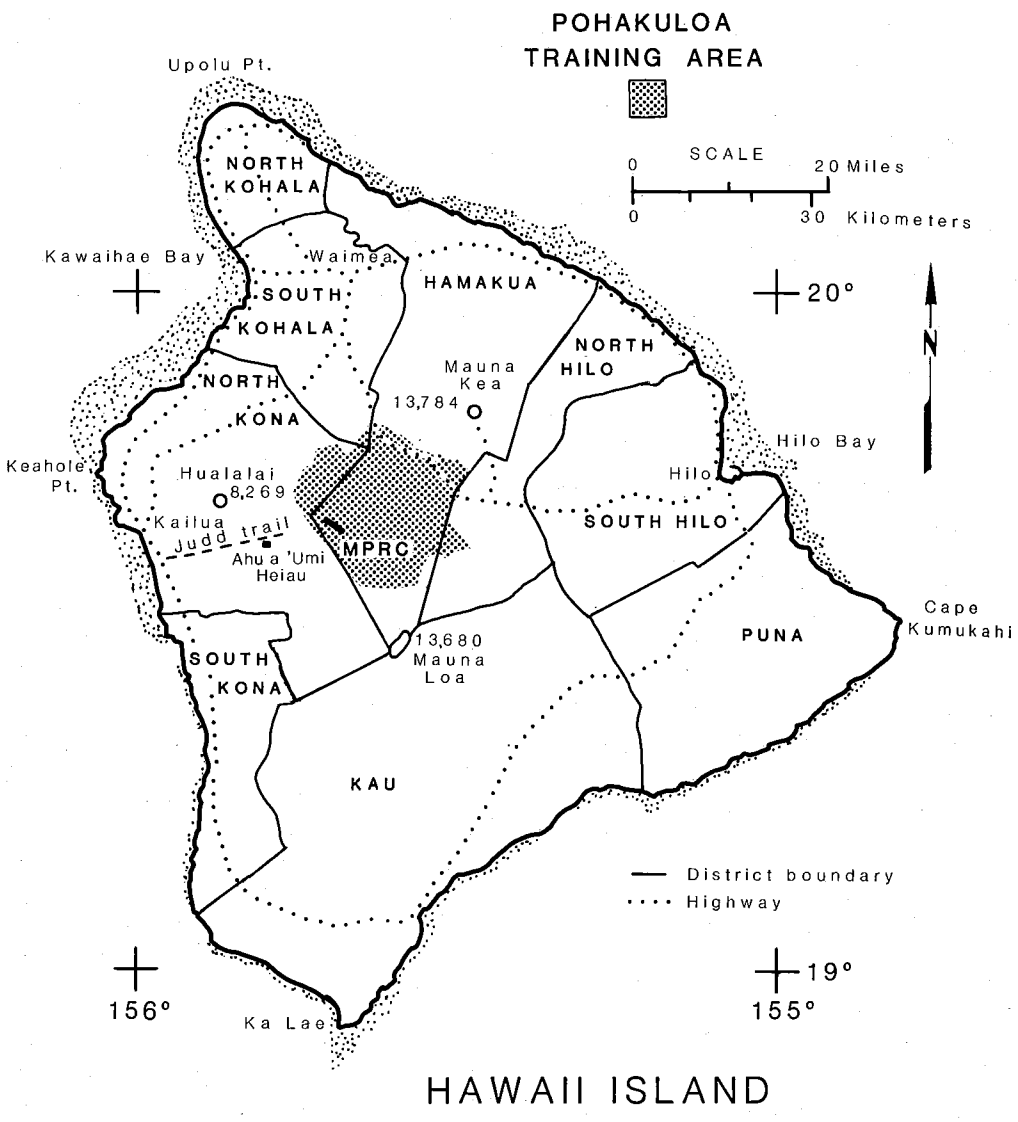

Fig. 1. Map of Island of Hawai'i showing Pōhakuloa Training Area and MPRC project area.

5 professional archaeologists. The project was codirected by 2 of the authors—Athens and Kaschko. Full details concerning the investigations are presented elsewhere (Athens & Kaschko 1989).

Location and Environment of Project Area

The MPRC is a 730 hectare (1,800 acre) undeveloped and mostly forested tract measuring 5.53 by 1.31 km. It is located in the saddle area of Hawai'i Island (Figs. 1,2). This is a high altitude plateau-like zone between the 3 major peaks of Mauna Loa to the south, Mauna Kea to the northeast, and Hualālai to the west. Fogs are common in the saddle area and there are occasional frosts. Because of the cold, agriculture would not be feasible with traditional Hawaiian cultigens. The Pōhakuloa Training Area (PTA), established in 1956 for training

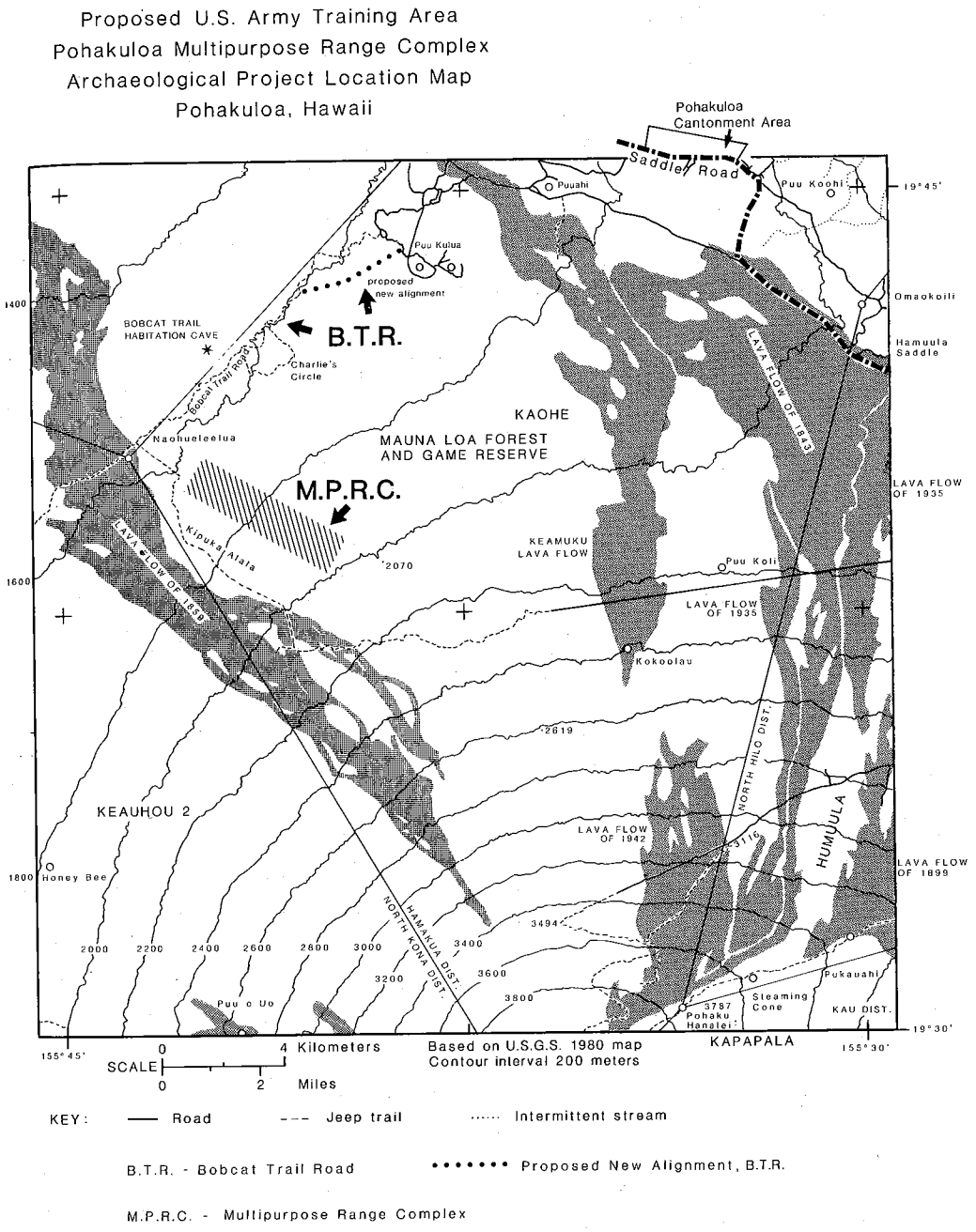

Fig. 2. Location map of MPRC project area and Bobcat Trail Habitation Cave.

exercises of military personnel, presently occupies much of the saddle area. The MPRC is situated just inside its western border in Hāmākua District on the lower slopes of Mauna Loa.

