

The Hawai'i Historical and Archaeological Research and Training Project 2013

Wai'āpuka, Makanikahio 1 and 2 and Pololū Ahupua'a

Michael W. Graves, S. Kekuewa Kikiloi, Mark W. Oxley, Joseph Birkmann, Samuel Kamuela Plunkett, and Kelley Uyeoka

With Contributions by: Kau'ilani Rivera, Kahealani Walker, Nick Ferriola, Ruth Aloua, Paul Duran, Tara Del Fierro, and Jana Morehouse



**SUBMITTED TO: KAMEHAMEHA SCHOOLS, HONOLULU, HI
AND SURETY KOHALA, INC, HAWI, HI**

**UNIVERSITY OF NEW MEXICO, ALBUQUERQUE, NM
JUNE 2014**

Table of Contents

FIGURES	4
TABLES	6
INTRODUCTION	7
OVERVIEW OF WINDWARD KOHALA ARCHAEOLOGY,	9
TRADITIONAL COMMUNITIES (AHUPUA‘A), STREAMS (KAHAWAI), AND BAYS (KŪ‘ONO) OF WINDWARD KOHALA	9
PREVIOUS ARCHAEOLOGICAL RESEARCH	16
FINDINGS OF THE HAWAI‘I ARCHAEOLOGICAL RESEARCH PROJECT FOR WINDWARD KOHALA	18
WINDWARD KOHALA IN THE 19 TH AND EARLY 20 TH CENTURIES	24
KAMEHAMEHA SCHOOLS AND UNIVERSITY OF NEW MEXICO: HISTORICAL DOCUMENTATION, ARCHAEOLOGICAL FIELD TRAINING, AND RESEARCH PROGRAM 2013	30
<i>Place Names and Land Divisions</i>	33
HISTORICAL, ARCHIVAL, AND ARCHAEOLOGICAL SURVEY AND MAPPING RESULTS	39
AGRICULTURAL IRRIGATION TUNNEL AND DITCHES (WAI‘ĀPUKA TUNNEL-WAI 20), IRRIGATED AGRICULTURAL TERRACE COMPLEX (WAI 16), AND HABITATION FEATURES (WAI 20H, 20I)	41
<i>Historical Background</i>	42
<i>Documentation</i>	43
<i>Setting</i>	44
<i>Archaeological Features</i>	45
<i>Wai‘āpuka Tunnel Technology and Dating</i>	51
AGRICULTURAL IRRIGATION COMPLEXES (WAI 21, 23, 39) ASSOCIATED DITCHES, AND HABITATION FEATURES	52
<i>Agricultural Irrigation Complex and Habitation Features (WAI 21)</i>	52
<i>Agricultural Irrigation Complex, Ditch, and Habitation Feature (WAI 23A, WAI 23B)</i>	55
<i>Agricultural Irrigation Terraces, Possible, Ditch, and Gully (WAI 39)</i>	56
<i>Managed or Cultivated Trees (WAI 40) and Habitation Feature (WAI 7), makai Wai‘āpuka</i>	58
<i>Ruth Aloua and Michael Graves</i>	58
<i>Possible Habitation or Other Architectural Feature (WAI 38)</i>	62
THE MAKAI WAI‘ĀPUKA-MANIKAKAHIO IRRIGATED AGRICULTURAL SYSTEM	64
<i>Ridge and Stream Drainage Topography in Relation to Traditional Hawaiian Irrigated Agriculture in Windward Kohala</i>	64
<i>Ridge Lands, Slopes, Stream Channels, and Engineering Irrigation Systems</i>	65
MAKANIKAHIO 1 AND 2 (MAA) AHUPUA‘A STUDY AREA	68
HISTORICAL, ARCHIVAL, AND ARCHAEOLOGICAL SURVEY AND MAPPING RESULTS: MAKANIKAHIO 1 AND 2	73
<i>Agricultural Barrage Terrace System (MAA 12)</i>	74
<i>Possible Ahupua‘a Boundary Alignment and Wall (MAA 13)</i>	76
<i>Managed Tree-Cropping Complex Consisting of Kukui and Hala Trees (MAA 14), Kauhaikulepe Gulch</i>	80
<i>The Kauhaikulepe Complexes in Relation to Mauka Maikanikahio and Coastal Pololū</i>	82
RESOURCES AND TERRITORIES IN HAWAIIAN HISTORY: A GIS-BASED STUDY OF WINDWARD AHUPUA‘A	85
<i>‘Okana or Āpana Ahupua‘a</i>	87
<i>Ethnohistoric Ahupua‘a Resource Holding Potential</i>	89
SUMMARY OF 2013 TRAINING AND RESEARCH PROGRAM	91
HISTORICAL AND ARCHAEOLOGICAL TRAINING	91
<i>Training in Historical Methods</i>	91
<i>Training in Archaeological Methods and Archaeological Archival Materials</i>	93

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

Kohala Community Outreach..... 95
Student Research Projects..... 96
HISTORICAL AND ARCHAEOLOGICAL FINDINGS..... 102
ACKNOWLEDGEMENTS 104
REFERENCES 106
STUDENT REPORTS, HAWAII HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT 2013 112

Figures

Figure 1. Map of north Kohala, Hawai‘i island, featuring the northeastern (windward) ahupua‘a territories.....7

Figure 2. Windward Kohala, showing ahupua‘a boundaries and names.11

Figure 3. Map of windward Kohala showing named drainages, including streams and gulches and embayments.13

Figure 4. Map of major traditional and historical agricultural complexes identified within Pololū Valley, Kohala (from Birkmann 2014; Field and Graves 2008).19

Figure 5. Radiocarbon dates from Pololū and Honokāne Valleys Ahupua‘a, northeastern Kohala, Hawai‘ Island.....20

Figure 6. Calibrated radiocarbon dates from agricultural complexes and habitation features from Hālawa, Makapala, and Niuli‘i Ahupua‘a.....22

Figure 7. Calibrated radiocarbon dates from agricultural complexes and habitation features from Wai‘āpuka, Makanikahio 1, and Makanikahio 2 Ahupua‘a.23

Figure 8. Land Commission (LCA) and Grant awards for Niuli‘i, Wai‘āpuka, Makankahio 1 and 2, and lower Pololū Ahupua‘a.27

Figure 9. Makai Wai‘āpuka study area, windward Kohala.32

Figure 10. Photograph of ki‘ei, an ‘ili ‘āina in makai ‘ili ‘āina. The location likely refers to the top of the slope pictured here.38

Figure 11. ‘Ākoakoa Point, on the cliff above the coast of Wai‘āpuka, adjacent to Neue Bay and a possible location for the gathering of canoes.38

Figure 12. Makai Wai‘āpuka land commission and grant awards with ‘ili ‘āina names placed in their relative locations.39

Figure 13. LiDAR imagery of makai Wai‘āpuka with Lydgate (left) and Loebenstein (right) historical maps overlaid and compared.41

Figure 14. Small hill under which the Wai‘āpuka Tunnel was excavated. Associated irrigated terraces would have been located on the lower slope and in the foreground (photograph by Samuel Kamuela Plunkett).42

Figure 15. Schematic of Wai‘āpuka Tunnel based on Cabot's 1888 drawing, showing number of shafts, a cross-section and plan view of tunnel, ditches, and irrigated terraces.43

Figure 16. Reconstructed plan view map of Wai‘āpuka Tunnel Complex, WAI 20 and WAI 16 and associated irrigation ditches.....45

Figure 17. Photograph of a collapsed shaft associated with Wai‘āpuka Tunnel, showing approximate diameter and depth.46

Figure 18. Photograph of ‘auwai (WAI 20D) leading from Waikama Stream to the entrance of Wai‘āpuka Tunnel.....47

Figure 19. Photograph of barrier wall at east entrance to Wai‘āpuka Tunnel.....48

Figure 20. Maps depicting WAI 16A, irrigated agricultural terraces adjacent to the Wai‘āpuka Tunnel as illustrated on the Loebenstein map and the LiDAR image. Note that LiDAR image shows "waffle-like" grid extending to top of Waikama Stream slope.....49

Figure 21. LiDAR hill slope imagery showing WAI 16, lo‘i complex associated with Wai‘āpuka Tunnel (WAI 20). Note remnant terraces identified as WAI 16B and WAI 16C to the south (mauka) and to the west and north (makai) of WAI 16A.....50

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

Figure 22. Entry to Wai'āpuka Tunnel showing excavation through bedrock of the tunnel passage way.....51

Figure 23. WAI 21, irrigated agricultural terrace complex depicted on Loebenstein map and barely visible on LiDAR imagery. Note possible irrigation ditch extending from the northwest corner of WAI 16A to WAI 21 shown on Loebenstein map.53

Figure 24. 1934 survey map of lo'i and 'auwai by Union Mill & Plantation of WAI 21, LCA 10490, Wai'āpuka. This plot is currently on land owned by Greg Chilton.54

Figure 25. Irrigated agricultural complex, with outline from Loebenstein (1904) and LiDAR of the same area (WAI 23A, WAI 23B).55

Figure 26. Current map of irrigated agricultural terraces in former cane lands (WAI 23A). Most of the individual lo'i are no longer recognizable on the ground (but note comparison to LiDAR image of same location.56

Figure 27. Overview map of irrigated agricultural complex (WAI 39), including upper 'auwai, gully, and lower (cliffline) 'auwai features. A possible dry land field plot is also illustrated57

Figure 28. Lydgate map (1881) and LiDAR image of makai Wai'āpuka archaeological features including the auwai section just above the cliff line (from Plunkett 2013).....58

Figure 29. Google Earth aerial image of historic hala grove (WAI 14) along the cliffline in Wai'āpuka at 'Ākoakoa Point.....59

Figure 30. Remnant hala grove (WAI 40) makai Wai'āpuka59

Figure 31. Dead or downhlala trees (WAI 40), makai Wai'āpuka at 'Ākoakoa Point.60

Figure 32. Map of WAI 35, illustrating the site and the mai'a grove located within and along the talus slope.....61

Figure 33. Large, mature mai'a (banana) tree grove along east talus and cliff of WAI 35.....62

Figure 34. WAI 38, a small walled enclosure with associated rock mound, mauka Wai'āpuka.....64

Figure 35. The Makai Wai'āpuka-Makanikahio Agricultural System in windward Kohala.67

Figure 36. View looking north from Wai'āpuka Tunnel showing the "ridge slopes" of lower Wai'āpuka and the possible directions of auwai supplying water to the WAI 21 complex.68

Figure 37. View of direction that 'auwai from WAI 23 would have taken into WAI 39, the Makai gully agricultural complex in lower Wai'āpuka.68

Figure 38. Upper Makanikahio 1 and 2 Ahupua'a study area in windward Kohala. Note this map needs to be corrected for the names of streams and drainages c.....69

Figure 39. Irrigated agricultural complex, MAA 6 at top of Kauhaikulepe Gulch on property assigned to Kaea in the mid-19th century (Lobenstein 1904).70

Figure 40. Map of MAA 6, an irrigated agricultural terrace complex in the former cane fields above Kauhaikulepe Gulch in upper Makanikahio,along with the lowermost section of MAA 4A, an agricultural irrigation ditch with associated terraces and cleared areas/.....71

Figure 41. Map of the upper, southern section of MAA 4A, an irrigation ditch that extended off of the west side of Waiakalae Stream in Upper Makanikahio 2 Ahupua'a.73

Figure 42. Top view of a kukui grove within lower Kauhaikulepe Gulch in Makanikahio Ahupua'a..74

Figure 43. Map of MAA 12, an irrigated and dryland agricultural terrace complex, along with managed zones of tree-cropping within Kauhaikulepe Gulch.75

Figure 44. Map of MAA 13, showing rock alignment and retaining wall alsong with associated masonry features on the east upper slope of Kauhaikulepe Gulch.76

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

Figure 45. MAA 12 and MAA 13, a related agricultural and habitation areas adjacent to a possible ahupua'a boundary wall complex.80

Figure 46. View from west of kukui grove within Kauhaikulepe Gulch on its west slope.....80

Figure 47. Representative view of complex of kukui nut trees growing within Kauhaikulepe Gulch.81

Figure 48. Newly sprouted kukui nut trees growing within the MAA 14 complex.81

Figure 49. Reconstructed irrigation and agricultural system linking upper Manikahio to lower Pololū (from Birkmann, 2014).83

Figure 50. Windward Kohala ahupua'a grouped into five hypothesized 'okana or āpana ahupua'a based on criteria developed by Ladefoged and Graves (2006).88

Figure 51. Correlation of total stream length against land area for the five 'okana or āpana ahupua'a in windward Kohala.88

Figure 52. Correlation of total weighted coastal length against land area for the five 'okana or āpana ahupua'a in windward Kohala.89

Figure 53. Windward Kohala ahupua'a by land area, total stream length of associated drainages, and weighted coastal access (from Ferriola 2014).90

Tables

Table 1. Listing of windward Kohala ahupua'a, associated drainages, embayments, and estimated areas.14

Table 2. List of LCA and Grant awards for Wai'āpuka and Makaanikahio 1 and 2 Ahupua'a, windward Kohala, derived largely from Uyeoka et al. 2013.28

Table 3. Partial listing of place names from Wai'āpuka and their possible lexical meanings.34

Introduction

Michael Graves, Kekuewa Kikiloi, and Kelley Uyeoka

This report describes archaeological field training and research in windward (northeastern) Kohala, Island (Figure 1) of Hawai'i during 2013 conducted by the University of New Mexico and University of Hawai'i at Mānoa under the co-direction of Dr. Michael Graves, Dr. Kekuewa Kikiloi and Ms. Kelley Uyeoka. This Program differs from recent years in that it was sponsored by the Kamehameha Schools and involved the training of seven advanced students in historical and archaeological field techniques and methods. Training focused on preparation of students for careers in cultural resource management and historic preservation. Fieldwork in 2013 was conducted from June 3 through July 4 and then again from October 12-18. The focus of this fieldwork was on the ahupua'a (territories of traditional Hawaiian communities) of Wai'āpuka Makanikahio 1 and 2, and to a lesser extent Pololū located in the northeastern (windward) portion of Kohala. This area is defined by a series of smaller stream gulches (valleys), some of which flow perennially. They lie immediately to the west of the much larger Pololū Valley and extend to the north and west to the tip of the Kohala peninsula. This report follows the format of several earlier reports (Field and Graves 2008; McCoy and Graves 2007, 2008, 2009; Graves et al. 2012, 2013) and builds on their findings as well.

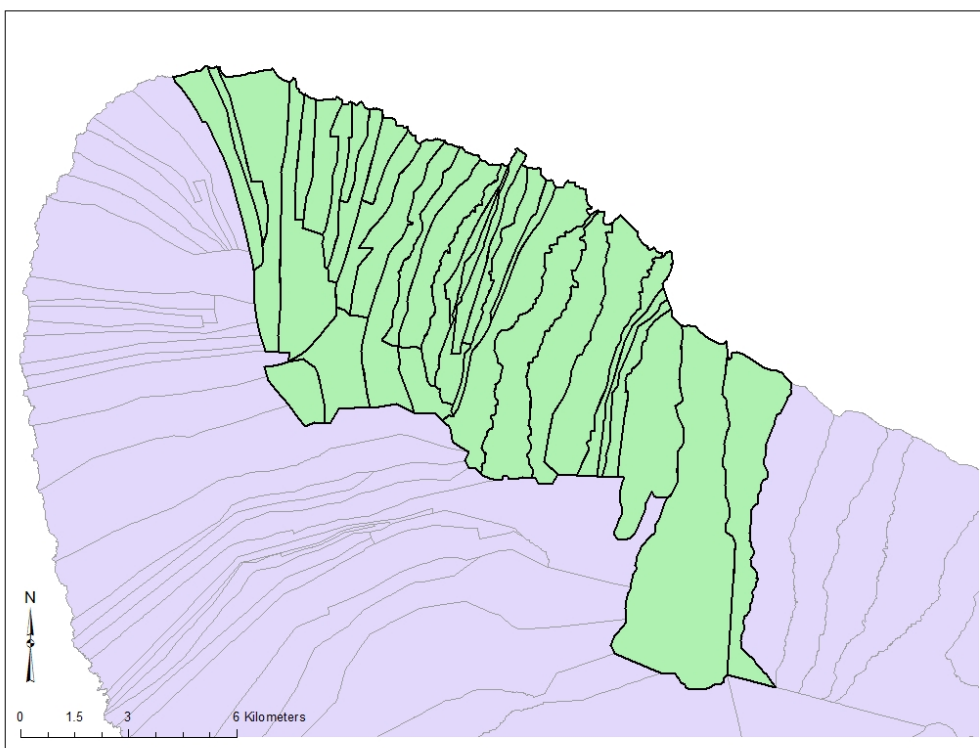


Figure 1. Map of north Kohala, Hawai'i island, featuring the northeastern (windward) ahupua'a territories.

Fieldwork in windward Kohala by the Hawai'i Archaeological Research Project (HARP) began in the summer of 2006 as part of a National Science Foundation supported archaeological field training

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

program. Thus far, members of this project have surveyed in a number of ahupua'a in this area, including the aforementioned communities along with portions of 'Iole, Hālawā, Niuli'i Makapala.

The goal of the research component of this program has been to reconstruct traditional and prehistoric agricultural practices in the windward gulches and valleys and adjacent ridge tops (tablelands). We have also utilized archival documents, both historical maps and previously documented archaeological sites (primarily from Pololū and Honokāne) to supplement field research. The historical maps developed between 1880 by Lydgate and 1904 by Loebenstein depict remnant traditional agricultural fields. Many of those fields, especially those on the ridges (or tablelands) separating drainages or in secondary drainages to the main gulch streams, were converted in the late 19th and early 20th centuries to sugarcane production. As a result, they have largely been obliterated on the land surface. Nonetheless, a number of these fields remain somewhat intact or evident when viewed through aerial means (Google Earth, LIDAR imagery), surface configurations, or subsurface excavations. We have also compiled Land Commission Award data for windward and leeward Kohala using a 1910 map for North Kohala, along with the official records. The historical record provides an endpoint between the early 19th and mid-20th centuries on land ownership and use in windward Kohala, often at the scale of individuals and smaller plots of lands that they were given or came to own. Much of the land was eventually purchased for sugar cultivation.

Beginning in 2011 H²ARP researchers have expanded their survey areas to include several drainages of gulches, a number of secondary drainages, and in areas farther upslope in ridge tops that were never converted to sugarcane. We discovered preserved archaeological features and complexes, many of them linked to traditional agriculture or to the former Hawaiian inhabitants of windward Kohala. These features and complexes are generally in better condition, display greater continuity, and illustrate aspects of agricultural and residential practices that can only be partially reconstructed in areas at lower elevations converted to sugar cane agriculture.

Where we have surveyed or recorded agricultural complexes, habitation features have been documented, and in a few instances, locations that may have held ritual importance (as evidenced by possible burials or heiau). The descriptions and locations of ritual sites will be included in copies of this report that are turned over to landowners.

Field research has focused on documentation of surface features and only limited excavations have been conducted, primarily to recover charcoal samples from beneath retaining walls for wood or other plant identification and ¹⁴C dating. Beginning in 2009 we periodically employed a backhoe to search for possible buried agricultural terraces and irrigation ditches in Hālawā, Makanikahio and Wai'āpuka. This has proved to be effective at testing areas where little or no surface archaeological or cultural remains are evident. Elsewhere, we have relied upon archival data including the two major historic maps that depict locations of taro fields under cultivation at the time each map was completed, as well as house sites, sugar cane plantation fields, roads and railroad tracks, and related milling and processing complexes. These two historic maps also suggest the extent to which traditional irrigated agricultural locations were lost between the late 19th and early 20th centuries. Archival work with archaeological maps and collections from Pololū and Honokāne

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

Valleys has provided us with relatively complete documentation of all surface features in these ahupua'a.

Training of undergraduate and graduate students in archaeology has always been a major focus of the field and research program in windward Kohala. The Program began as a NSF REU Site and more than 30 undergraduate students from across the US and Hawaii was trained during this time. Beginning in 2009, after the completion of the NSF funded Program, we shifted to a UNM sponsored archaeological field school, and beginning in 2010, the Program scaled down to provide training to a much smaller group of graduate students from the University of New Mexico. With funding from Kamehameha Schools in 2013, the Program has been re-envisioned to train Native Hawaiians along with a few undergraduates from UNM who wish to pursue professional careers in archaeology or as cultural resource managers. We also attempted to integrate the historical materials for the area with the archaeological record we had been documented both for training purposes and to guide research. All of the students in 2013 completed the first phase of their research projects in the month of June we spent in Kohala, and then returned to Honolulu in October with updated and revised project results to present at a professional conference as papers and posters (see the Appendix 1. del Fierro 2013; Ferriola 2013; Plunkett 2013; Rivera 2013; Walker 2013).

Overview of Windward Kohala Archaeology,

Michael W. Graves, Kekuewa Kikilo, Kelley Uyeoka, Mark Oxley, Joseph Birkmann, and Nicholas Ferriola

Traditional Communities (Ahupua'a), Streams (Kahawai), and Bays (Kū'ono) of Windward Kohala

Windward Kohala consists of a relatively incised landscape comprising steep-sided, narrow valleys (often called gulches) and a few true valleys with ridges between, and extending to the uplands where the Kohala Mountain forms a western and northern boundary. Rainfall is abundant in this part of Kohala, ranging from ca. 1200-1500 mm at the coast to more than 3000 mm in the mountains. The ridge tops separating the gulches on the western end of this area were mostly converted to sugarcane cultivation in the late 19th and early 20th centuries to about 1200' above sea level. Streams (or kahawai) can be found in the upper reaches of most drainages but may disappear before reaching the coast, particularly in the smaller gulches in the western portion of windward Kohala and in lower Pololū Valley where perennial stream flow is absent. The Pololū stream reappears as a large marsh behind a coastal sand dune. Stream flow can vary considerably depending upon rainfall and location in windward Kohala. During times of sustained and/or heavy rainfall, stream flows can increase significantly and some drainages that do not support perennial streams at the coast may have water flowing at these times.

The naming of traditional communities, streams (and parts thereof), and the bays (or kūono) into which the streams flow) in windward Kohala has produced a welter of Hawaiian terms. Because these names derive from no later than the historical, post-European contact period, they are treated as "archaeological", that is, referring to places, territories, and streams that likely predate

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

the arrival of Europeans to Hawai'i in the late 18th century. Ahupua'a communities and their associated territories are one of the building blocks of prehistoric and historic Hawaiian culture and society (Handy and Pukui 1958; Hommon 1986). Often depicted as containing all of the resources, especially foods, needed by Hawaiians to maintain themselves, they have been described as autonomous, endogamous, and sustainable units of organization. An estimated 35 traditional Hawaiian communities are known for windward Kohala (Figure 2); these were recorded and mapped in the mid to late 19th century (and appear today on USGS topographic maps). Territorial boundaries do not always match across different maps and some boundaries are discontinuous because there were no informants available (or willing) to confirm these locations. Recent research (Ladefoged and Graves 2006; Ladefoged et al. 2008), however, suggests the size and hence the boundaries for ahupua'a were dynamic and more varied in the past. In some instances early communities were established over larger areas that in turn were sub-divided into smaller areas. This pattern has been documented in leeward Kohala (Ladefoged and Graves 2006) and this dynamic of territory partitioning describes the pattern of ahupua'a territorial boundaries in windward Kohala. Native Hawaiian terms for these larger territories may include 'okana or kalana.

Beginning at the north and west and continuing eastward on the Kohala peninsula the named ahupua'a are: Kealahewa, Hualua (sometimes divided into two areas), Kāhei (sometimes divided into three or four areas), Ka'auhuhu, Hāwī, Pāhoa, Honomaka'u, Kapu'a, Pūhuehu, Lā'umama, Hana'ula, Honopueo, Kapa'au, 'Āinakea, 'Iole, Hala'ula, Ma'ulili, Pueke, Kukuiwaluhia, 'Āpuakaohau, Halelua, Napapa'a, Hālawa (HLW), 'A'amakāō, Makapala (MAK), Niuli'i (NIU), Wai'āpuka (WAI), Mekanikahio 2 (MAA), Mekanikahio 1 (MAA), Pololū (POL), Honokāne, and 'Āwini. There are three "capping" inland ahupua'a, Pu'uokamau, Nunulu Iki and Nunulu Nui, whose territories slope towards windward Kohala and hence are included here. They cap several windward communities whose boundaries extend down to the coast: Ka'auhuhu, Kāhei, Honopueo, Kapa'au, 'Āinakea, and 'Iole. While the boundaries separating ahupua'a were mapped historically, they are best considered to be rough proxies for the original territories. The boundaries separating the easternmost communities of Hālawa and 'A'amakāō, the communities of Makapala, Niuli'i, and Wai'āpuka, and Mekanikahio 1 and Pololū are not completely known or shown on most maps. On some historical documents there is an additional ahupua'a known as Auau situated between those of Wai'āpuka, and Mekanikahio 2 (Iao 1910; Loebenstein 1904). It is also referred to in a number of the testimonies for the Land Commission Awards.

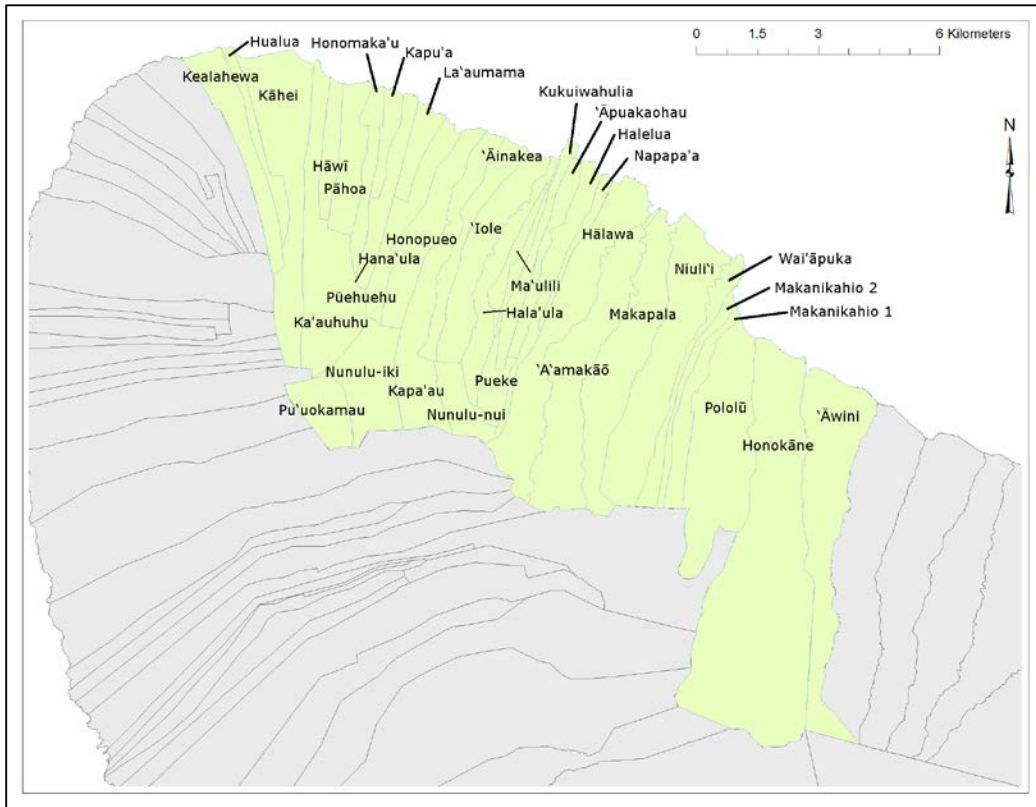


Figure 2. Windward Kohala, showing ahupua'a boundaries and names.

In leeward Kohala rainfed agricultural resources likely varied in their abundance and predictability across ahupua'a. Windward Kohala communities also varied in terms of their size, access to irrigated and wetland agricultural resources, and differed in fields' proximity to the coast, predictability of stream flow, and the extent of irrigation or other water control facilities. Based on the historic maps (Lydgate 1881; Loebenstein 1904) for portions of windward Kohala, communities also varied in terms to the extent to which irrigated agricultural complexes were placed on the ridge tops (or tablelands) or used secondary drainages that cut through the tablelands. This finding needs better documentation since by the time the first historic maps showing traditional agricultural locations were completed large areas for sugar cane production had already been established and likely obliterated the surface features of such complexes. Also by this time, many of the land parcels acquired by Hawaiians through the conversion to fee simple title through the Mahele process, had been lost or sold to the owners of the sugar companies.

The association of gulches and streams with ahupua'a in windward Kohala is complex. While there are several communities whose boundaries do not appear to have overlapped with named drainages many ahupua'a boundaries extend across or incorporate multiple independent drainages. In several instances, where a named gulch branches in the uplands, names were associated with each branch. Table 1 lists the ahupua'a and the named drainages with which they are associated. These are illustrated in Figure 3. The various independent gulches or valleys vary in their size, catchment area, and the amount of water flowing in the main drainage stream. Stream flow is a function of rainfall, which increases from west to east in windward Kohala. Generally, gulches are shorter in total extent (from coast to uplands) to the west (e.g., Lipoa in Hāwī), and

THE HAWAII'Ī HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

longer to the east (e.g., Waikama in Wai'āpuka) where there is more likely to be perennial stream flow to the coast. Some gulches support stream flow only at higher elevations. Springs are unevenly distributed and poorly documented throughout the drainages but do occur in East Hālawā and in secondary drainages to Waiakalae. Three gulches, Waiakala'e, Kapaloa, and Kuahaikulepe on the far eastern boundary of Makanikahio 1 drain into Pololū Valley rather than to the coast. The first two are perennial streams above Pololū. The uppermost reaches of several gulches cross or originate in the upper elevations of a few leeward Kohala ahupua'a (e.g., Puakāne, and Waikama in Kehena 2). Note that in many cases the drainage and catchment of a single gulch may incorporate multiple windward communities. There are seven named bays located in windward Kohala, from the north and west to the east and south, they are: Keawaeli ('Iole Ahupua'a, Pali Akamoa and Waianaia Gulches); Hapu'u (Hālawā Ahupua'a and Hālawā Gulch); Kapanāia ('A'amakāō and possibly Makapala Ahupua'a, Walaohia and 'A'amakāō Gulches); Kēōkea (Niuli'i and Makapala Ahupua'a, Waikani, and Niuli'i Gulches), Neue or Naue (Wai'āpuka and Niuli'i Ahupua'a, Waikama Gulch); Pololū (Pololū Ahupua'a, Pololū Stream and tributaries), and Honokāne (Honokāne Ahupua'a, Honokāne Iki Stream, Honokāne Nui Stream). Smaller embayments can be seen for many of the streams and drainages that flow into the ocean; for ease of locating them, we have given them the Hawaiian names of the respective gulches.