Sloping in a northwesterly direction, the MPRC ranges in elevation from 1,605–1,995 meters (5,263–6,545 ft). The surface is generally rocky, and there are several areas having lava flows. A total of 4 major environmental zones have been recognized (Fig. 3). Zone A is the largest of

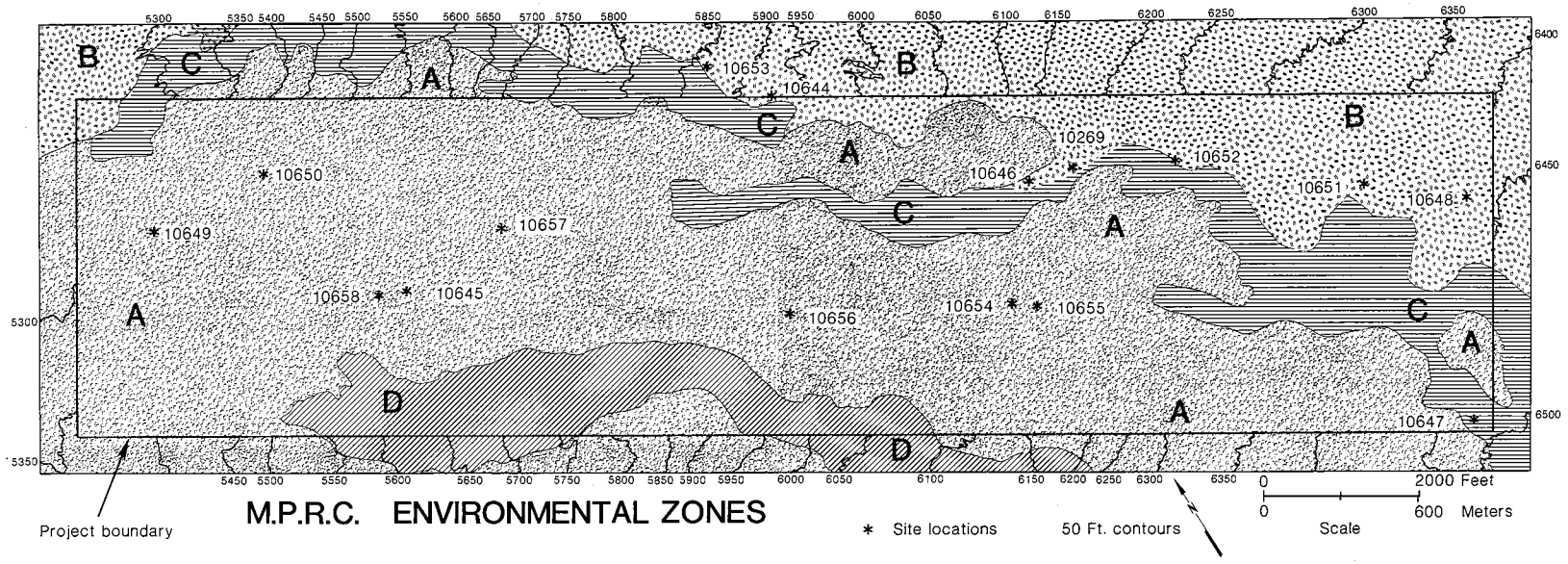

Fig. 3. Map of MPRC environmental zones and archaeological site locations. Zone A = old weathered *pāhoehoe* flow *kīpuka*, *naio-mamane* forest. Zone B = unweathered *pāhoehoe* flow, open *'ōhi'a* forest. Zone C = unweathered *a'ā* flow, open *'ōhi'a* forest or pioneer vegetation. Zone D = weathered *a'ā* flow, open *'ōhi'a* forest with mixed native trees.

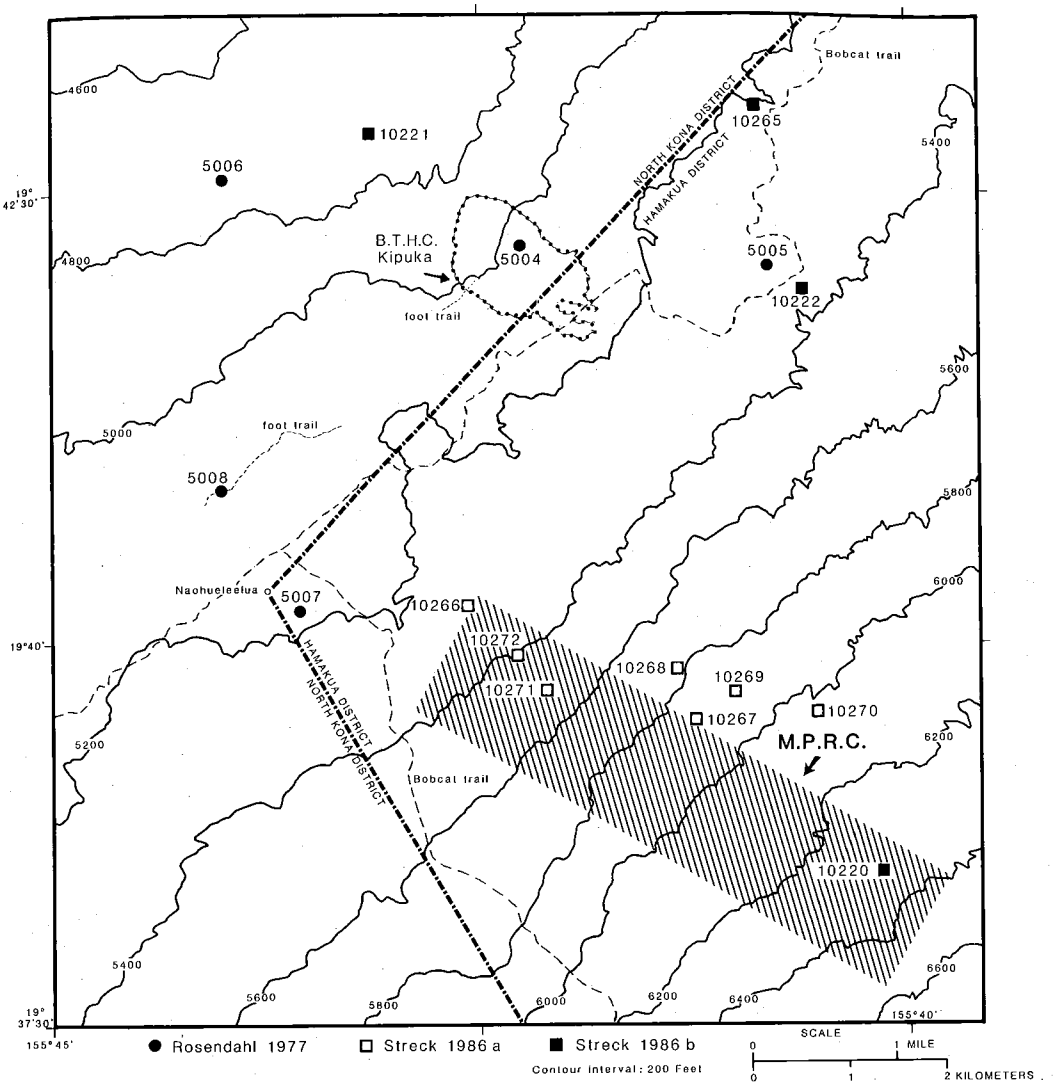

Fig. 4. Map showing previously recorded archaeological site locations at the Pōhakuloa Training Area in vicinity of Bobcat Trail Road and MPRC. Note that there are 14 archaeological sites inside the Bobcat Trail Habitation Cave *kīpuka*, including the BTHC (Site 5004). The locations of all sites reported by Streck (1986a) are inaccurate due to lack of ground reference points at the time of his work. Except for Site 10269, these sites have not been relocated.

these and consists of old weathered *pāhoehoe* and *naio-mamane* (*Myoporum sandwicense* and *Sophora chrysophylla*) forest in a *kīpuka*-like area. Dense thickets of often quite large *'a'ali'i* (*Dodonaea eriocarpa*) are found intermixed with the *naio-mamane* forest in the intermediate and lower elevation areas. Zone A occupies the central portion of the MPRC and is bounded by younger lava flows (Zone B = *pāhoehoe*; Zone C = *a'ā*) with *'ōhi'a* (*Metrosideros collina*) forest to the north and east. An older *a'ā* flow with open *'ōhi'a* forest and mixed native trees is located along the southwest boundary of the MPRC (Zone D). To the south and west, outside of the MPRC, is the lava flow of 1859, which is mostly barren *a'ā*.

It is important to emphasize that the MPRC is located within a *kīpuka*. This is a special type

of Hawaiian environmental zone characterized by a discrete "island" of older terrain surrounded by more recent lava flows. Perhaps in recognition of this, the place name "Kipuka Alala" appears on USGS topographic maps for the general vicinity of the MPRC location. Thus, in certain areas where volcanism and lava flows are relatively common occurrences and lead to the formation of *kīpuka*, environmental zones may be highly segmented rather than extending uninterrupted over wide areas. This is significant to our study because the type of resource exploitation pattern we describe for the MPRC may not be generally characteristic of the saddle area as a whole. Based on our informal aerial observations (multiple helicopter flights over the Pōhakuloa Training Area), in fact, it appears that the type of forested environment contained within the MPRC *kīpuka* zone is of limited occurrence in the saddle area. Furthermore, the MPRC may have one of the largest such environmental zones. This is not to say, however, that other major *kīpuka* are not present within the Pōhakuloa Training Area; they just have different environmental characteristics (e.g., mostly nonforested or lightly forested).