Several of the leeward ahupua'a have mauka (inland) territories that extend onto the eastern slopes of the Kohala Mountains and thus are technically within windward Kohala. These include: Kahena Nui, Kahua Nui, Kahua Iki, Kalala, Pohakulua,. The significance of such boundaries extending into the windward zone from the leeward area of Kohala is unclear. At these elevations and rainfall levels, permanent agricultural production would have been limited. Presumably, groups living in these leeward ahupua'a would have been able to access water and forest resources in the mountains but it would not have been possible in most cases to transport water from the eastern slopes to the leeward, western slopes. Still the lack of perennial streams in leeward Kohala would have made the upper reaches of streams in windward Kohala a reliable source of water for leeward groups, especially those living in the uplands and working in the Leeward Kohala Field System.

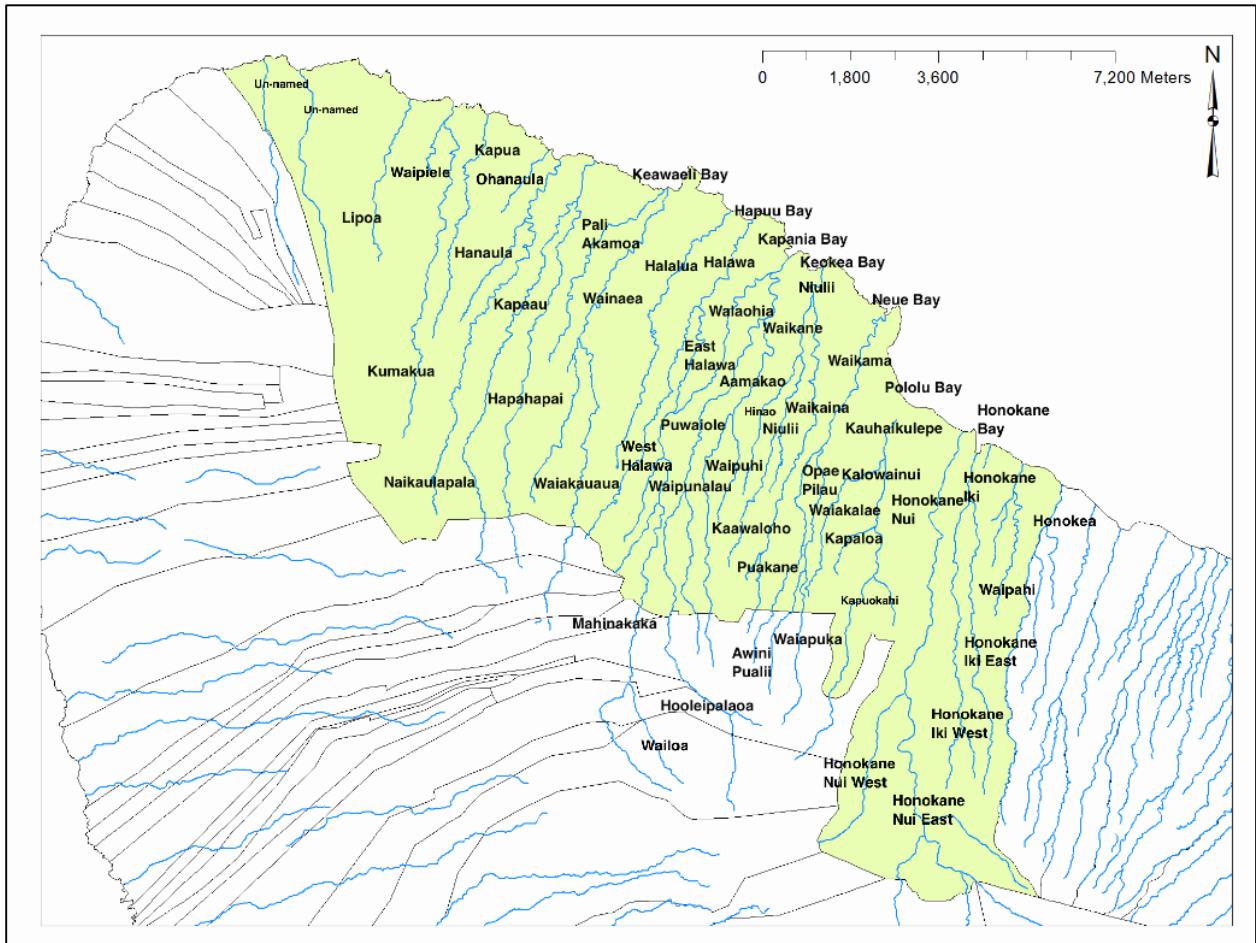


Figure 3. Map of windward Kohala showing named drainages, including streams and gulches and embayments.

There is considerable variation in the area of the 35 windward ahupua'a, (see Table 1) from less than 0.50 km² (Makanikahio 2) to more than 19 km² (Honokāne). Larger ahupua'a tend to be associated with named bays and several different named gulches or streams, suggesting that these were early established locations for both habitation and farming. The smaller ahupua'a may have little or no coast, and what they may have would be mostly cliff lines.

Since 2006, HARP (now retitled H²ARP in 2013) field research has focused on the easternmost gulches and ahupua'a of windward Kohala: Hālawā, 'A'amakāō, Makapala, Niuli'i, Wai'āpuka, Makanikahio 2, and Makanikahio 1. Archival research that employed previous archaeological studies extends this research to Pololū and Honokāne. Sugar cane plantation agriculture was assumed to have destroyed much of the prehistoric archaeology and traditional Hawaiian sites in the area. Fortunately, within the gulches and side drainages and especially above the area where sugar cane was planted a considerable and generally well-preserved array of archaeological sites can be found. For the most, these are agricultural complexes that include terraces, irrigation ditches, and other water control features, and less often habitation and ritual sites. In 2006 and again in 2013, we conducted archival research on the history and archaeology of Pololū Valley, adjacent to the easternmost "gulch" ahupua'a of Makanikahio 1.

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

Table 1. Listing of windward Kohala ahupua'a, associated drainages, embayments, and estimated areas.

	Ahupua'a	Gulches/Valleys	Bays (Kūono)	Area (km²)
Aamakao	'A'amakāō	Walaohia	Kapanaia (Kapana)	7.06
		Mahinakaka		
		Puwaiele, Paliuli		
		Ho'oleipalaoa		
		'A'amakāō		
		Waipunalau		
Ainakea	'Āinakea	Hapahapai	<u>Coast No Bay</u>	2.18
		Wainaia		
Apuakaohau	'Āpuakaohau	Halelua	<u>Coast No Bay</u>	1.19
Awini	'Āwini	Waipani, Waipahi	Waipani	8.00
		Honokāne Iki East		
		Honokea		
		Kalele		
Halaula	Hala'ula	Waianaia	Keawaeli	2.45
		Waiakauaua		
Halawa	Hālawa	West Hālawa	Hapu'u	6.42
		East Hālawa		
		Waiaohia		
		Mahinakaka		
		Kauauai		
Halelua	Halelua	Halelua	Halelua	3.03
Hanaula	Hana'ula	Ohana'ula	Ohana'ula	2.53
		West Hālawa		
		Waikuiapaia		
Hawi	Hāwī	Lipoa	Lipoa	1.29
Honokane	Honokāne	'Āwini	Honokāne	19.03
		Honokāne Iki		
		East Honokāne Iki		
		West Honokāne Iki		
		Honokāne Nui		
		East Honokāne Nui		
		West Honokāne Nui		
Honomakau	Honomaka'u	Waipiele	Kumukua	1.46
		Kumukua, Kumakua		
Honopueo	Honopueo	Hana'ula	Hana'ula	3.30
		Kapu'a		
		Waikaulapala, Naikaulapala		
		Kapa'au		

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

Hualua	Hualua	<u>Unnamed Drainage</u>	<u>Unnamed Bay</u>	1.08
Iole	'Iole	Pali Akamoa	Keawaeli	3.86
		Waianaia, Wainaea		
Kaauhuhu	Ka'auhuhu	Lipoa	<u>Coast No Bay</u>	6.52
Kapaau	Kapa'au	Kapa'au	Kapa'au	4.88
		Hapahapai		
		Naikaulapala		
Kapua	Kapu'a	Kapu'a	<u>Unnamed Bay</u>	0.91
Kealahewa	Kealahewa	<u>Unnamed Drainage</u>	<u>Unnamed Bay</u>	2.99
Kukuiwaluhia	Kukuiwaluhia	East Hālawā	<u>No Coast</u>	1.37
Kahei	Kāhei	<u>None</u>	<u>Coast No Bay</u>	6.37
Laumama, Laaumama	Lā'umama	Hana'ula	Hana'ula	0.95
Makanihahio 2	Makanihahio 2	Waiakalae, Kapuaikahi	<u>Coast No Bay</u>	0.93
		Kuahaikulepe		
Makanihahio 1 (Aua)	Makanihahio 1	Waiakalae	<u>Coast No Bay</u>	0.49
		Kuahaikulepe		
		Possibly 'Ōpaepilau		
Makapala, Maekapala	Makapala	Hinao	Kēōkea	5.59
		Waikani		
		Waipuhi		
		Waipunalau		
		Mahinakaka		
Maulili	Ma'ulili,	Waiakauaua	<u>No Coast</u>	0.82
Napapaa	Napapa'a	<u>None</u>	<u>Coast No Bay</u>	0.58
Niulii	Niuli'i	Niuli'i	Neue (Naue)	7.06
		Ka'alaloho		
		Waikane		
		'Ōpaepilau		
		Puakane		
		Hinao		
		Waikama		
		'Āwini Puali'i		
Nunulu Iki	Nunulu Iki	Waiakauaua	<u>No Coast</u>	3.51
		Waianaia		
		West Hālawā		
Nunulu Nui	Nunulu Nui	Waikaulapala	<u>No Coast</u>	1.52
		Kapa'au		
Pahoa	Pāhoa	Waipiele	Kumukua	3.09
		Kumukua, Kumakua		
Pololu	Pololū	Pololū	Pololū	7.73
		Waiakalae, Kalowainui		

THE HAWAI‘I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

		Kalawao, Kalowai iki		
		Kapoloa, Kapaloa		
		Kuahaikulepe		
Pueheuhu	Pūehuehu	Kapu‘a	Kapu‘a	1.77
Pueke	Pueke	Waiakauaua	Keawaeli	0.72
Puuokamau	Pu‘uokamau	<u>None</u>	<u>No Coast</u>	1.92
Waiapuka	Wai‘āpuka	Waikama	Neue (Naue)	2.14
		‘Ōpaepilau		
		‘Āwini Puali‘i		
		Wai‘āpuka		
		Waiakalae (Wai‘akalae or Waikala‘e)		

Previous Archaeological Research

Archaeological field research in windward Kohala began with H. David Tuggle’s work in Pololū and, Honokāne Nui, Honokāne Iki, and ‘Āwini Valleys (Tuggle 1976; Tuggle and Tominari-Tuggle 1980). This project was seen as a complement to the University of Hawai‘i archaeological research at coastal (Griffin & Tuggle, 1973) and upland (Rosendahl 1972, 1994) Lapakahi Ahupua‘a on the leeward (western) side of Kohala. Since then relatively few archaeological surveys have been done in windward Kohala, with the exception of partial inventory surveys done at Kapa‘au (Erkelens & Athens, 1994a), Wai‘āpuka (Erkelens & Athens, 1994b), and ‘Iole (T. R. Wolforth 2003, 2008, 2009).

M. Tominari-Tuggle (1988) completed an overview of the cultural and historical resources of North Kohala that is the most comprehensive review of the area’s history and archaeology. At the time, the main archaeological study was that completed by H. David Tuggle (Tuggle, 1976) in the valleys of Pololū, Honokāne Nui, Honokāne Iki, and ‘Āwini. For Pololū, Tuggle documented a number of habitation loci across the back face of the large sand dune that reaches nearly across the entire mouth of the Valley at the Coast. Other habitation features, both prehistoric and historic, are located in the lower portion of the Valley usually adjacent to the lower slopes. Tuggle’s work also provides the most completely documented array of agricultural features in Hawai‘i. He mapped the extensive dryland agricultural terraces and alignments in Pololū, along with the smaller array of irrigated terraces. Although Tuggle noted the occurrence of terraces in the large marsh just inland from the coastal dune in Pololū, Tominari-Tuggle identified a map of historic rice fields in the marsh cultivated by immigrant Chinese. As she (Tominari-Tuggle, 1988) suggests, many of these terraces likely correspond to where taro was traditionally grown in the valley. Although not as well mapped, Tuggle also documents a number of archaeological in upper Pololū, Valley, above the waterfall at the back of the lower Valley. These include historic camp sites and other features associated with the construction of the Kohala Ditch in early 20th century, although Tuggle also identified a number of agricultural and habitation features on either side of the stream within the narrow confines of the upper Valley. In Honokāne, Tuggle mapped numerous smaller irrigated agricultural terrace complexes along with habitation features, extending several kilometers into the main valley of Honokāne Nui and Honokāne Iki.

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

Archival sources for northeastern Kohala include historical materials and maps, some of which date to the late 18th and early 19th century. These historical materials include oral traditions and accounts that extend history into a period that otherwise would only be knowable from archaeological materials. Archival sources also include previous archaeological research in Kohala—field notes, maps, inventory lists, and archaeological materials from excavations. For windward Kohala these come almost exclusively from Tuggle's field research, his unpublished report, reports by various students in his field schools, and more recently by students in the NSF funded REU Site program (from 2006-2009). As part of that program, in 2006, Julie Field identified charcoal remains from Tuggle's excavations that were not previously dated and potentially recovered from early prehistoric contexts. This included stratified deposits from habitation occupations on the large dune at the front of Pololū Valley and several agricultural complexes located in the lower valley that had only limited reliable chronometric dating. In 2010, Graves recovered additional charcoal materials from other agricultural contexts not only in lower Pololū but in the upper Valley and from habitation and agricultural contexts from Honokāne Nui. These materials were identified to taxa by Gail Murakami from IARII, Honolulu, HI and have been dated. We (Field and Graves, 2008) published the first array of ¹⁴C dates (both conventional and AMS) on known charcoal materials. A former undergraduate from the University of Hawaii, Mark Oxley and his colleagues (Oxley, et al. 2008) conducted a macroscopic and geochemical analysis of basalt artifacts from Tuggle's research and potential source materials from Pololū, as part of his honors thesis and REU site project (Oxley, 2006) There is a known adze quarry within lower Pololū and materials from this quarry site have been studied by archaeologists. Students from the REU Site program completed several studies, including a reconstruction of the hydrology of Site 4838, a combined dryland and irrigated complex (Espiritu, 2007); in Pololū; the array of agricultural complexes in lower Pololū (Graves et al., 2007), the historic artifacts from the Pololū Dune sites (Graves et al., 2006), and several historic habitation complexes within the lower Valley. Elsewhere, students have studied the Land Commission and Royal Patent awards from the mid-19th century that converted ownership to fee simple property (Richards, Calugay, McCoy, & Graves, 2007) and have compiled ¹⁴C dates from previous archaeological projects on Hawaii Island.