Previous Archaeological Investigations

The best known investigations in highland areas on Hawai'i Island are those concerned with the Mauna Kea adze quarry complex of sites (McCoy 1977; McCoy & Gould 1977; Allen 1981; Cleghorn 1982). The various sites, which include temporary shelters and shrines, are associated with the mass production of stone adze preforms from a distinctive dense, blue-black basalt found on the upper slopes of Mauna Kea. Most sites are located well above the tree line (11,000–12,400 ft elevation), though stone working has been more recently reported at somewhat lower elevations (McCoy 1986). Use of these sites began as early as about A.D. 1100 (Cleghorn 1982:51), while intensive quarrying did not start until the A.D. 1400s (Allen 1981:58–59).

Within the Pōhakuloa Training Area, archaeological studies began with the investigations of Rosendahl in 1977, who surveyed by air and with field checks 1,211 hectares (2,991 acres) in 30 separate sampling units distributed throughout the facility (Rosendahl 1977; Hommon & Ahlo 1982:36).[3] He recorded 4 shelter caves (including the Bobcat Trail Habitation Cave [BTHC]), 4 trail segments, and 1 complex of post-contact walls). The density of shelter sites computes to 1 per 3 sq km.

Rosendahl's investigations were followed by an intensive survey of the Bobcat Trail Habitation Cave *kīpuka*, and test excavations primarily focused within the BTHC lava tube (Haun 1986). This *kīpuka* and site complex are located only 3 km from the northwest corner of the MPRC at an elevation of approximately 1,524 meters (5,000 ft; see Fig. 4). A total of 8 tube sites were recorded (including the BTHC) in the 127 hectare (314 acre) *kīpuka*, which calculates to a density of 1 shelter site per 0.16 sq km. This density is much higher than that reported by Rosendahl for his more general survey. There were also 2 trail segments, 3 cairns, and 1 volcanic glass lithic scatter.

The BTHC shelter, particularly rich in cultural remains, contained terraces, a shelter wall, hearths, oven features, stone niches (also called cupboards; presumably for storage), numerous dense concentrations of organic material, midden remains, and various artifacts (Haun 1986:41–47). The 10 sq meters of excavation (8 in the BTHC and 1 each in Sites T–101 and T–107) produced preserved remains of taro, banana, sugarcane, pandanus, sennit cordage, coconut, gourd, *ti* leaf, *kukui* nut, bird bone, shell midden, volcanic glass, *ti* leaf sandals, and several other items (see Haun 1986:76–90). Only a single flake of dense basalt and 1 probable polished adze flake were recovered; there were no basalt adzes.

3. The Pōhakuloa Training Area occupies an area of approximately 47,102 hectares (116,341 acres or 182 sq m), measures approximately 24.5 km north-south and 27.5 km east-west, and has an elevation ranging between approximately 1,280–2,680 meters (4,200–8,800 ft).

A

Table

Site	Beta no.
10220	13094
10221	13561
10221	13561
10222	13563***
10222	13564***
10269	16432
10269	16433
10272	16434
5004	15230
5004	15231
5004	15232
5004	15233
5004	15234
5004	15235
T–101	16402
T–102	16403
T–107	16404
T–107	16405

*S = Streck (1986b and pe
**From Stuiver and Rein
***Small sample; extend

Of the total of 903.
weight) was that of th
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4. Haun (1986:106) belie
mouse bones in the BTHC

Table 1. List of radiocarbon dates for PTA archaeological sites.

Site	Beta no.	Provenience	Source*	Calibrated date range and probability**	
10220	13094	fireplace	S	A.D. 1418–1639	(100%)
10221	13561	oven 2	S	A.D. 866–1075	(85%)
10221	13561	oven 3	S	A.D. 942–1160	(96%)
10222	13563***	deposit	S	A.D. 1408–1666	(98%)
10222	13564***	oven	S	A.D. 1408–1678	(93%)
10269	16432	Feat. A hearth, 8–12 cm b.s.	S	A.D. 1490–1691	(55%)
				A.D. 1722–1811	(35%)
10269	16433	Feat. B hearth, Level 2/3	S	A.D. 1431–1668	(96%)
10272	16434	hearth, sample 3	S	A.D. 1399–1531	(77%)
				A.D. 1544–1636	(23%)
5004	15230	TU–1; firepit; I/1	H	A.D. 1277–1470	(100%)
5004	15231	TU–3; HF–1; I/1	H	A.D. 1642–1712	(24%)
				A.D. 1715–1886	(60%)
5004	15232	TU–3; II	H	A.D. 1262–1410	(100%)
5004	15233	TU–7; Ter. 1; II/4	H	A.D. 1679–1741	(25%)
				A.D. 1805–1937	(75%)
5004	15234	TU–8; Ter. 4; HF–2	H	A.D. 1654–1896	(83%)
5004	15235	TU–8; Ter. 4; HF–3	H	A.D. 1635–1955	(98%)
T–101	16402	TU–10; Feat. B–3	H	A.D. 1449–1653	(100%)
T–102	16403	Feat. D	H	A.D. 1294–1375	(51%)
				A.D. 1376–1441	(49%)
T–107	16404	TU–6; HF–1	H	A.D. 1636–1900	(82%)
T–107	16405	TU–6; HF–2	H	A.D. 1437–1533	(55%)
				A.D. 1538–1638	(45%)

*S = Streck (1986b and pers. comm.); H = Haun (1986).
**From Stuiver and Reimer (1986); age range probabilities of less than 20% are not presented in this table.
***Small sample; extended counting time.

Of the total of 903.6 grams of bird bone collected in the BTHC excavations, 94.7% (by weight) was that of the Dark-rumped Petrel (*Pterodroma phaeopygia sandwichensis*), 4.2% was that of *Nēnē* or Hawaiian Goose (*Branta sandvicensis*), and the remaining 1.1% was that of various small procellariid, rallid (rails), small and medium-sized passeriforms, and unidentified small birds and small raptorial birds (either owls or diurnal birds of prey). Because the small passeriform birds traditionally used for feather working purposes were so few in number, being almost exclusively found in the upper levels with rat and mouse bones (the latter being an historic introduction), Haun (1986:106) believes these remains to be the result of owl predation and not a result of human exploitation.[4]

The BTHC radiocarbon dates (a total of 10) suggest an occupation beginning sometime between about A.D. 1300 to 1400 and continuing, presumably on an intermittent and temporary basis, into the historic period (Table 1). The major conclusion Haun (1986:104) draws from the BTHC investigations is that occupation consisted of a combination of use of the shelters for extended periods as well as sporadic short-term occupations. He furthermore regards the BTHC site complex as representing a destination area for upland resource exploitation, and

4. Haun (1986:106) believes that the 3 occurrences of small passeriform bones *not* associated with historic rat and mouse bones in the BTHC are due to their use as food remains and are not a result of feather collecting.

not as a shelter area associated with a cross-island travel or communication route (Haun 1986:104).

The only other archaeological fieldwork prior to the present investigations concerns several small survey projects undertaken by Streck (1984, 1985, 1986a, 1986b) for the U.S. Army Corps of Engineers. His investigations include the survey of 6 discrete land units totaling 54 hectares (133 acres), as well as helicopter reconnaissances with ground inspection of potential sites (primarily sinkholes with lava tubes). A total of 11 new sites were reported, and all of these were shelter sites in lava tubes or sinkholes (Fig. 4). Of the 11 sites, 8 were identified as being within the MPRC project area. Our subsequent investigations, however, have shown that only 1 of these is actually within the MPRC boundaries as they were finally determined. Due to lack of suitable ground reference points at the time of his fieldwork, Streck was unable to provide accurate site locations.

Some of Streck's shelter caves contained relatively abundant cultural remains, including terraces, oven and hearth features, walls, stone niches, and midden remains consisting of bird bone, small amounts of marine shell (primarily *Cellana* spp.), and fish bone. Also found were flaked volcanic glass, "adzed" wood chips, sandals (made from *ti* leaves), coconut fiber cordage, a single wooden adze handle, and organic concentrations including *kukui* nut shell, coconut shell, pandanus, *ti*, and gourd. Many of the sites, however, contained only a very small amount of archaeological material. In terms of excavation and analysis, Streck removed only charcoal samples for radiocarbon dating from the shelter caves. Of the 8 reported radiocarbon dates (Table 1), 2 are relatively early, yielding age ranges of A.D. 866–1075 and A.D. 942–1160 (Site 10221; calibrated with 95% confidence interval). The other dates were in the A.D. 1400 to 1600 time range.

One of Streck's major conclusions from this work is that there is no support for the argument made by Hommon and Ahlo (1982:47) and McCoy (1986:6) that the Pōhakuloa cave shelter sites provided logistical support in the form of food and resources for personnel engaged in adze-blank production at the Mauna Kea basalt quarry sites. As Streck (1986b:38) observes, the Pōhakuloa sites are virtually devoid of the distinctive Mauna Kea basalt. Haun (1986) also arrived at a similar conclusion based on his investigations at the BTHC complex.

MPRC SITE INVENTORY

Systematic ground survey of the entire MPRC area resulted in the recording of 15 archaeological sites and 1 site with avian paleontological remains (Table 2). All of the archaeological sites consist of shelter caves, and all but 1 of these are in underground lava tubes with access from sinkholes (see Figs. 5,6). The exception, Site 10657, is located in a dome-shaped lava bubble that rises above the ground surface. The only surface feature noted was that of a small boulder wall constructed across the sinkhole entrance to a lava tube (Site 10656). The sites are generally widely dispersed across the MPRC (Fig. 3) with no evident spatial clusterings (though no sites were found within environmental zones C and D, which are *a'ā* flows and not appropriate for the formation of caves). The shelter caves have a density of 1 site per 0.48 sq km within the MPRC, which is only one-third as dense as the BTHC *kīpuka*, but still much more dense than Rosendahl's findings elsewhere in the Pōhakuloa Training Area.

None of the shelter sites contain particularly extensive remains of prehistoric activities, though some of the sites have considerably more than others (Table 3). Actual structural features are limited to only a few sites, consisting of stone rings for hearths (3), terrace or terrace platforms (3), a single wall, 2 stone niches, and several miscellaneous features (a stone pile, a possible pathway, 2 stone alignments, and a blocked entrance to a small tube). Most of the sites, however, have charcoal concentrations and bird bones. Gourd and *kukui* nut shells were also found at a few sites, along with coconut shell, pandanus leaves, and probable sugarcane.

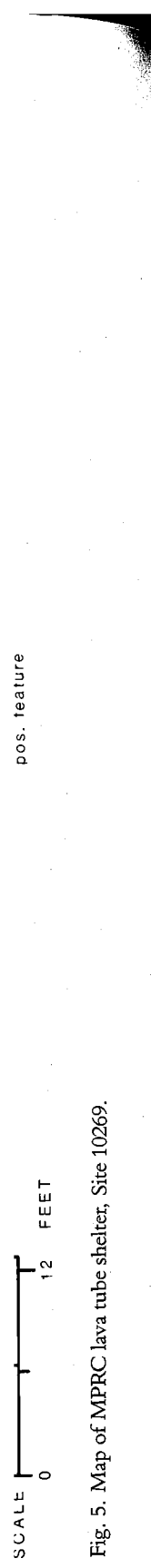
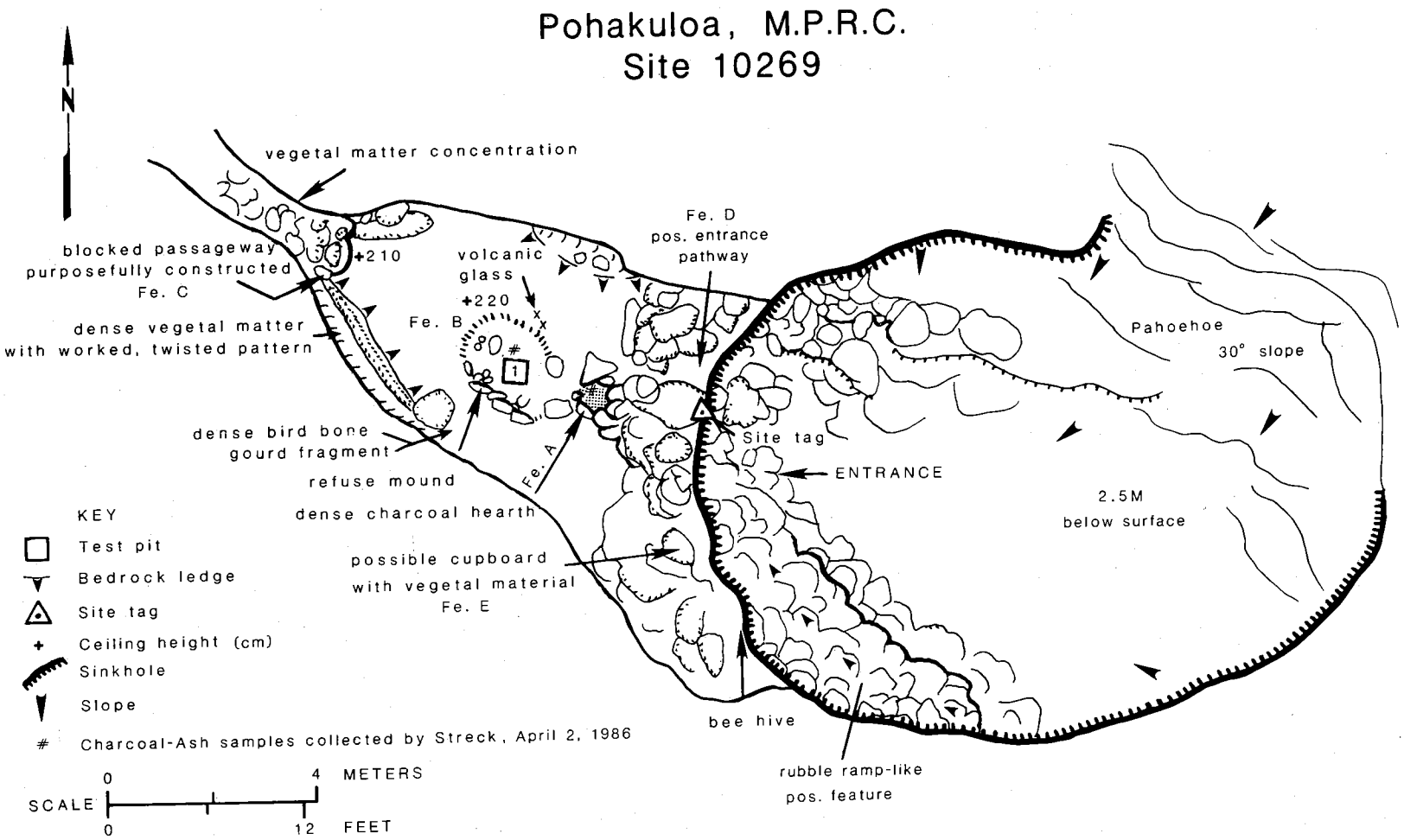


Fig. 5. Map of MPRC lava tube shelter, Site 10269.



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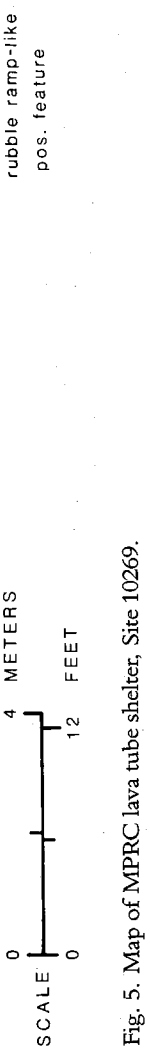

Fig. 5. Map of MPRC lava tube shelter, Site 10269.