Substantial archaeological research has been conducted in leeward Kohala in both coastal and upland settings over the past 15 years, the result of several large projects (see Field et al., 2007; Field et al., 2011; Kirch 2010, Ladefoged and Graves 2008, 2010). Large sections of the coast have been surveyed and mapped, first as part of a state-wide survey (Bonk 1969)), and then as a result of a number of development projects in Kahua and Waika (Allen 1985; Graves and Franklin 1998), Kaiholena (Dye 2003), Puakea (P. Rosendahl 1983) and as part of the NSF funded Hawaii Ecodynamics Project (Field et al. 2007; Field et al. 2011). The upland Kohala Dryland Field System has been mapped in several contiguous areas across the following ahupua'a: Kahua Iki, Kahua Nui, Pahinahina, Makiloa, Kalala, Pohakulua, Kehena, and Kaiholena. Other surveys have been done in the upland portion of Lapakahi, Mahuknona, and Kukuipohu (Hammatt and Borthwick 1986; Newman 1970; O'Hare and Goodfellow 1994; Wulzen and Goodfellow 1995).

As a consequence, much is now known about the settlement of leeward Kohala, the development of dryland agriculture, community organization and ritual systems linked to upland heiau, as well as the physical parameters of rainfall, elevation, temperature, and soils on agricultural production

across the more than 60 sq km of the field system. Much less is known about the prehistory of windward Kohala.

Graves and his colleagues have conducted surveys, site mapping and recording, and limited test excavations at a number of archaeological complexes across ahupua'a that encompass several smaller drainages (or gulches) to the west of Pololū. These now include 'Iole, (Field & Graves, 2008c), Halawa (McCoy and Graves 2007; Field, Graves and Stephen 2008a), Makapala (McCoy & Graves, 2007), Niuli'i (McCoy & Graves, 2007), Wai'āpuka (Graves, et al. 2012; McCoy and Graves 2008), Makanikahio 1 (Graves, et al. 2012), and Makanikahio 2 (Graves, et al. 2012). This work has integrated the use of historical maps showing former agricultural plots and other cultural sites, with new surveys and the discovery of additional agricultural complexes, and habitation and ritual sites. Most recently the focus has been on the ahupua'a of Makapala, Niuli'i, Wai'āpuka, Makanikahio 1 and 2 where a variety of agricultural complexes have been documented in different landscape settings along, adjacent, and above Niuli'i-Waikane, Waikama-'Ōpaepilau, and Waiakalae Streams.

Findings of the Hawai'i Archaeological Research Project for Windward Kohala

A number of publications and presentations represent the various strands of the archaeological research conducted in windward Kohala by HARP since 2006. Here we summarize the work in relation to several themes: 1 the timing and nature of agricultural development in windward Kohala; 2 the nature of innovations in agricultural practices and technology; 3 the spatial organization of linked agricultural complexes 4 settlement patterns and land use; and 5 development of socio-political complexity through the time of Kamehameha I.

We have now compiled more than 50 ¹⁴C dates for windward Kohala, most from contexts that reflect agricultural practices. For Pololū, and Honokāne there are 20 dates, four of which were reported by Tuggle and Tominari-Tuggle (1980) but for only Pololū. The new dates extend and elaborate our understanding of the settlement and agricultural development of both valleys, although Pololū is still much better represented among these dates. Pololū was mapped by Tuggle (1976) and this map was updated by Field and Graves (2008) to include the historic and likely prehistoric irrigated agricultural complex (POL 4800) located within the marsh area at the mouth of the valley (Figure 4). This marsh supported the single largest wetland complex in windward Kohala, more than 5 ha in size. These fields were converted to pond field rice agriculture in the early 19th century by Chinese farmers.

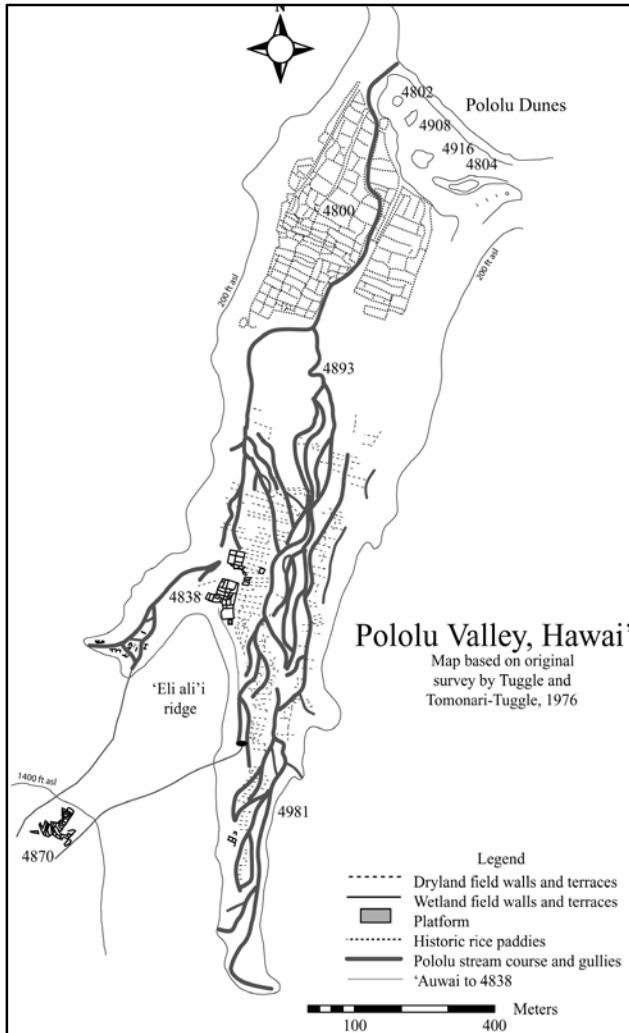


Figure 4. Map of major traditional and historical agricultural complexes identified within Pololū Valley, Kohala (from Birkmann 2014; Field and Graves 2008).

Several of the earliest dates come from the Pololū Dune site excavations of habitation features or deposits (Field and Graves 2008) and extend the earliest, well-established occupation in Kohala to approximately AD 1200-1300 (see **Figure 5**). Given the proximity of the dune to the coastal marsh just inland from it, this would probably date the beginning development of the marsh for taro production. Elsewhere in the lower Pololū Valley dry land or rain fed agriculture dominated the landscape as can be seen on the map (Figure 4) derived from Tuggle's work.

The earliest date on dry land agriculture in Pololū is from a buried agricultural wall in a dry land complex (POL 4893) in the lower Valley and is bracketed to the late 13th century. For Honokāne, the earliest date for occupation and agriculture is AD 1400-1500 from a habitation complex associated with the largest irrigated terrace complex near the front of the valley. Agricultural complexes (e.g., POL 4852) are also found in the Upper Pololū Valley above the waterfall at the back of the valley. The western boundary of Pololū extends to the upper slope (adjacent to Makanikahio 1) where Tuggle recorded an agricultural and habitation complex (Site 4870). A single ¹⁴C date from this site places its use to AD 1500 or thereafter (Birkmann, An Irrigated Agricultural System Linking Makanikahio and Pololū Ahupua'a , Hawaii'i Island:, 2014). Tuggle also dated a

buried wall for dry land agriculture adjacent to the Pololū Adze Quarry site to AD 1450-1600 (Tuggle & Tominari-Tuggle, 1980). The conversion to irrigation of a section of the dry land agricultural complex at POL 4838 is dated no earlier than about AD 1700 (Field & Graves, 2008), although this area was under dry land cultivation as early as AD 1400-1500. This complex was linked by an irrigation ditch back to a waterfall that flows down the west cliff line, just below POL 4870.

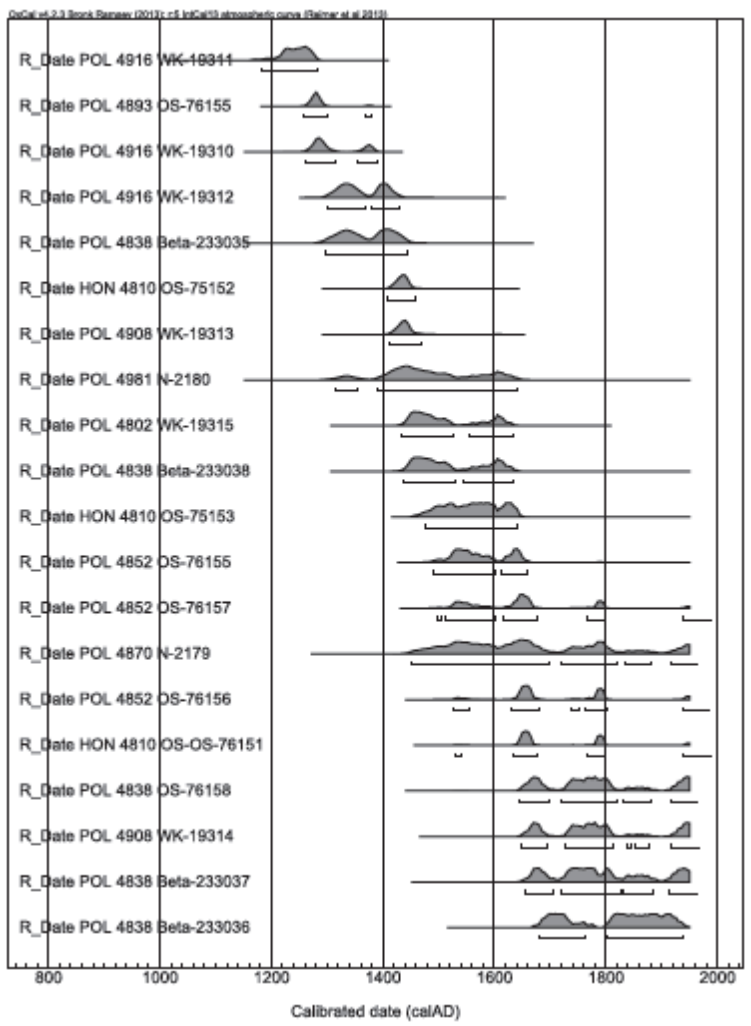


Figure 5. Radiocarbon dates from Pololū and Honokāne Valleys Ahupua'a, northeastern Kohala, Hawai'i Island.

Elsewhere in windward Kohala, we have more than 30 ¹⁴C dates from agricultural complexes and habitation sites in Hālawa, Makapala, Niuli'i, Wai'āpuka and Makanikahio 1 and 2 Ahupua'a (see Figures 6 and Figure 7). Sixteen dates are reports from Hālawa, Makapala, Niuli'i, and include the earliest directly dated agricultural complex at HAL 29L in Hālawa Gulch. Here, we have excavated a deeply buried and stratified agricultural terrace was established early in the 13th century and rebuilt several times over the next 400-500 years (McCoy et al. 2010; McCoy, Browne Ribero, et al. 2013) and continued in use through the late 19th century where it is depicted on a historic map (Lydgate, 1881). Radiocarbon dates on various terrace complexes in lower and upper Hālawa suggest rapid expansion of irrigated agriculture through the 15th and 16th centuries. A large "chiefly" irrigated complex in lower Hālawa is dated to the 16th and 17th centuries and was likely in

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

use until the 19th century. On Lydgate's (1881) map there is nearly a continuous area of developed irrigated agriculture from Hapu'u Bay to the Government Road, a distance of over 1 km. In a number of locations, traditional agricultural complexes first documented by Lydgate in the late 19th century are absent from Loebenstein's map completed in the early 20th century. Much of this can be attributed to the purchase of many former Hawaiian lands by planters and their conversion to sugar cane cultivation. Even where cultivation did not extend into the gulches proper, often traditional plots were abandoned as water for irrigation was diverted to sugar.

In Makapala and Niuli'i, we have dates from both coastal and upper valley agricultural contexts. The coastal complex (NIU 1) located in Makapala is similar, although larger in size and scale, to the "chiefly" complex in Hālawā and also dates to between AD 1500-1600 (Graves et al. 2011; Field and Graves 2008b). Just upstream from NIU 1 is a second irrigated terrace complex, NIU 30, whose irrigation supplies water to the coastal complex via a ditch excavated into the slope bedrock for a distance of 200 m. A number of dates from a large irrigated agricultural complex in upper Makapala as well as NIU 30 suggest establishment as early as AD 1450 but with most of the dates after AD 1650. Along the east bank of Niuli'i Stream in Niuli'i Ahupua'a is an irrigated terrace complex (NIU 31) that is watered through a ditch, now mostly eroded away. NIU 31 is dated to after AD 1650 as well.

In Wai'āpuka and Makanikahio, we have 16 radiocarbon dates that document a number of agricultural complexes and now have compiled a series of dates associated with several of them including barrage-type terraces (see Kirch 1977) built within secondary drainages (or gullies). Using historical maps, we have confirmed the locations of irrigation complexes built on the ridge (tablelands) that would have been irrigated via ditches extending upslope (Graves, et al. 2012; Graves, et al. 2013; McCoy and Graves 2008, 2010). While a number of these complexes or associated features have been dated, reconciling the dates from linked complexes is still underway. A few, such as WAI 1 associated with the historic Catholic Church in Wai'āpuka were likely constructed relatively late in the sequence, sometime after AD 1600-1650, and perhaps as late as the 18th and possibly 19th centuries.