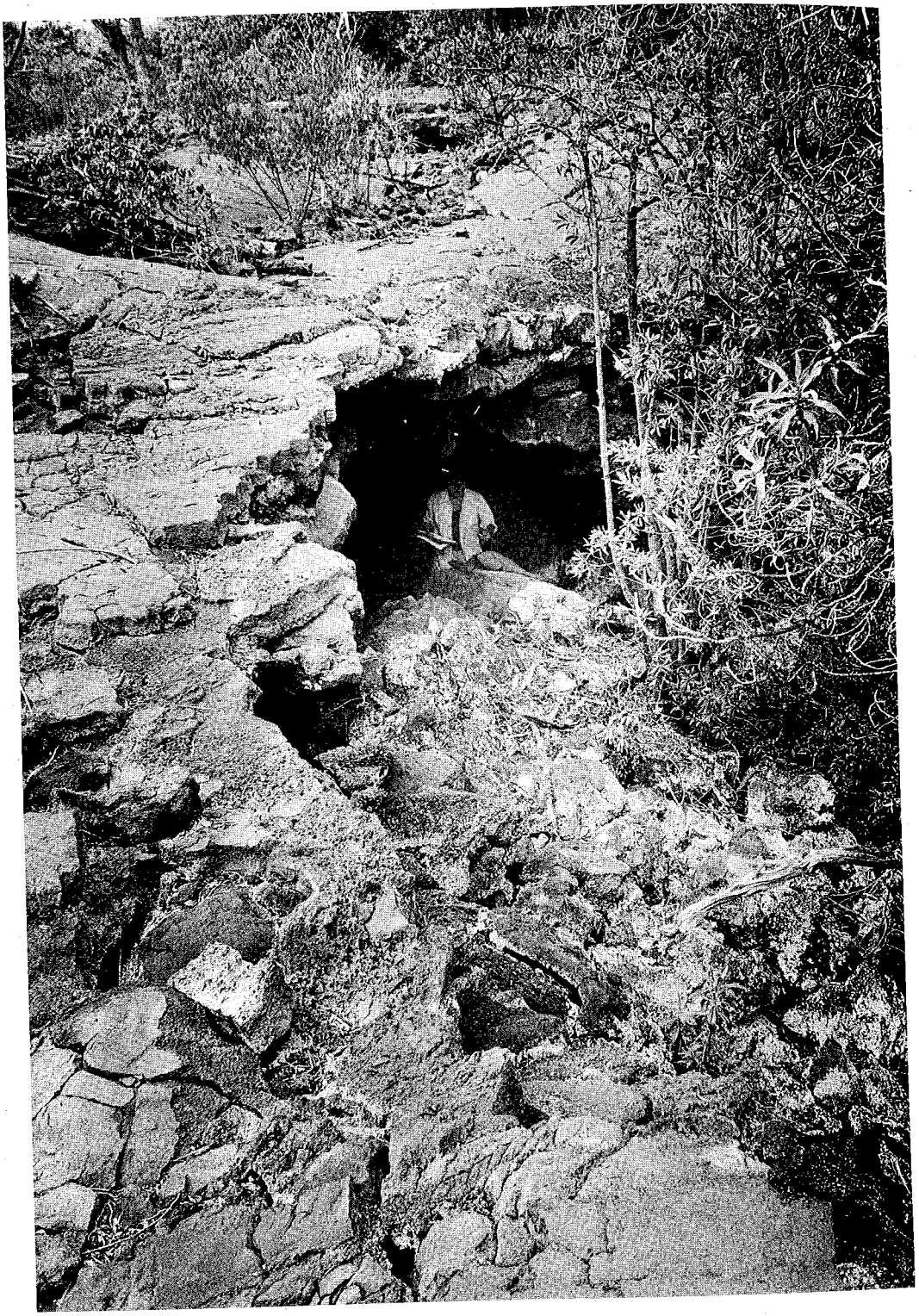

Fig. 6. Photograph of Site 10269 showing sinkhole and lava tube entrance.

Table 2. List of archaeological sites in MPRC.

Site no.	Coordinates	Elevation (ft)	Site type	No. of features	Site plan map	Environmental zone
10269	N 296,857 E 438,940	6,123	S. C.*	5	yes	B
10644	N 299,678 E 436,162	5,935	S. C.	2	yes	B
10645	N 300,070 E 430,933	5,576	S. C.	1	yes	A
10646	N 296,982 E 438,400	6,100	S. C.	4	yes	B
10647	N 291,400 E 441,570	6,505	S. C.	1	yes	A
10648	N 293,860 E 442,980	6,425	S. C.	3	no	B
10649	N 302,380 E 428,625	5,367	S. C.	4	yes	A
10650	N 302,240 E 430,215	5,448	S. C.	5	yes	A
10651	N 294,700 E 441,980	6,350	S. C.	2	no	B
10652	N 296,240 E 440,050	6,230	S. C.	2	yes	B
10653	N 300,420 E 435,690	5,860	S. C.	1	yes	B
10654	N 295,790 E 437,400	6,100	S. C.	1	yes	A
10655	N 295,750 E 437,500	6,120	S. C.	1	yes	A
10656	N 297,142 E 434,920	5,970	S. C.	2	yes	A
10657	N 432,356 E 300,060	5,700	S. C.	1	yes	A
10658	N 300,169 E 430,607	5,550	paleon-tological	–	no	A

*S. C. = shelter cave.

Basalt flaking debris and/or finished tools were absent, though probable adzed wood chips were noted for Site 10657.

In terms of possible cultural implications for the remains, none of the sites indicate more than sporadic and very temporary habitation or use. However, there are some notable differences between the shelter cave sites. Site 10269, for example, contains several apparent leaf bundles (*ti* or pandanus), an apparent blocked tube passageway, and a substantial fire-hearth ash mound suggestive of periods of reuse (see Fig. 5). Sites 10649, 10656, and 10657 are also notable for their relatively extensive and varied deposits. In contrast, many of the sites have only minimal signs of prehistoric occupation by Hawaiians, perhaps having been used for shelter for nothing more than a single night's stay (Sites 10645, 10651, 10653, 10654, and 10655).

Limited test excavations and/or sample collection were undertaken at all 16 MPRC sites. A summary of the collected remains is provided in Table 4. Of the 12 categories listed, 6 are

Table 3. List of archaeological features and other remains in MPRC sites.

Site	Stone ring hearth	Hearth or ash mound	Charcoal concentration	Terrace or terrace platform	Cleared area	Wall	Cupboard	Bird bones	Leaf-wrapped bundle	Human skeletal remains	Nonfeature sediment deposits with possible archaeological remains	Miscellaneous features	Historic materials	Gourd	*Kukui* nut
10269	–	2	–	–	–	–	1	x	2	–	–	2	–	x	x
10644	–	–	1	–	1	–	–	x*	–	–	?	–	–	–	–
10645	–	–	1	–	–	–	–	x*	–	–	–	–	–	–	–
10646	1	1	–	–	–	–	1	x	1	–	–	1	–	x	–
10467	–	–	1	–	–	–	–	x	–	–	?	–	–	–	x
10648	–	–	2	–	–	–	–	x	–	–	?	1	–	–	–
10649	1	1	1	1	–	–	–	x	–	–	x	–	–	x	x
10650	1	1	–	2	–	–	–	–	–	x	x	1	–	x	–
10651	–	–	1	–	1	–	–	x*	–	–	–	–	–	–	–
10652	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–
10653	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
10654	–	–	1	–	–	–	–	x	–	–	–	–	–	–	–
10655	–	1	–	–	–	–	–	x	–	–	x	x	–	–	–
10656	–	–	1	–	–	x	–	x	–	–	x	–	–	–	–
10657	–	–	1	–	–	–	–	x	–	–	x	–	x	x	x
10658	–	–	–	–	–	–	–	x	–	–	–	–	–	–	–

x = present; x* = very small quantity.

represented by only a single occurrence (wood concentration, gourd container, basalt pebble, fireplow, hammerstone, and human bone), and several others are represented by only minor quantities (*kukui* nut shell, marine shell, volcanic glass, and historic leather). In contrast, charcoal samples were recovered from all but the paleontological site (Site 10658), and bird bone was recovered from most of the sites.

In terms of excavation methodology, an effort was made to maximize the recovery of small bird bones, particularly those belonging to the passerines, or small perching birds. To accomplish this, all excavation sediment samples were collected in bulk for laboratory water-screening through 1/16 inch mesh. The remaining residues were then entirely sorted.

In general, the excavation results support the surface survey interpretation that all of the shelter caves were utilized very sporadically and for brief periods, with a few of the sites apparently being revisited and/or having slightly longer periods of use. The association of bird bones with the cultural remains is perhaps the most notable aspect of the archaeological data. In many of the sites this association is unequivocal (the bone was burnt and/or found in hearth features), and in others it is highly likely.

Radiocarbon Dating of MPRC Sites

A total of 22 samples (charcoal and several wood samples) from all 15 shelter sites was processed for radiocarbon dates (2 additional dates were obtained by Streck [see Table 1]). A list of the resulting dates is presented in Table 5. A graphic depiction of the calendar ages of

Table 4. List of archaeological materials collected from MPRC sites.

Site	Charcoal	Wood	Bird bone***	Shell	*Kukui* nut	Vol. glass	Gourd container	Basalt pebble	Historic leather	Fire-plow	Hammer-stone	Human bone	Adzed wood
10269, F-B	1,461.0**	–	210.9	5.1	2.3	16*	–	–	–	–	–	–	–
surface	–	–	–	–	–	2*	–	–	–	–	–	–	–
10644	10.6	–	1.7	–	–	–	–	–	–	–	–	–	–
10645, Tube 1, F-A	26.3	–	–	–	–	–	–	–	–	–	–	–	–
10646, Sink A, F-D	–	251.4	–	–	–	–	–	–	–	–	–	–	–
Sink B, F-A	122.9*	–	13.2	0.3	–	–	–	–	–	–	–	–	–
surface	–	–	–	19.8	–	–	–	–	–	–	–	–	
10647	1.9	–	0.1	–	–	–	–	–	–	–	–	–	–
10648, Tube A	33.0	–	9.0	–	–	–	–	–	–	–	–	–	–
10649, F-B	42.1	–	18.5	3.4	0.5	11*	–	1*	–	–	–	–	–
F-C	5.0	–	64.1	–	–	–	–	–	–	–	–	–	–
F-D	5.4	–	–	–	–	–	–	–	–	–	–	–	–
surface	–	–	66.0	–	–	–	1*	–	–	–	–	–	–
10650, Sink C, F-E	116.5	–	1.3	–	–	–	–	–	–	–	–	–	–
Sink E, F-B	70.1**	–	3.3	–	–	–	–	–	–	–	–	1*	–
10651	7.6	–	–	–	–	–	–	–	–	–	–	–	–
10652, Conc. #1	18.7	–	–	–	–	–	–	–	–	–	–	–	–
Conc. #2	67.4	–	–	–	–	–	–	–	–	–	–	–	–
10653	17.6	–	–	–	–	–	–	–	–	–	–	–	–
10654	29.3	–	–	–	–	–	–	–	–	–	–	–	–
10655	21.8	x	4.2	–	–	–	–	–	–	–	–	–	–
10656, TP-1	41.2**	–	104.5	–	–	–	–	–	–	–	–	–	–
TP-2	86.8	–	4.8	–	–	–	–	–	–	–	–	–	–
10657 char. conc.	32.7	–	–	–	–	–	–	–	–	–	–	–	–
TP-1	29.9**	–	11.0	–	2.3	–	–	–	–	–	–	–	–
surface	–	–	–	–	–	2*	–	–	4*	1*	1*	–	1*
10658, surface	–	–	27.5	–	–	–	–	–	–	–	–	–	–
Totals	2,247.8	251.4	540.1	28.6	5.1	31*	1*	1*	4*	1*	1*	1*	1*

Weight in grams; Conc. = concentration; x = present.
*Count.
**Charcoal weight is that of ¼-in. screen fraction only (smaller fraction not sorted and weighed).
***Very minor amounts of non-bird bone included in this category (see Table 6).

these dates, based on the age range probabilities for each sample computed from the calibration program by Stuiver and Reimer (1986), is provided in Figure 7. We have used an arbitrary tripartite scheme for representing the age range probabilities, which we believe most usefully represents the age range information. Thus, a solid bar is used to represent the most probable true age ranges (between 51–100% probability), a dashed line represents relatively lower probability age ranges (11–50%), and dots represent extremely low probability age ranges (0–10%).

It may be noted that our graph does not discount or ignore any age ranges based on the probability distributions. However, it does highlight the more statistically probable ranges. We believe that with a large set of dates such as we have for the MPRC, this more clearly reveals meaningful patterns in the distribution of calibrated dates. Otherwise such information may be obscured by the complications involved in interpreting multiple age range distributions for a large number of dates.

Evidence for use of the MPRC area first begins to appear between A.D. 1000 and 1200. However, the striking characteristic of the Figure 7 graph is that it shows quite clearly that it is not until about A.D. 1400 to 1450 that this region really begins to be substantially utilized. In fact, A.D. 1400 appears to be almost a watershed point in the use of the MPRC: before that time evidence for use is very minor, and after that time it appears to suddenly become relatively

12	Adjusted B. P. date
4	190 ± 50
l	410 ± 60
2	560 ± 70
5	440 ± 80
3	150 ± 60
7	480 ± 50
)	510 ± 60
3	450 ± 140
)	370 ± 50
4	290 ± 60
	770 ± 60
2	220 ± 70
4	430 ± 50
	520 ± 50
5	440 ± 60
7	160 ± 50
)	440 ± 50
)	250 ± 50
	470 ± 50
	500 ± 70
	130 ± 50
5	920 ± 60

Fig. 7 (see also Athens

ived extended counting

exploitation of the
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is time, of course,
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result of sampling
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g Area does not imply
ddle area seems always
ver, this marginal use

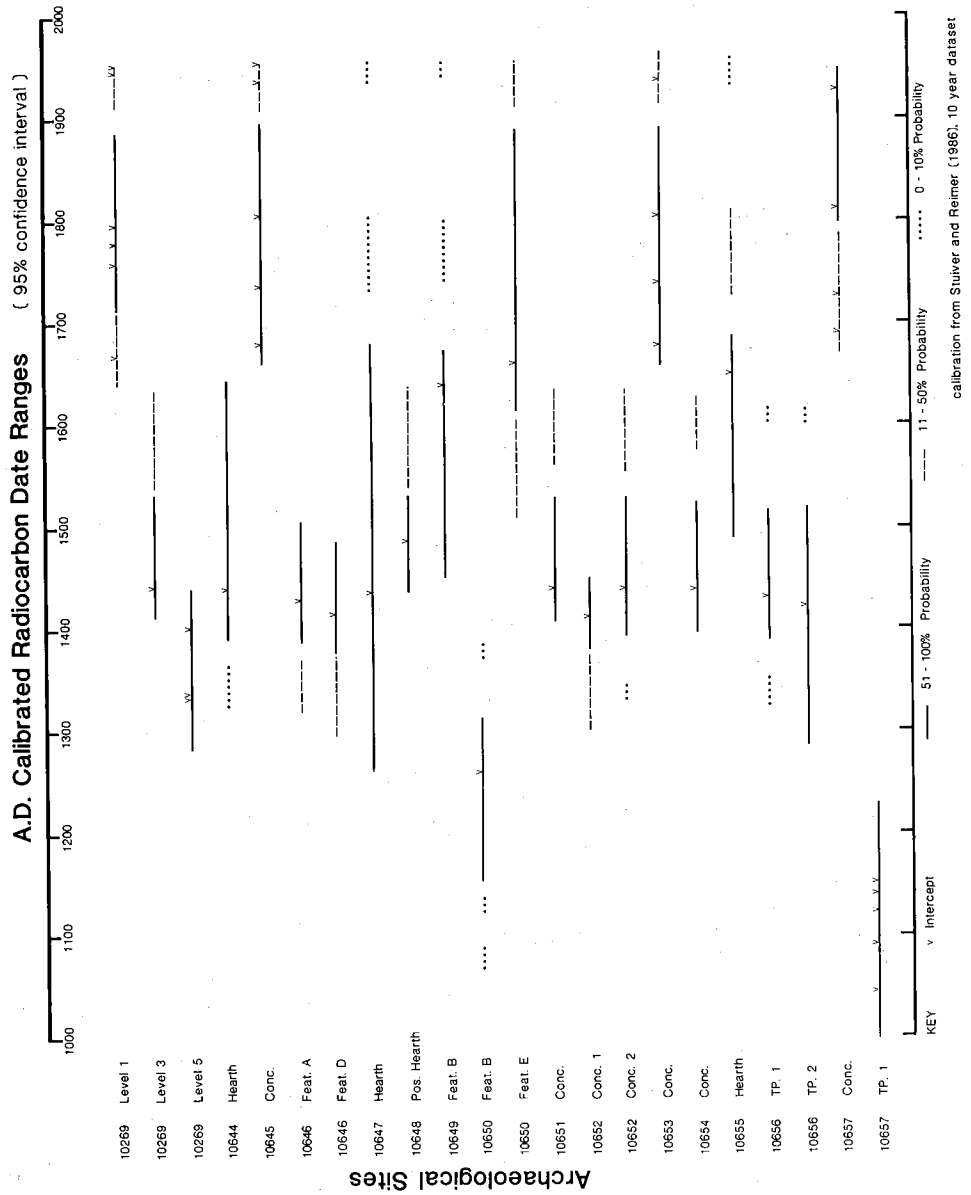


Fig. 7. Graphic representation of calibrated radiocarbon dates from MPRC sites.

Table 5. Radiocarbon dates from MPRC sites.

Site no.	Lab. no.*	Cat. no.	Provenience	B. P. date	C13/C12	Adjusted B. P. date
10269**	24593	17	F-B hearth, L–1	200 ± 50	−25.4	190 ± 50
	26593	19	L–3	410 ± 60	−25.1	410 ± 60
	24594	24	L–5	550 ± 70	−24.2	560 ± 70
10644	24596	34	hearth	430 ± 80	−24.6	440 ± 80
10645	24592	15	char. conc.	160 ± 60	−25.8	150 ± 60
10646	24595	33	hearth, F-A	470 ± 50	−24.7	480 ± 50
	26594	26	hearth, F-D	540 ± 60	−27.0	510 ± 60
10647	24597***	35	hearth	450 ± 140	−24.8	450 ± 140
10648	24598	36	pos. hearth	390 ± 50	−26.0	370 ± 50
10649	24590	3	F-B hearth, L–2	300 ± 60	−25.4	290 ± 60
10650	24591	10	F-B hearth, L–2	740 ± 60	−23.1	770 ± 60
	26592	12	F-E hearth, L–1	240 ± 70	−26.2	220 ± 70
10651	24599	37	char. conc.	450 ± 50	−26.4	430 ± 50
10652	26595	38	char. conc. #1	550 ± 50	−27.1	520 ± 50
	24600	39	char. conc. #2	410 ± 60	−23.3	440 ± 60
10653	24601	40	char. conc.	190 ± 50	−26.7	160 ± 50
10654	24602	41	char. conc.	450 ± 50	−26.0	440 ± 50
10655	24603	42	hearth—ash mound	250 ± 50	−25.0	250 ± 50
10656	24606	56	TP–1—char. conc.	490 ± 50	−26.1	470 ± 50
	24607	58	TP–2, L–2	540 ± 70	−27.1	500 ± 70
10657	24604	44	hearth—char. conc.	160 ± 50	−27.1	130 ± 50
	24605	55	TP–1, L–2	920 ± 60	−24.8	920 ± 60

Conc. = concentration. Calendar calibrations and date range probabilities are presented in Fig. 7 (see also Athens and Kaschko 1989 for details).