We have also documented irrigated terraces, most of them relatively modest in size (WAI 2, WAI 8, WAI 13) along the west side of Waikama Stream and its upper tributaries. We have archaeological evidence that the traditional Hawaiian agricultural technology was adapted in Niuli'i, Wai'āpuka and Makanikahio 1 and 2 to tap water sources where it could be diverted from streams and along the slopes of the drainages to locations where irrigated terraces could be placed, and then onto the ridge lands (M. Graves et al. 2012, 2013). The technology employed used bedrock cut ditches, as well as more traditional ditches simply dug into the soils. Because the ridge lands slope down, northward towards the coast, it was also possible to collect water runoff even in the absence of ditches within "ridge slopes" (Plunkett, 2013). Complexes along the same ridge slope were often connected by some combination of irrigation ditches and small gullies or secondary drainages. In a few cases, water was returned to streams or valleys, particularly at lower elevations. As we document here, some of these 'systems' are well over 1 km in length

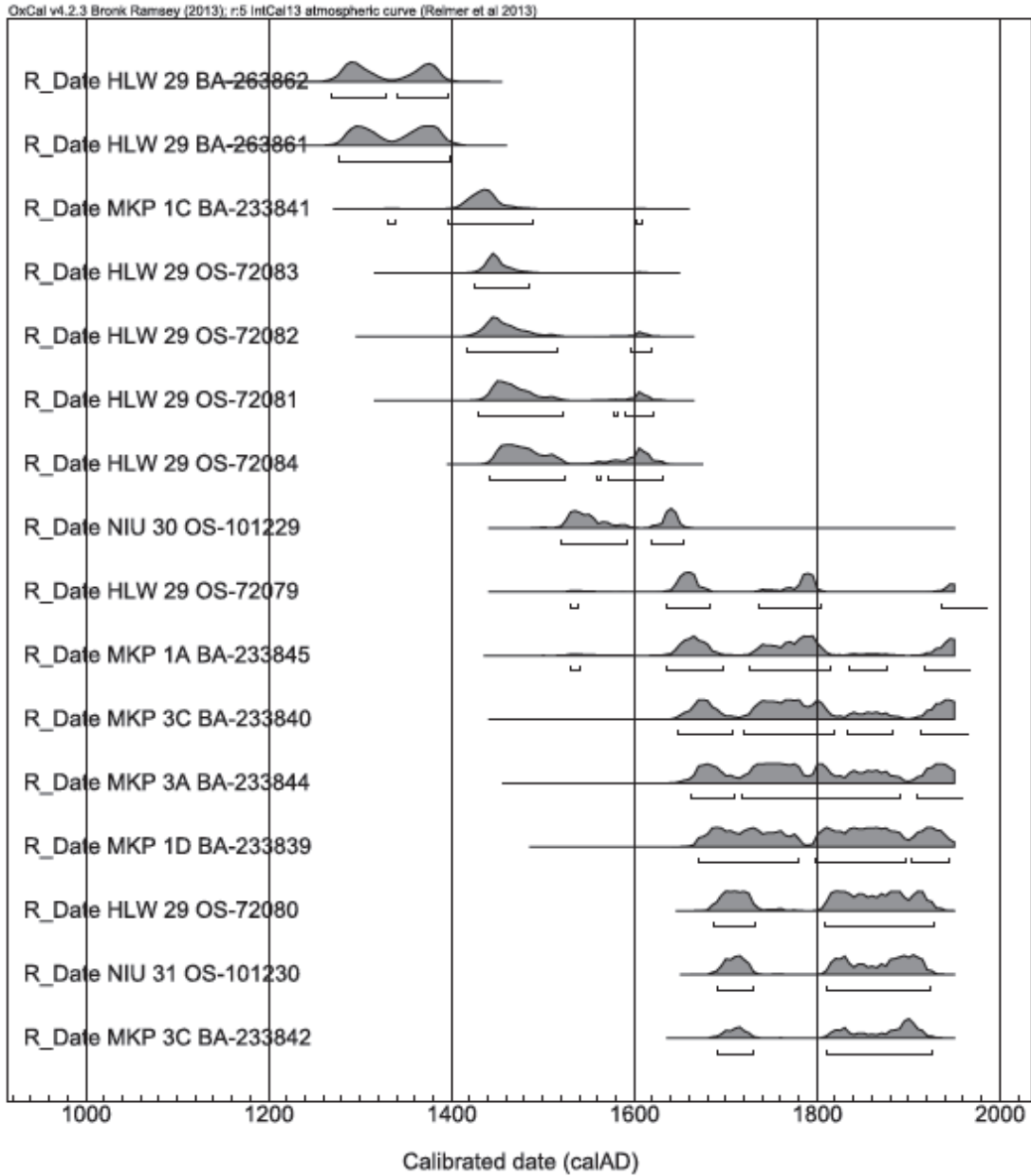


Figure 6. Calibrated radiocarbon dates from agricultural complexes and habitation features from Hälawa, Makapala, and Niuli'i Ahupua'a

Habitation or residential features are present throughout the study areas of windward Kohala, although any that were located on ridge lands converted to sugar cane have largely been obliterated. Consequently, these features are best preserved within the gulches where they are often associated with irrigated agricultural terraces, and in the forested uplands that were never brought under sugar cultivation. Radiocarbon dates from these features overlap with the range of ^{14}C dates from agricultural features and we do have evidence for relatively early occupation in the uplands before AD 1500. At least two ahupua'a boundary walls or alignments have now been identified in the area between Makanikahio 1 and Makanikahio 2 (Birkmann 2014), and between Makanikahio 2 and Wai'āpuka (Graves et al. 2012). Other boundary walls (or iwi 'aina) are

mentioned in the testimonies given to the Ahupua'a Boundary Commission for Niuli'i, Makapala, Makanikahio 1 and Makanikahio 2 (Lyman 1874).

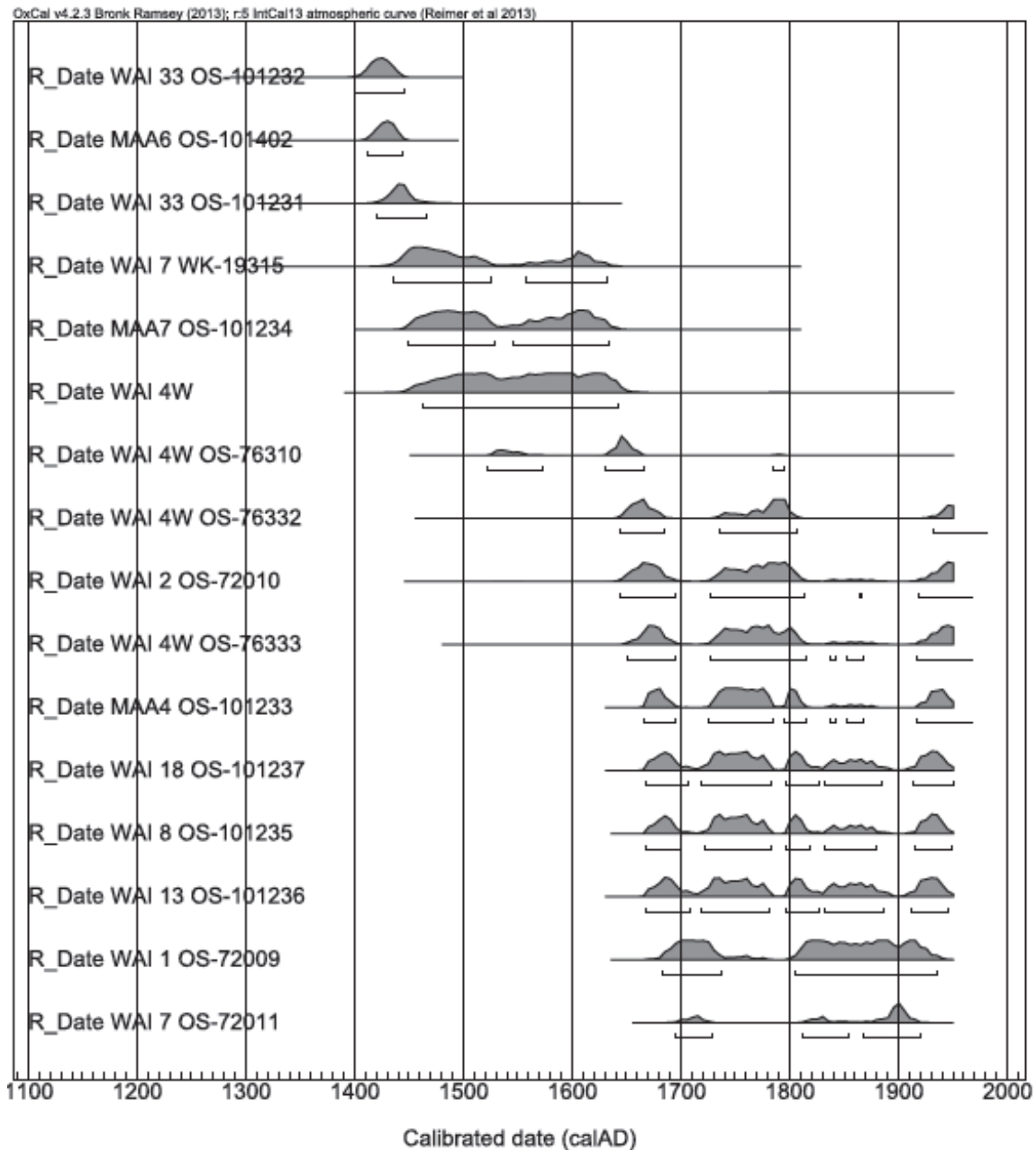


Figure 7. Calibrated radiocarbon dates from agricultural complexes and habitation features from Wai'āpuka, Makanikahio 1, and Makanikahio 2 Ahupua'a.

While not originally a major focus of this research program, we have been able to locate and document a number of traditional Hawaiian ritual sites, mostly heiau but also some burial sites. Some of these were known from the work of John Stokes from the Bishop Museum who conducted a survey of ritual sites on Hawaii Island in the early 20th century (Stokes and Dye 1991). But several others have been discovered in the course of the survey work, which went unreported even though they appear to have been known to local residents. Because such sites are sensitive, we have worked closely with landowners about documenting them while at the same time preserving

their site locations. Along the windward Kohala coast heiau are spaced fairly regularly and typically occupy locations at the top of cliffs or along major bays. Several smaller heiau, perhaps used for agricultural rituals, have been located in the uplands, although one complex that is potentially a former heiau is located in the uplands on a small hill near an ahupua'a boundary. This location provided view planes to a number of agricultural complexes on the surrounding ridge lands. The array of preserved and/or known heiau sites and their geographic distribution across the region is a testament to religious and political importance of Kohala during late prehistory and early history on Hawai'i Island and the main islands of the archipelago. Unfortunately, few of these sites have been dated, except those associated with known chiefs.

Windward Kohala in the 19th and early 20th Centuries

With the arrival of Europeans and Americans in the late 18th and early 19th centuries, and then the large-scale immigration of Asians to work on plantations in the late 19th and through the mid-20th centuries, traditional Hawaiian society was irreversibly disrupted. Population loss, which likely began with the arrival of Cook in 1778, reduced the population by at least 50% and even more in some areas. The conversion to fee simple property ownership as part of the Mahele, made it possible for non-Hawaiians to eventually acquire lands for new large-scale agricultural plantations. These resulted in the removal of or loss of titles to lands by many Native Hawaiians. Northeast, windward Kohala was particularly affected by these developments and with the completion of the Kohala Ditch in 1906, sugar cultivation was fully established in the area. This resulted not only in the conversion of lands to production, but construction of roads, a railway, several mills for processing sugar, and housing for plantation workers clustered in several communities, such as Niuli'i, Hālawa, Kapa'au, and Hāwī.

Thus, notable cultural changes in windward Kohala were wrought by contact and trade, loss of Native Hawaiian population and property titles, and replacement by large, industrial scale plantations, concentrated land ownership, and the use of Asian labor to work these lands. This kept the area largely rural, undeveloped except for sugar-based agriculture, and somewhat isolated from the rest of the Island. In the following, we describe the history of windward Kohala primarily within the contexts of agriculture, land use, water resources, and through the lens of the role that Kamehameha 1 played in this his homeland, where he was raised.

At the time of first European contact in the late 18th century of Hawai'i, substantial changes in Hawaiian political organization were already underway on the Island of Hawai'i. A series of Hawaiian chiefs on Maui and Hawai'i islands had attempted to expand and consolidate their political authority and territories in the previous three to four centuries (Graves, et al. 2010). While consolidation of political power had occurred by the 17th century on both islands, it began earlier on Maui where a paramount chiefdom or early state had been achieved by AD 1500. Both the large size and greater emphasis on dry land agriculture in Hawai'i Island made political consolidation more challenging to achieve and to maintain over time. Hence, there had been a series of native Hawaiian leaders who emerged but whose descendants had not been able to maintain their ancestral dominance over this largest island in the archipelago.

This changed at the very end of the 18th and early part of the 19th century with the ascendance of Kamehameha I. He wrested control of Hawai'i Island through a series of battles with other chiefs on

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

the eastern side of the island and with the cooperation of chiefs from the Kona district. Kamehameha's origins lay in Kohala, particularly north Kohala where he is said to have been born and raised until he was a young adult. Kamehameha's rise has been attributed to his adoption of western military and maritime technology, but he also possessed a number of personal characteristics that influenced his success. In particular, his interest in technology extended to agricultural pursuits and he was credited with expanding irrigated agriculture in Kohala, as well as on other islands after he had integrated them under his political authority by AD 1810. Kamehameha established a dynasty of leaders who ruled Hawai'i through most of the 19th century, only to be overthrown by just before the 20th century by disaffected American planters and a number of former missionary families

Kamehameha competed successfully both in warfare and in the native Hawaiian religious system. He is credited with building the large heiau at Pu'u Kohala in south Kohala and re-furbishing a number of other major heiau sites on Hawai'i Island and the other main islands that came under his dominion. Although the traditional state-level Hawaiian religious system would not survive Kamehameha's death, his descendants ruled the islands for much of the 19th century.

The arrival of American missionaries in the early 19th century just after Kamehameha's death and the catastrophic loss of population in Hawaiian through infectious disease exposure changed the economic and social relationships that had permeated traditional Hawaiian culture. Missionary influence in Kohala was not as direct as it was in Honolulu, which had become one of the capitals of the Kamehameha monarchy. Still, western churches were established throughout Hawai'i Island and efforts were made to baptize native Hawaiians and to convert them to Christianity. The traditional relations and differences between social classes and between men and women were altered by exposure to Western belief by the middle of the 19th century.

As described by early missionaries, the windward, northeastern section of North Kohala was densely populated and under intense cultivation (Ellis, 1969 [1831]). Most of the observed settlements were near the coast but habitation sites could be found along most streams and at the top of cliffs and slopes overlooking the ocean. Unfortunately, many habitation sites near the coast, on the cliffs above, or on the lower ridges were destroyed when sugar cane cultivation was introduced to Kohala, and so much less is known about the antiquity of these occupations. Fortunately, many more of the agricultural complexes were preserved in the bottom of the smaller valleys or those with steeper slopes that had low potential for conversion to sugar cane.

Anecdotal historic accounts (Ellis, 1969 [1831]) of traditional agricultural production in windward Kohala emphasize its productivity despite the relatively small alluvial areas where it could be developed in the valleys (and gulches) of the region. These accounts also note the effects of torrential rainfall on stream flows in this area, which sometimes could be devastating. There are fewer accounts of the irrigated agricultural fields on the ridge top tablelands, although those in 'Iole on what would become the Bond Estate were kept in production until the middle of the 20th century as were the lo'i in Wai'āpuka on property now owned by the Chilton family. Comparing the map of Lydgate (1881) with that produced by Loebenstein (1904), both of which depict plantation lands in the eastern-most gulches, as well as locations still under kalo production, it is possible to reconstruct aspects of the distribution of irrigated agricultural fields, particularly in the

gulches where there was less conversion of land to sugar production. Virtually every portion of the bottom of the perennial streams' drainages was converted to irrigated agriculture where it was possible to build terraces. These locations were more consistently identified within one kilometer of the coast and are noted less often moving upslope and up drainages. The use of secondary drainages for barrage terrace irrigation farming is also depicted but inconsistently and by the early 20th century some of these locations had been filled in or graded by sugar cultivation. Irrigated terraces are also shown on the ridge lands between drainages on both historic maps. The distribution of these complexes is more difficult to predict given that even by 1880 much of the ridge lands had been converted to plantation agriculture and there were relatively few parcels that still belonged to Native Hawaiians or which were kept by the families who first acquired them in the mid-19th century.

In the mid-19th century land conversion to fee simple titles that could be transferred and/or purchased by individuals changed land use and ownership irrevocably. Native Hawaiian as well as newer arrivals to the islands could purchase property. This practice separated families many from the traditional relations that bound makā'āinana and ali'i to one another, in which access to land for agricultural pursuits and for living were conferred from the latter to the former. For Kohala, the conversion of traditional agriculture to large scale plantation-based sugar cultivation began in the mid to late 19th century with a series of land purchases and acquisitions by foreigners. They began to populate their plantations with foreign workers, mostly from Japan but also including Chinese, Filipinos, Portuguese, and other nationalities. Windward Kohala was transformed by this into a series of first independent and then integrated sugar companies.

For all of this, native Hawaiians in windward Kohala were more successful in gaining land grants and patents during the conversion to fee simple land ownership, particularly among individuals living in the eastern gulches of Kohala (Table 2). Figure 8 shows a map from the early 20th century of Land Commission Awards in the eastern gulches area of windward Kohala, including Makapala, Niuli'i, and Wai'āpuka. The relatively large number of separate awards highlights the efforts of Kohala Hawaiians to establish fee simple ownership of their homes and properties in the area. This likely reflects the long history of Hawaiian occupation of the area, investments made over time in irrigated agriculture, and the proximity to ocean resources. Still, by the early 20th century water resources were largely controlled by the sugar companies and the Kohala Ditch, finished in 1906, provided reliable water for the area. This ditch began at the headwaters of Honokāne Valley and transported towards the west where sugar production was established on the ridge top tablelands and where plantation settlements and associated mills and other sugar cane infrastructure were built near the coast.

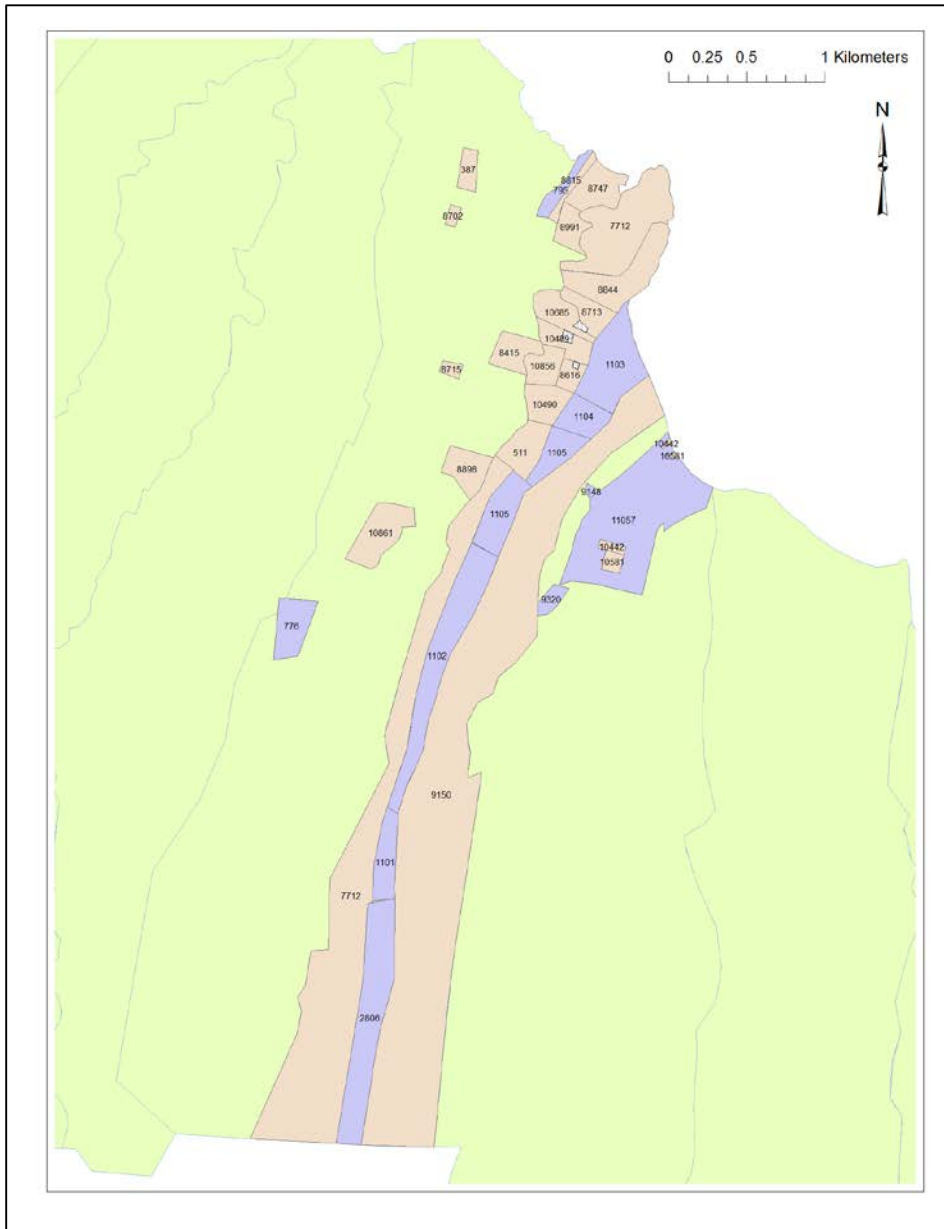


Figure 8. Land Commission (LCA) and Grant awards for Niuli'i, Wai'āpuka, Makanikahio 1 and 2, and lower Pololū Ahupua'a.

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

Table 2. List of LCA and Grant awards for Wai'āpuka and Makanikahio 1 and 2 Ahupua'a, windward Kohala, derived largely from Uyeoka et al. 2013.

Land Award	Ahupua'a	Awardee (later owners)	Area (ha)	Cultural Features	Place Names	Archaeological Features
Land Grant	Wai'āpuka	Kekuanaoa	43.75	101.8 ac for 7 LCA awards (511, 8616-B, 8713, 8814, 10489, 10490, 10865)		
LCA 511	Wai'āpuka, may extend into Makanikahio	Parker, J.P. (remains in family)	12.06	Wai'āpuka tunnel and irrigated loi complex, 21.1 ac	Ili of Nakamaka, Mamakaka and Ahuilaniiki	WAI 20, WAI 16
LCA 7712	Wai'āpuka	Kekuanaoa		500 ac on lao map of LCA awards; may include both makai and mauka sections Old Catholic Church, Japanese Camp,	Various	WAI 1, WAI 2, WAI 4W, WAI 4E, WAI 13, WAI 30, WAI 31
LCA8616-B	Wai'āpuka	Kamaialii (J.S. Loa? To C.F. Hart)	2.67	12 loi patches, 1 dry land cultivated lot, 6.66 ac	Ili of Kiei	WAI 23
LCA 8713 Royal	Wai'āpuka	Kaluahi (H. Sheldon to C.F. Hart)	4.82	5 loi patches, dry land or pasture, 12 ac	Ili of Inaiahue	WAI 39
LCA 8814	Wai'āpuka	Kaipukani, Kaipukane (S.W. Keaneapala to C.F. Hart)	11.26	House lot with 4 houses, 17 loi patches, 4 dry land patches, 27.82 ac	Ili of Paina and Kaualo, Kane	
LCA 10489,	Wai'āpuka	Nihoe, Nihoa	4.45	2 workshops, 1 house site, 6 ac	Ili of Kalihi	WAI 23
LCA 10490,	Wai'āpuka	Inaina, Nainaina (S. Kaeae to C.F. Hart, J. Williams)	4.86	5 loi patches, 1 loi patch; 14 loi patches, 12 ac	Kii (Kiei), Kukuihaa, Haai, Inaihakue	WAI 16, WAI 21
LCA 10856,	Wai'āpuka	Paku (J. H. Brown to C.F. Hart)	4.28	17 loi patches, 10.25 ac	Ili of Kiei, Kalohi, and Lakai, Pakai	WAI 23
LCA 10865	Wai'āpuka	Pi	4.48	4 loi; 2 konohiki patches	Ili of Kanalo and Inaiahui, Inaiahakue	WAI 39

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

LCA 9150	Makanikahio 1	Kupa for Keaka	113.72	281 ac in Makanikahio Boundary Testimony		MAA 3,
	Makanikahio 2, Auau	Government, Lunalilo, W		243 ac, in 6 land grants listed in Tuggle-Tominari (this would be the entire ahupua'a plus other lands)		
Grant 1105	Makanikahio 2, Auau	Haupu, Kepau (W.C. Acbi to C.F. Hart)	21.25	52.5 ac, 1853		
Grant 1104	Makanikahio 2, Auau	Inaina, Nainaina (J. Smith to C.F. Hart)	6.07	Dry land only, 15 ac, 1853		
Grant 1103	Makanikahio 2, Auau	Kauku, Kuuku (J. Kawainui to C.F. Hart)	17	MAA 3, 42 ac, 1853		
Grant 1101	Makanikahio 2	Kapau	6.68	16.5 ac, 1853		
Grant 2806	Makanikahio 2, Auau	Parker, J	28.33	70 ac, 1861		
Grant 1102	Makanikahio 2, Auau	Kaea		7.6 ac, 47.60 ac in Land Grant book, 1853		MAA 6, MAA 4

The native Hawaiian population of Kohala diminished through the 19th century while sugar cane production introduced other groups, primarily Asians, to the area. Yet, for the most the region remained rural, with small towns scattered in the windward region and much of the leeward area abandoned at the coast and converted to livestock production and cattle ranches at higher elevations. Sugar production in windward Kohala ceased in the mid-1970s.

Kohala has remained a tightly knit community even as it welcomed new residents. The Kohala area remains closely associated with Kamehameha both in history and in oral traditions. Efforts to preserve the history and archaeology of the region continue to advance. Hawaiian families remain proud of the role that Kohala has played in the historical transition of Hawai'i during the Kamehameha monarchy.

Kamehameha Schools and University of New Mexico: Historical Documentation, Archaeological Field Training, and Research Program 2013

Michael Graves, Kekuewa Kikiloi, Kelley Uyeoka

In 2013 the program of summer fieldwork in windward Kohala by University of New Mexico faculty and students was re-fashioned into a four-week intensive Historical and Field Training Program sponsored by the Kamehameha Schools and University of New Mexico for five Native Hawaiian and local students from Hawaii, as well as two advanced undergraduates from the University of New Mexico. This Program was designed to: introduce students to the history and archaeology of windward Kohala, provide training in historical and archaeological techniques and methods, and for each student to complete a small research project that integrated archaeological and historical sources. As a result fieldwork in 2013 was explicitly joined with archival and historical research and documentation particularly to achieve the following:

1. Linking archaeological features visible on the surface or using aerial photography and LiDAR mapping with historical maps that locate these same features.
2. Linking historical maps of land commission (LCA) and royal patent awards with the archaeological and/or historical features noted above.
3. Integrating accounts of both native and foreign testimonies that were solicited as part of the LCA process or as part of determining ahupua'a boundaries.
4. Identifying other historical maps, such as those detailing ahupua'a boundaries that include place names and historical properties
5. Conducting field surveys to include remnant trees and other cultivars that likely reflect management along with the cultivation of kalo and other crops.

In addition to exercises involving the identification and documentation of historic sites, students were shown how to access and develop historical resources that would complement and/or add new findings to those generated by archaeology. Prior to the Program, Kekuewa Kikiloi had developed a large corpus of historical documents including maps, native and foreign testimonies, mo'olelo, listing of Land Commission and Grant awards, ahupua'a boundary commission testimony, and accounts of Kamehameha I. Kelley Uyeoka (Uyeoka, et al., 2013) had previously completed an overview of Kamehameha Schools property in Kohala that included detailed records and summaries for the Ahupua'a of Wai'āpuka, among others. We also had access to the list of Mahele awards from a report by Tominari-Tuggle (1988) report as well as an unpublished MA paper on leeward Kohala land commission awards (Calugay 2007). All of the previous reports from the recent archaeological field training and research programs in windward Kohala, as well as other reports for the area by consulting archaeologists were also made available to students in the program.

Students developed research projects based on the available historical and archaeological information that we had previously developed. They first presented the results of their work at a Ho'ike for the Kohala community on June 28, 2013, and then at the Annual Conference of the Society for Hawaiian archaeology in October 2013. They turned in their final reports on their

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

projects in November and December 2013. Six of these reports can be found in Appendix 1, an electronic compendium of reports, presentations, and posters. We have also integrated students' findings into the body of this Report as well.

Wai'āpuka (WAI) Ahupua'a Study Area

Samuel Kamuela Plunkett, Kehealani Walker, Kauī Rivera, Ruth Aloua, Joseph Birkmann, Kelley Uyeoka, and Michael Graves

The Ahupua'a of Wai'āpuka is located on the windward side of the District of Kohala, adjacent to the Ahupua'a of Niuli'i (to the north and west) and Makanikahio 2 (to the east), and Pololū Valley less than 1 km away (see Figure 9). The distance from the coastline to the mountain border is approximately 7 km. This area receives ample rainfall each year, with Waikama Stream serving as the major drainage for the ahupua'a. A second stream, 'Ōpaepilau, flows into upper Waikama from the east, and forms the western boundary of the ahupua'a above its confluence with Waikama. At higher elevations the Waikama branches into two named drainages: Wai'āpuka and Awini Puali'i Gulches. All three branches provide a constant flow of water in the upper portion of this drainage. There are numerous waterfalls, particularly along the 'Ōpaepilau branch. Towards its mauka boundary, Wai'āpuka is bounded by Waiakalae Stream on the east, and Makanikahio 2. Waiakalae ultimately flows into a side branch of the lower Pololū Valley. Wai'āpuka shares not only Waikama Stream with Niuli'i it also shares a portion of Neue Bay. East of the Bay, there are steep cliffs with more limited access to the ocean.

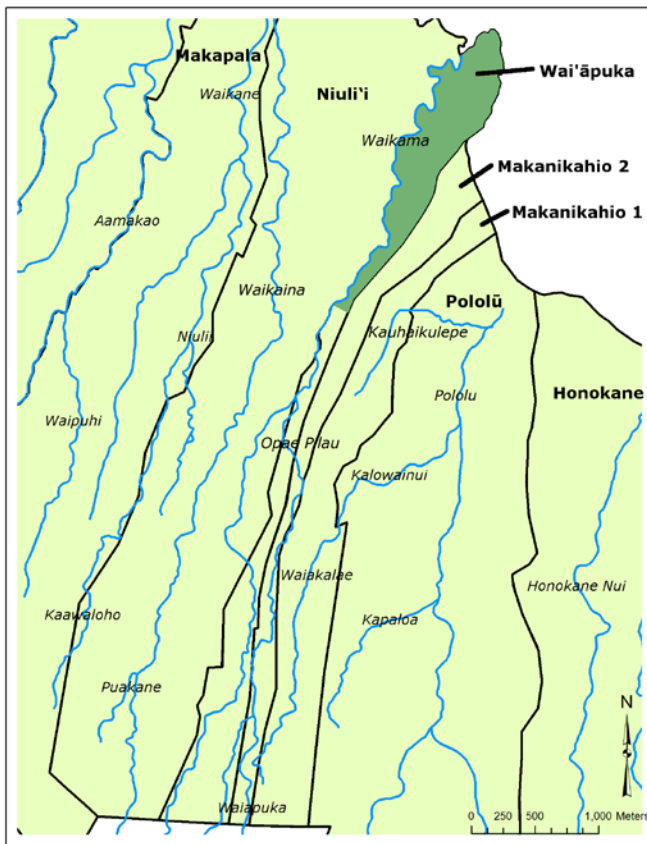


Figure 9. Makai Wai'āpuka study area, windward Kohala.

The study area in June 2013 for both archival work with historical sources and archaeological fieldwork was primarily limited to the north (or the makai) part of Wai'āpuka, from the edge of the

coastal cliff line that defines the east side of the ahupua'a from about 100 to 700 feet above sea level (asl). The west boundary of Wai'āpuka at this elevation is formed by Waikama Stream. The eastern boundary abuts the ahupua'a of Makanikahio 2. Much of these lands are owned by Kamehameha Schools and Kohala Surety, Inc. with title to several smaller parcels in the middle portion of the study area acquired by individual property owners. In October 2013, we returned to this area, working farther upslope from about 700 to 1100 feet asl on property owned by Kamehameha Schools.