*Beta Analytic Inc.

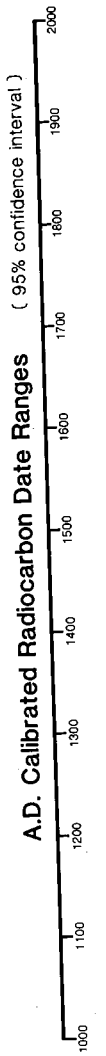
**See Table 1 for additional 2 dates from this site as reported by C. Streck.

***Small sample size; 1.9 g of charcoal collected and 0.15 g of carbon extracted. Sample received extended counting time to reduce statistical error.

heavy.[5] It is believed that such a clear-cut temporal boundary for increased exploitation of the MPRC, if applicable to the rest of the saddle region, may have considerable significance in terms of the development of Hawaiian sociopolitical organization.

Another trend revealed by the Figure 7 graph is the slight decline in the intensity of occupation and use of the MPRC area after approximately A.D. 1500 to 1540. After this time, of course, there is still fairly substantial use of the area, but it definitely appears to be less intense than in the previous century. The reason for this is unclear, though a number of factors could be responsible for this pattern. It is possible, for example, that the region was exploited less intensively during the later period due to resource depletion, a reduced demand for products, or other unknown factors. It is also possible that the dating pattern is the result of sampling bias and that there was actually no decline in the intensity of occupation and use of the MPRC area after A.D. 1500 or so.

5. We would like to emphasize that relatively heavy use of the MPRC or Pōhakuloa Training Area does not imply that a substantial number of people began moving into this region after A.D. 1400 or so. The saddle area seems always to have been extremely marginal in terms of population numbers at any one time. However, this marginal use apparently did dramatically increase after approximately A.D. 1400 within the MPRC.



Avian Faunal Remains

One of the most intriguing questions about the archaeological data from the Pōhakuloa Training Area in general concerns what the ancient Hawaiians were doing in this region, especially because the saddle area is climatically inhospitable for occupation on a long-term or short-term basis. Elsewhere we have gone to considerable length to identify *potential* resources within this region that the Hawaiians *might* have exploited (i.e., native plant and animal species with recorded ethnographic uses; Athens & Kaschko 1989:33–40). This proved quite useful in generating ideas and tentative hypotheses concerning our approach to the archaeological data. However, it is the empirical findings themselves that must ultimately determine which interpretations are useful, merit further analysis, and provide a basis for understanding prehistoric Hawaiian adaptations and exploitation patterns.

The primary direct evidence for resource exploitation in the MPRC concerns the avian faunal remains (see Table 4).[6] All other items observed or collected at the archaeological sites consisted of either extremely minor quantities often clearly brought from lowland areas (e.g., marine shell, gourd, *kukui* nut shell), or by-products of shelter occupation and not resources exploited per se (e.g., charcoal and wood samples collected from hearths and concentrations).

The avian faunal remains consist of approximately 11,111 bones and bone fragments (512.6 grams[7] of bone were recovered from 10 of the archaeological sites and another 27.5 grams were obtained from the paleontological site). Many of the smaller fragments could not be identified. However, 1,418 bones were either positively or tentatively identified at least to the level of genus (or for passerines, at least to the order). Table 6 presents a summary breakdown of the identified remains (see James in Athens & Kaschko 1989 for provenience and skeletal parts information). There are 3 seabird taxa, 1 shorebird taxon, 5 non-passerine land bird taxa, and 5 passerine bird taxa represented. Most of these birds are now extremely rare or no longer present within the MPRC, and the 2 flightless rails are extinct.[8]

In the collected bone remains, the seabirds (petrels) are clearly dominant, making up 73.7% of the total (by number of identified bones), while non-passerine land birds comprise 7.2% and perching birds 19% (the shorebird category is negligible with just 1 bone). What these figures mean in terms of resource utilization and exploitation is far from clear. Though bird hunting was obviously an important activity in the MPRC area, the data are not straightforward as to the primary motivation or purpose behind it.

One possibility is that we are seeing a "generalized" pattern of avian resource exploitation, perhaps either entirely or only partially for immediate subsistence purposes during the procurement of other as yet unidentified resources in the saddle area. These other resources could be any of a number of food or raw material plant or wood products that might not leave physical

6. Adzed wood chips were found in Site 10657 that could indicate a type of activity associated with resource exploitation, in this case perhaps specific native wood species.

7. Very small amounts of rat, mouse, fish, and sea urchin remains are included in this figure.

8. The 56 bones tentatively referred to Bonin Petrel require further study to determine whether they might in fact represent a different, undescribed species of petrel of similar size, which is known from skeletal remains at lower elevations on Hawai'i Island and O'ahu. We believe these bones are best interpreted as remains of birds that were breeding in the vicinity. (The Bonin Petrel is not known to breed at high elevations and there is no record of it breeding on Hawai'i Island during the historic or recent periods.) We doubt that these are remains of birds that were brought up from the coast by the Hawaiians. Except for a very minor amount of shellfish remains, the Pōhakuloa sites contain no evidence for other high protein foods such as dog, pig, chicken, or fish (other than a few tiny bones, probably the result of petrel feeding) deriving from areas of Hawaiian settlement near the coast. This suggests that coastal protein foods were not important to prehistoric visitors to the Pōhakuloa area, and thus petrels of any kind were probably not carried up there from the coast for food.

Eleven bones (two individuals) were identified as Harcourt Storm Petrel, perhaps indicating that this species was breeding in the Pōhakuloa area as well.

Table 6. List of animal taxa identified from the MPRC sites of the Pōhakuloa Training Area.*

Avian Skeletal Remains			
Seabirds			
Pterodroma phaeopygia	Hawaiian Petrel or ʻUʻau	837	(142)
Pterodroma cf. *hypoleuca*	Bonin Petrel	53	(3)
Oceanodroma cf. *castro*	Harcourt Storm Petrel or Oeoe	11	
Shorebirds			
Pluvialis cf. *fulva*	Pacific Golden-Plover or Kolea	1	
Non-passerine Land Birds			
Branta sandvicensis	Hawaiian Goose or Nēnē	30	(7)
cf. *Asio flammeus*	Short-eared Owl or Pueo	4	
Porzana cf. *sandwichensis*	Hawaiian Rail or Moho	56	
Porzana sp.	small unknown species	2	
Buteo solitarius	Hawaiian Hawk or ʻIo	2	(1)
Perching Birds (Passeriformes)			
bones referred to Passeriformes, family through species undetermined		178	
Chasiempis sandwichensis	ʻElepaio	1	
Myadestes cf. *obscurus*	Hawaiian Thrush or ʻŌmaʻo	20	(42)
Hemignathus obscurus	ʻAkialoa	1	
Loxops virens	ʻAmakihi	6	(20)
cf. *Himatione sanguinea*	ʻApapane	1	
		1,203	(215)
Total identified and tentatively identified avian skeletal elements = 1,418			
Non-avian Remains			
Mammalia			
Rattus sp.		95	
(*Rattus* cf. *rattus*)	black rat		
(*Rattus exulans*)	Pacific rat		
Mus musculus	house mouse	13	
Osteichthys	unidentified fish	23	
Echinodermata	unidentified sea urchin	16	

*Common names and the total number of specimens identified follow the Latin name. The number of specimens only tentatively attributed to each taxon is in parentheses.

Table 7. Endemic Hawaiian birds used for feather adornments.

ʻAkialoa (*Hemignathus obscurus*)	yellow feathers	(e)
ʻIʻiwi (*Vestiaria coccinea*)	red feathers	
ʻŌʻū (*Psittirostra psittacea*)	green feathers	
ʻApapane (*Himatione sanguinea*)	red feathers	
Hawaiʻi ʻŌʻō (*Moho nobilis*)	yellow feathers	(e)
Mamo (*Drepanis pacifica*)	yellow feathers	(e)
Hawaiʻi ʻAmakihi (*Loxops virens*)	greenish-yellow feathers	

e = extinct.

Other bird taxa were also used for featherwork (e.g., the Hawaiian Crow, the Hawaiian Hawk, the Hawaiian Owl, and certain seabirds [Holt 1985:68–70; Malo 1951:38; Handy & Handy 1972:257–58]), though the above list represents the most important and valuable feather birds. It is likely that most if not all of these bird species were once (i.e., prehistorically) present within the confines of the MPRC project area.

With respect to the archaeological data, only 3 taxa are represented from the list of primary (passerine) feather birds. These are the 'Akialoa, 'Apapane, and 'Amakihi. The first 2—the 'Akialoa and the 'Apapane—are represented by just 1 identifiable skeletal element each. The 'Amakihi, however, is somewhat more common, being represented by 26 identifiable (or tentatively identifiable) skeletal elements. Thus, taken at face value, the archaeological data seem to suggest that feather collecting may have been only a marginal activity of Hawaiians utilizing the MPRC shelter caves.

An alternative consideration, however, is that like the juvenile petrels, the important feather birds may be absent precisely because they were transported whole to the lower elevation population areas where they were then given to highly skilled feather workers. The fact that there are a relatively high number of passerine birds represented in the skeletal collection (19%) could be the result of the capture of the little-used passerines during the trapping of valued feather birds. These birds, then, would have been eaten rather than discarded. Since some of the trapping techniques were not species-specific (see Emerson 1894:107–9), it would not be surprising for a fair number of "non-feather" small birds to be caught, which evidently were relished as delicacies as noted by Emerson.

During such feather bird hunting excursions into the saddle area, possibly to meet required chiefly tribute payments, there would obviously be a need for food to sustain the hunters. One of the most readily accessible sources for this food—at least on a seasonal basis—would be the nesting sea birds and non-passerine land birds, the latter being most importantly represented by the *Nēnē* or Hawaiian goose. Based on known nesting and migration patterns of the Dark-rumped Petrel, Bulwer's Petrel, and the *Nēnē*, it appears that from August through October these birds would have been most abundant (see Richardson 1957:29; Simons 1985), which also coincides with the preferred season recorded for feather bird hunting at this high elevation (Emerson 1894:104).

IMPLICATIONS FOR HAWAIIAN SOCIAL ORGANIZATION AND CHIEFDOM DEVELOPMENT

It is recognized that our sample of sites is rather small and geographically limited for deriving any firm conclusions concerning patterns in dating, distribution, or functions of the archaeological remains. Furthermore, there is some definite ambiguity in the interpretation of the bird bone remains: though lots of birds were being caught and eaten, does this mean that the reason Hawaiians were in the MPRC area was to catch juvenile petrels to transport them to the lowlands, or that specialized feather collecting was a major activity, or perhaps that there were other purposes not considered here? In any case, given the remoteness and climatic severity of the MPRC, it seems likely to us that there was more going on than just procurement of birds for immediate consumption.

Disregarding the sampling problems and, for the sake of argument, assuming that either feather collecting or juvenile petrel hunting, or both, were the primary objectives in the occupation of the MPRC shelter sites, an interesting observation can be made regarding Hawaiian social organization and the prehistoric development of chiefdom level societies. Feather adornments were emblems and symbols of rank and status, and the procurement of a special and difficult to obtain but nonessential food such as represented by juvenile petrels also implies hierarchical social differentiation. Both of these points are well established in the

remains in the shelter caves due to preservation problems or transport to the lowlands where the Hawaiian population resided.

It is possible, however, that some of the birds themselves were being transported to the lowlands, perhaps for chiefly food. In this respect, adult petrels are present in the highlands only seasonally and for nesting purposes (Richardson 1957:29). Given the fact that petrel chicks were a special, sought-after chiefly food (Henshaw 1902:120), and that these would have been available during much of the time that the adult birds were taken, it may not be surprising that our MPRC skeletal parts data show a striking absence of juvenile bones. Thus, it is possible that juveniles or nestlings were simply transported to the lowlands for chiefly consumption while the adults were eaten by the hunters in the shelter caves. Although such an interpretation is dependent in large part on negative evidence—the absence of juvenile skeletal remains—it is very difficult to understand how these could have been ignored while the adults alone were hunted. In fact, as Henshaw (1920:120) indicates, petrel chicks were avidly collected:[9]

> They [Hawaiian natives] say also that formerly this bird ['Ua'u] nested in great numbers in the lava between Mauna Kea and Mauna Loa. They have visited the old nesting sites within a year or two, but report that they are no longer occupied, having been invaded by the mongoose. It is said that years ago the nestlings of the uuau ['Ua'u] were considered a great delicacy, and were tabooed for the exclusive use of the chiefs. Natives were dispatched each season to gather the young birds which they did by inserting into burrows a long stick and twisting it into the down of the young which were then easily pulled to the surface.

A potential problem with interpreting all of the avian faunal remains as strictly a food resource for people doing something else in the saddle area is that a relatively large percentage (19% of identifiable bones) of the bird remains are those of the passerine or perching birds. For the most part these are very small birds. As such, they would have offered minimal returns in terms of food for the amount of energy expenditure required to obtain them. As Emerson (1894:110) notes: "While the plumage-birds were of such diminutive size and so difficult of capture that it would not have been profitable to hunt them for food, they were in reality such delicacies for the table, that the hunters were quite willing to use them in that way." Thus, their procurement strictly or primarily for food would not make much sense in energetic terms. Whether this in fact was the case is difficult to evaluate without a better knowledge of the conditions and constraints of hunting petrels and *Nēnē* for which data do not appear to be available.

Yet another interpretation of the avian faunal remains has to do with specialized feather collecting. As is well known, feather adornments, including helmets, capes and cloaks, god images, and *lei*, were very important in traditional Hawaiian society for use as emblems and symbols of rank and status (see Holt 1985). The 7 endemic birds considered as the most desirable for these purposes are listed in Table 7 (Holt 1985:20–33; Emerson 1894:102–103).

9. The breeding cycle of Dark-rumped Petrels on Maui is discussed by Simons (1985). While it is not known if the breeding cycle of the Hawai'i Island population was synchronous with the Maui population, each phase would have required the same amount of time. Most adults arrive to breed in late February, depart again in late March, and return for egg laying between late April and mid-May; eggs hatch in late June through mid-July, nestlings remain in the burrows for about 110 days before fledging in October and departing the islands in November, by which time the adults have already left. This cycle includes roughly 1 month for breeding, 2 months for sitting, 3 months with young in burrows, and 1 month with fledglings present but flying out to sea to feed (during part of which time adults would not be present). Though it is possible that the birds were hunted during the 3 months that adults are present but young are not, there is no apparent reason why this would be so. Also, as the Henshaw quote suggests, petrel chicks were hardly a neglected resource.

ethnographic and ethnohistoric literature (Henshaw 1902; Emerson 1894; Holt 1987). If the reason for the rather sudden onset of increased use of the MPRC beginning about A.D. 1400 was primarily for feather collecting, juvenile petrel hunting, or both, then this date could mark the time when distinctions in rank and status had become increasingly important in Hawaiian society. The MPRC investigations, therefore, suggest that it was approximately at A.D. 1400 that large chiefly societies developed on Hawai'i Island (see also Cordy 1981, ms.; Kirch 1984:243–63, 1985:284–308; Hommon 1976 among others for discussions of the rise of social complexity in Hawai'i).

It is of interest to note Hommon's (1985:61, 65) argument that "large-scale expansion into the inland zone did not begin until the fifteenth century" on Hawai'i Island, and that it was this "inland expansion [that] initiated the development of the *ahupua'a* as a socio-economic unit." Clearly, therefore, the A.D. 1400 time period should mark a period of major change in Hawaiian territorial organization. With the growth and expansion of population and territorial units, evidence for major changes in social organization, particularly the formation of hierarchical chiefdom societies with the elaboration of rank and status differences, would be expected (see also discussion in Kirch 1985:305–6). Data on the timing of the increased procurement of feathers from forest birds or the capture of juvenile petrels in the interior of Hawai'i Island, because of their probable use as symbolic markers of rank and status and/or authority, may provide a means for determining with some precision when these changes in social organization occurred and whether they are coincident with the initiation of the *ahupua'a* system as proposed by Hommon. In this respect, the MPRC data may indicate that the development of large chiefdom societies occurred very quickly during the early A.D. 1400s, a time frame that coincides quite well with Hommon's model.

CONCLUSION

The study of high altitude archaeological sites in Hawai'i has considerable potential for expanding our knowledge about prehistoric Hawaiians. Although the significance of the Mauna Kea adze quarry sites has been recognized for some time, work within the high forest zone has been minimal. With the MPRC investigations it has been possible to greatly expand the available information concerning this neglected area. We believe that we have demonstrated the considerable potential that archaeological sites in this area have for informing us about a very interesting aspect of Hawaiian prehistory. At the same time, however, it is clear that a number of important interpretive problems remain to be resolved before we can confidently say in any comprehensive manner what was going on prehistorically in the highland forests. The possible variety of motivations and apparent range of exploitation strategies as indicated by the MPRC data may well have been much more complex and interrelated with other sociocultural factors than previously appreciated.

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