Place Names and Land Divisions

Kaui Rivera, Kelley Uyeoka, Kekuewa Kikiloi, and Michael Graves

Ahupua'a territories were divided into smaller, named land units, of which 'ili 'āina are perhaps the best known. A number of these are known for Wai'āpuka through the testimonies provided during the Land Commission Awards (LCA). Figure 12 shows the relative location of the 'ili 'āina identified in the makai section of Wai'āpuka based on a reconstruction from Native testimonies (see Uyeoka et al. 2013: 28-43). LCA and other land awards are also depicted in Figure 12 and illustrate the relationship between 'ili 'āina and the land parcels allotted to individuals in the mid-19th century. Note the variants in spelling that occur in the testimonies (see Table 3) and a few that are here treated separately may also be variants (e.g., Kalohi and Kalihi). There are between 9 and 12 'ili 'āina represented on the map, one of which is likely located in Makanikahio. 'Ili 'āina apparently took on different spatial configurations, including some that spanned across (from east to west) Wai'āpuka and others that were oriented along a makai to mauka (or north-south) orientation. LCA awards exhibit some variation in size, with the single largest parcel, more than 200 ha in size, awarded to Kekuanaoa for the upland portion of Wai'āpuka. The median size of the remaining land awards in Wai'āpuka is much smaller, ca 4-5 ha for individual parcels. There are a range of cultural features located on the various LCA parcels, although all were said to have contained lo'i or other kinds of agricultural plots. Other cultural features were less consistently associated with land awards such as house sites or pasture lands. Claimants also noted unused lands adjacent to theirs; none of them made mention of individuals claiming or using lands in Niuli'i, the ahupua'a with which Wai'āpuka shares a boundary and the stream of Waikama. However, in descriptions of the locations of lands that were claimed the ahupua'a of Niuli'i is consistently identified as being to the west of these Wai'āpuka parcels.

Named land units can also represent Hawaiian place names with various meaning that can be attributed to them. There is a comprehensive listing of Wai'āpuka place names in the report by Uyeoka et al (2012). Kaui Rivera (Rivera, 2013) conducted a preliminary analysis of a number of these features drawing on the perspective offered by Kikiloi (2012): “[Place names] help to transform once-empty geographic spaces into cultural places enriched with meaning and significance” (Kikiloi 2010). Within the area of Wai'āpuka in northern Kohala iloko, there are numerous documented place names that still remain attached to the land, and whose names reflect locations, possible land features, people and their relationships, and traditional land usage. The place names referring to 'ili 'āina from Wai'āpuka were presented in Table 2 and their spatial relations estimated in Figure 10. 'Ili aina and other place names are listed in Table 3 with possible lexical meanings derived from Hawaiian language. These areas and their individual names create a

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

basis to reconstruct and enhance the traditional landscape by identifying these places, their location, and their significance as derived through translation and interpretation (see Table 3).

Table 3. Partial listing of place names from Wai'āpuka and their possible lexical meanings.

Place Name	Possible Function	Meaning
Ahulamiki (Variant 1)	'Ili 'āina Location	'Ā-: prefix, in the nature of ('āpali = like a cliff)/'ā: fiery, burning, blaze; to glitter, sparkle/hula: the hula, to dance the hula/hulā: to prod, pry, uproot, pierce and penetrate/miki: quick, active, nimble, prompt, alert; to suck in, dip in, to shrink
Ahulaniiki (Variant 2)	'Ili 'āina Location	Ahu: heap, pile, collection, mound, mass, altar, shrine, cairn/lani: sky, heaven, spiritual; very high chief, majesty, host, royal, exalted, high born, noble, aristocratic; kinds of flowers/iki: small, little, slightly, a little
Akoakoa	Edge of Cliff Line, Lae	'Ākoakoa: To assemble, assembled, collected, heaped; to congregate, muster, throng; to collect, gather/'Āko'ako'a: Coral in general, coral head
Awini Pualii	Stream, Kahawai (Ahupua'a Boundary?)	Āwini Pualii: āwini- sharp, bold, forward; pu—short prefix for puna, spring (of water); coral, lime, plaster, mortar; section between joins or nodes; cuttlebone; ali'i—chief, chiefess, officer, ruler, monarch, headman, noble, aristocrat, king, queen; to rule or act as a chief, govern, reign, to become a chief
Haoi	'Ili 'āina Location	Hā'o'i: to limp/hā:to breath, exhale; hoarse, hoarseness; stalk that supports the leaf and enfolds the stem of certain plants; trough, ditch, sluice, to form a ditch or trough/oi: to move, to turn sideways, to slouch along, to pull away/'oi: sharp, acute, sharpness; best, superior, superb, main, prominent, to exceed
Haai	'Ili 'āina Location	Hā: four, fourth (hā and multiples of four are sacred or formulaic numbers); see "hā" above/ai: coition, to have sexual relations, cohabit/a'i (a'ia'i): bright as moonlight, fair, white, clear, pure, brilliant/'ai: food or plant, to eat, destroy or consume as by fire; score, points in a game; dancing style or type; stroke or hold in lua fighting; stone used in the kimo game other than the stone that is tossed and caught
Huamoa	Ahupua'a Boundary	Huamoa: round-ended bone entering the hip socket, type of house with thatch purlins separated by a width of three fingers; a native variety of banana; a variety of sweet potato; hua: fruit, tuber, egg, produce, yield, ovum, seed, grain, offspring; to bear fruit, tuber, or seed; to bear a child, fruitful; round object, as pill or bead; result, effect, credit, as for a university course; testicles; word, letter, figure, watchword/huā: envy, jealousy, envious, to stir up trouble due to envy; hu'a: foam, froth, bubble, suds, scum; rim border edge, side, hem; suburb, boundary; piles of mats or tapa/moa: chicken, fowl; a native banana fruit with large and plump skin and flesh yellow; tufted, green, leafless plants; children's game with moa twigs; a dart, tapering at one end; stone fastened to rope, used as a war weapon/mo'a: cooked, burned, as by sun, cooking food, made brittle
Inaihakue (variant 1)	'Ili 'āina Location	Īna'i: Accompaniment to poi, usually meat, fish, or vegetable (garnish)/hāku'e: sea urchin (hā'uke)
Inaihaku (variant 2)	'Ili Aina Location	Īna'i: See above/haku: lord, master, overseer; to compose, invent; Core, lump, as of poi, coconut sponge

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

Inaihakui (variant 3)	'Ili 'āina Location	ʻĪnaʻi: See above/hākui: to steam, as by placing fish, meat, or vegetables...; spike, as of the hāʻukeʻuke/hākuʻi: to beat, pound, pummel; to echo, reverberate, flutter, palpitate
Inaihakua (Variant 4)	'Ili 'āina Location	ʻĪnaʻi: See above/hakua: passive variation of "haku"
Kaba	Ahupuaʻa Boundary Location	
Kapakahea	Ahupuaʻa Boundary Location	
Kukupaa (Variant 1)	'Ili 'āina Location	Kukui: candlenut tree; lamp, light, torch; guide, leader/paʻa: firm, solid, tight, solidified, stuck, secure; pair
Kukuihaa (Variant 2)	'Ili 'āina Location	Kukui: see above/haʻa: low, short stature; to lower, humble; dance
Kiei (Variant 1)	'Ili 'āina Location	Kiʻei: to peer, peep, as through a door or crevice; to protrude forth
Kii (Variant 2)	'Ili 'āina Location	Kiʻi: image, statue, picture, photograph, drawing, illusion; to fetch, get, procure; to try and go; hula step, gesture in hula/kī: ti, a woody plant, the Spanish needle, to shoot or aim as with a gun, bundle of 40 pandanus leaves/ʻI:to say, speak, suppose; supreme, great, best; hard, close, stingy
Kalihi (Variant 1)	'Ili 'āina Location	Ka: Kaʻi [the]/lihi: edge, rim, border, boundary, margins, brim; small quantity, particle, a little bit, slight; "piece of land usually between two ahupuaʻa and of unestablished ownership."
Kalohi (Possible Variant 2)	'Ili 'āina Location	Ka: kaʻi [the]/lohi: slow, tardy, late, retarded, backward, deliberate, gradual, to delay; sim. ʻalohi [sparkle, shine]
Kamalo	'Ili 'āina Location	Ka: kaʻi (the)/malo: male's loincloth; leaf sheath that protects the young leaves of the breadfruit tree/malō: taut, firm, straight; variation of maloʻo: dry, dried up, evaporated, desiccated
Kanala	'Ili 'āina Location	Ka: kaʻi (the)/nala: variation of ulana, to plait; a kind of fish; a easurement of 6cm/Kana: see "Kanalo"/lā: see "Lakai"
Kanamakaohua	Ahupuaʻa Boundary Location	
Kapoho	'Ili 'āina Location	Ka: kaʻi (the)/poho: hollow or palm of the hand, depression; mortar (to knead as bread or poi), patch, as in clothes; to belly out, puff out; unit of measure equal to half a span, bundle of tapa pieces/pohō: loss, damage, out of luck, vain, useless; bog, swamp, sunken, marshy
Kaualo	'Ili 'āina Location	Ka: kaʻi (the)/ualo: to call out, as for help, to resound, a call/kau: to place, put, hang, suspend, affix, to set; to come to rest as the setting sun; period of time, lifetime, any season/kāu: your, yours/alo: front, face, presence; leeward/ʻalo: to dodge, evade, elude, avoid; to be with, come near, go with, attend, endure
Kileauea (Also Puu Kileauea)	Hilltop, puʻu, Ahupuaʻa	Kīlauea: caldera (island of Hawaiʻi), volcanic pit; kī: ti, a woody plant in the lily family; the Spanish needle; to shoot or aim, as with a gun; to squirt water; bundle of 40 pandanus leaves, sorted for size and length;

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

	Boundary Location	key, latch, pitch, and clef in music; trigger of a gun; tea/kī-: intensifying prefix/ki-: same as kī-/lau: see above/ea: sovereignty, rule, independence; life, air, breath, respiration, vapor, gas, fumes; to rise, go up, raise, become erect; to smell/'ea: hawksbill turtle; reddish-brown, as the color of the 'ea shell; a general term for infections and infectious diseases; spray; noisy, to yell, whoop, whoop/'e'a: dust, dirt, dust cloud, spray; mountain banana patch; a fish similar to 'a'awa, but with dark flesh
Maa	'Ili 'āina Location	Ma'a: accustomed, used to, knowing thoroughly, habituated, familiar, experienced, to adapt, custom, habit; sling, as made of coconut fiber, human hair, or aerial pandanus; to tie; snapper at the end of a whip/mā'ā: badsmelling/ same as mā'ā'ā: to reach out, as a baby or as an octopus; goat's bleat;
Makana	'Ili 'āina Location	Makana: give, present, reward, award/mā: faded, wilted, stained, discolored, blushing/kana: horizontal support in houses for carrying poles; a stroke in lua fighting
Makamaka (Variant 1)	'Ili 'āina Location	Makamaka: Intimate friend with whom one is on terms of receiving and giving freely; raw, fresh; many eyes (?)
Nakanaka (Variant 2)	'Ili 'āina Location	Nā: Ka'ī [plural the]/Kānaka: human being, man, person, individual, party, mankind, population/naka(naka): to quiver, quake, tremble, shake; to crack open, a land shell, a sea creature
Makanaka (Variant 3)	'Ili 'āina Location	Maka: eye, face, countenance; beloved one, favorite person, point, bud, protuberance; raw, uncooked/māka: mark, marker, blaze, target/mākā: a kind of stone/naka: see above
Moana	Ahupua'a Boundary Location	Moana: ocean, open sea, lake; campground, consultation place for chiefs; broad, wide, extended, expansive, spread out/mō: short for "moku"/mō-: short for mo'o, succession; short for mo'o, lizard/ana: to measure, survey, evaluate, rate, fathom; to have enough or too much, satisfied, satiated, surfeited; cave, grotto, cavern; larynx; 'ana: pumice, used as a rubber; siliceous sponge, used as medicine and as sandpaper
Nakoa	'Ili 'āina Location	Na: By, for, belonging to/nā: plural demonstrative particle; calmed, quieted, pacified, soothed; to moan, groan, wail/koa: brave, bold, fearless, valiant; soldier, warrior, fighter; the largest of native forest trees/ko'a: coral, coral head; fishing grounds; shrine, often consisting of circular piles of coral or stone
Neue (Variant 1)	Embayment	Nē: fretting, teasing, or nagging for something; murmuring as the sea, returning persistently as a thought or desire/ue: to jerk, pull, twist, pry, turn, sway (naue)/uē: to cry, weep, lament, mourn; a cry, lamentation, weeping; to salute
Naue (Variant 2)	Embayment	Naue: to move, shake, rock, sway, tremble, to quake as the earth, to vibrate, to march, loose and insecure, as a tooth, revolving as hips in hula
Ohilauli	Gulch or Drainage	Ohi: Young animal, usually female; maiden just entering womanhood; youth; youthful growth; to peel, as bark; shoots from roots, as of the wauke plant/'ohi: to gather, harvest, cull, pick, select; to collect, as wages or taxes; to take away or usurp, as land; to draft, as soldiers; to buy; gathering, selection; bundle, as of taro leaves; to gush, chatter aimlessly and ramblingly, gabble/lau: leaf, frond, leaflet, greens; to leaf out; dragnet, seine, so called because formerly made of ti leaves (lau) tied to a rope; a bundle of grass or ferns set in water to attract shrimps or 'o'opu fish; sheet, surface, blade, as of grass; to be much, many, very many, numerous, four hundred; pattern, as for quilts, design; thatched mountain hut, as used by farmers, canoe-makers; tip as of the

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

		tongue; sweet-potato slip or vine/lī: chills, to have chills, to tremble with cold, shuddery feeling of horror; lace, as of shoes, to lace or tie; to hang, gird; to furl or reef, as a sail
Opaepilau	Stream	ʻŌpae: general name for shrimp/pīlau: rot, stench, rottenness, to stink, putrid, spoiled, rotten, foul, decomposed.
Paina	ʻIli ʻāina Location	Paina: to lift, lifting, swelling, fine cloth like serge, pine trees, ironwood/Paʻina: to crackle, snap, click, tick, pop/pāʻina: meal, dinner, party
Palihai Or Palihae	Boundary	Pali: cliff, precipice, steep hill or slope suitable for olonā or wauke, full of cliffs, to be a cliff; (fig. An obstacle, difficulty, haughty, or disdainful)/hai: offering, sacrifice, to offer, sacrifice; same as hahai, to follow; to hire, employ/haʻi: to break or snap, as a stick, broken, fracture, joint, break; to say, tell, mention, state, declare, confess; edge, border; coquettish, flirtatious, to flirt; to sway, bend; house; someone else, another person, another place, elsewhere
Pakai (Variant 1)	ʻIli ʻāina Location	Pakai: spleen amaranth, coarse, erect, spineless, weedy, tropical herb/slender amaranth, resembles spleen amaranth and used for greens, spreads close to the ground
Lakai (Possible Variant 2)	ʻIli ʻāina Location	Lakai: No possible translations/lā: sun, sun heat, sunny solar; day, date, a sail, fin/kai: sea, sea water; area near the sea, seaside, lowlands, tide, current in the sea/-kai: swollen, bloated/kaʻi: to lead, direct, lift up and carry; to walk or step in a row or procession
Puaa	Land Division Boundary Location	Puaʻa: pig, hog, swine, pork (many references to puaʻa are to Kamapuaʻa and his plant forms), a chief-seeking pig; formerly a general name for introduced quadrupeds; banks of fog or clouds, often as gathered over a mountain summit, a sign of rain and believed to be the cloud forms of Kamapuaʻa.
Waikama	Stream, Kahawai (Ahupuaʻa Boundary)	Wai: water, liquid/kama: child, person; to bind, tie, wrap; cavern, cleft, rock fissure
Waiakalae	Stream, Kahawai (Ahupuaʻa Boundary)	Wai: see above/ka:kaʻi (the)/lae: forehead, brow; cape, headland, point, promontory; wisdom, mental or emotional qualities; an insulting term, followed by qualifiers, referring to kauā/laʻe: same as laʻelaʻe, pure in sentiment/kālaʻe: clear, calm, unclouded
Waiapuka	Stream, Kahawai (Ahupuaʻa Boundary)	Waiʻāpuka; Wai: water, liquid/kama: child, person; to bind, tie, wrap; cavern, cleft, rock fissure; āpuka—of a hole, perforation, door, entrance, gate, slit, vent, opening, issue; to perforate, puncture, make a hole; to pass through, appear, emerge, come out

A number of these terms appear to be variants of the same lexical unit although this cannot simply be assumed. In addition to the ʻili ʻāina locations, terms refer to locations identified as on or near to the ahupuaʻa boundaries for Waiʻāpuka, the major named streams and drainages, the primary embayment at the coast and the related cliff line to the east. The multiple meanings of some terms along with the possible variants used for the same place name makes it challenging to interpret place names in the absence of context—relational information, geographic location, view planes to name but a few. A few observations can be made about the place names of Waiʻāpuka. For streams and gulches there is generally some reference to water or its characteristics, or organisms that live in or are associated with water (e.g., kalo). Even Āwini Pualiʻi, one of the

named upper branch streams of Waikama is associated with water as 'pu' can be a shortened, prefix for a spring of water.

For the 'ili 'āina locations, all have multiple potential meanings, although Rivera suggests that some are more likely than others. For instance, it is likely that ki'ei is the mostly term associated with this 'ili 'āina given its translation as to peer, peep, or protrude forth. A visit to this location revealed a small slope and hill top (see Figure 10. Photograph of ki'ei, an 'ili 'āina in makai 'ili 'āina. The location likely refers to the top of the slope pictured here.) from which it would have been possible to peer over to the low-lying areas below.



Figure 10. Photograph of ki'ei, an 'ili 'āina in makai 'ili 'āina. The location likely refers to the top of the slope pictured here.

Similarly, the cliff line place name of 'ākoakoa can or to gather. It also refers generally to coral. Rivera suggests that 'Ākoakoa Lae or Point may refer to an area where people would come to gather for meetings or other various activities as it is the most makai portion of the ahupua'a of Wai'āpuka. It also has a view down the Hāmākua coast line and the point juts out enough to protect sailors from the trade winds. Such a reference to gathering of individuals has been suggested by Fred Cachola for all of the windward Kohala embayments.



Figure 11. 'Ākoakoa Point, on the cliff above the coast of Wai'āpuka, adjacent to Neue Bay and a possible location for the gathering of canoes.

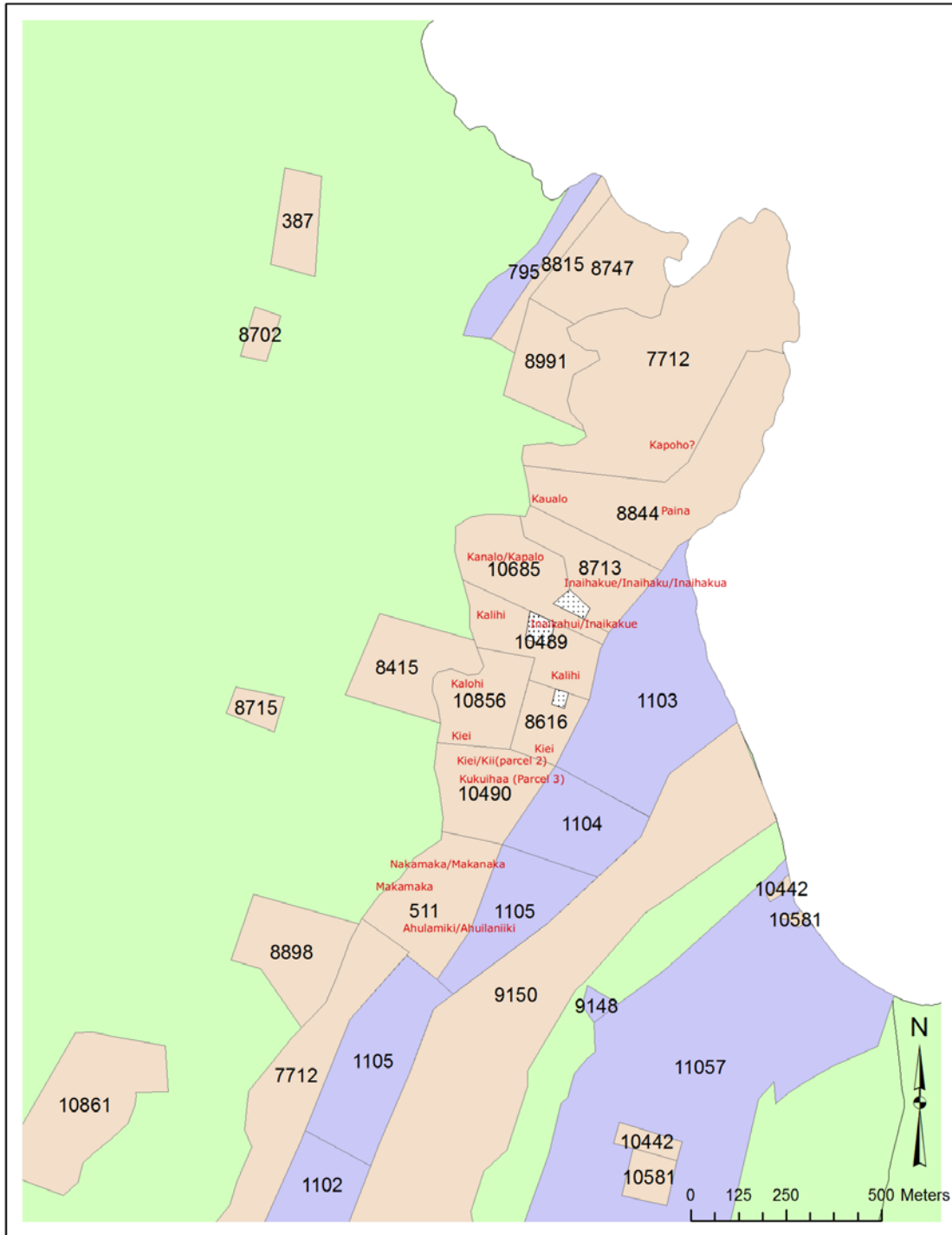


Figure 12. Makai Wai'āpuka land commission and grant awards with 'ili 'āina names placed in their relative locations.

Historical, Archival, and Archaeological Survey and Mapping Results

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

Currently, there are 28 archaeological and/or historical sites recorded in Wai'āpuka; 22 of these were previously listed (Graves, et al. 2012). This report includes new archaeological and historical data developed as a result of archival research as well as field survey, mapping, and documentation. Several sites (e.g., WAI 16) have been previously reviewed (Graves et al 2012, 2013) but had not been archaeologically documented. We also revisited a number of previously recorded features or complexes to provide additional documentation and mapping (WAI 4W a, WAI 18, WAI 34). As work continued a number of new archaeological features, usually associated with known complexes, were identified or documented for the first time.

In addition to archaeological documentation, we also conducted extensive archival research on Wai'āpuka using resources compiled by Kekuewa Kikilo'i and the recent overview of the ahupua'a by Kelley Uyeoka and her students (Uyeoka, Ah Sam, Mahi, Macabio, Santos, & Kapuni-Reynolds, 2013). These materials were used by students in most of their reports. The testimonies for the LCA awards were particularly useful as they described not only the parcels of land but the relationships among some of the claimants, as well as improvements to the land such as lo'i and dry land farms, and houses. Historical maps particularly those done to establish the boundaries of Wai'āpuka and its neighboring ahupua'a, show a number of place names. These place names were inventoried and then a sample analyzed by Rivera (2013) for her research project. Similarly, one of the students surveyed a number of locations in Wai'āpuka for remnant "managed" trees and other cultivars (Aloua 2013). These materials will be integrated into the descriptions of historical and archaeological features from the two study areas presented here.

Table 2 lists the land awards made during the Mahele, conversion of land titles to fee simple property. This occurred as chiefs were awarded title to lands by the monarch, Kamehameha III or who had their previous land awards recognized at this time. It also occurred through the Land Commission Award process, where individuals could put forward their land claims based on their history of residing and improving the land, as well as oral testimonies regarding previous land awards, often from local chiefs, or konohiki. As both Table 2 and Figure 9 show, the larger land awards were made as grants and/or made to ali'i. There was also a cluster of contiguous LCA awards made in makai Wai'āpuka.

Much of the historical and archaeological research was focused on two agricultural and habitation complexes in makai Wai'āpuka (see Figure 10): WAI 16/20 and WAI 23. These complexes were noted on either or both of the historical maps by Lydgate and Loebenstein. WAI 16 and 20 represents the Wai'āpuka Tunnel and its associated irrigated agricultural terraces, along with irrigation ditches that transported water from Waikama Stream through the tunnel, and into at least two ditches that fed the lo'i in WAI 16 as well those farther down slope in WAI 21, 23, and MAA 3. All of these complexes represent irrigated agricultural terraces placed on the ridge lands above Waikama Stream, a traditional Hawaiian innovation that we have noted previously. The tunnel would represent a second innovation, although one that currently was not as widely replicated based on our current surveys (Figure 11).

The agricultural complexes depicted on the historical maps are distributed across land parcels that were awarded in fee simple during the early to middle 19th century, including one made to J. Parker, and the remainder to native Hawaiians: Inaina, Paku, Pi, Kamalii, Nihoa, and Kaluahi.

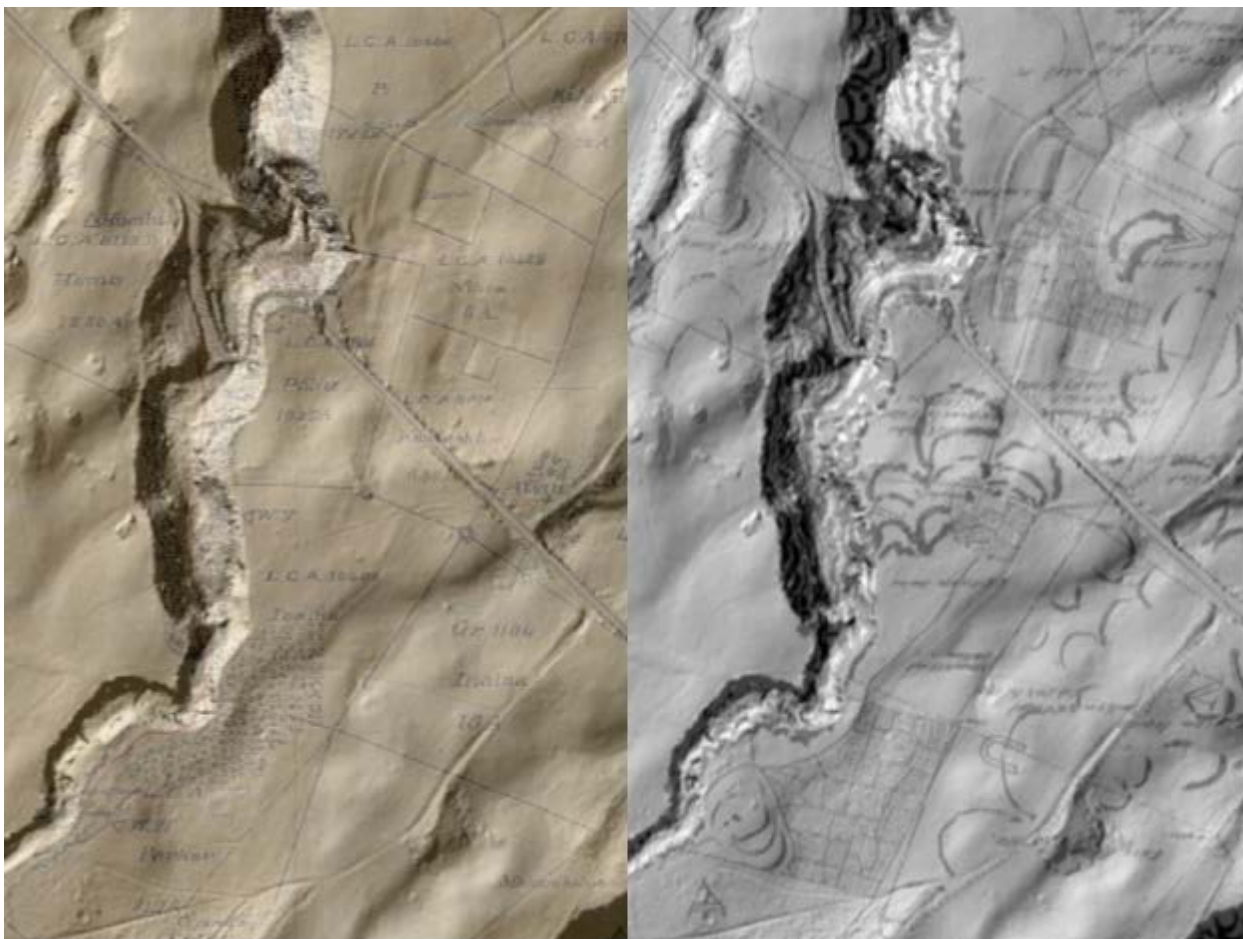


Figure 13. LiDAR imagery of makai Wai'āpuka with Lydgate (left) and Loebenstein (right) historical maps overlaid and compared.

Agricultural Irrigation Tunnel and Ditches (Wai'āpuka Tunnel-WAI 20), Irrigated Agricultural Terrace Complex (WAI 16), and Habitation Features (WAI 20H, 20I)

WAI 20 is comprised of a tunneled irrigation system (WAI 20A, 20D, 20E, 20F), a cultural feature unique for its time and traditional association to Wai'āpuka. The tunnel portion was dug through the base of a small pu'u (hill) or ridge (see Figure 12). This site is approximately 500 m mauka (north) of Highway 270 (Akoni Pule) and begins directly on the east side of Waikama stream. The property was formerly part of lands given to J. Parker by Kamehameha 1 in the early 19th century, first as a grant and then later as part of the Land Commission Awards (LCA). This complex contains a historic barrier to the tunnel (WAI 20B), a modified pond area with petroglyphs (WAI 20C), a ditch ('auwai) leading to the tunnel entrance (WAI 20D), and both a tunnel excavated through bedrock (WAI 20A) and a series of shafts (WAI 20G) dug from the surface of the pu'u down to a level intersecting the path of the tunnel below. The tunnel emerged from the hill midway up from its base on its northeast side. At this point there were two irrigation ditches (WAI 20E, WAI 20F) and a large irrigated terrace complex (WAI 16A) located along the north and east face of the hill. We have also identified two additional terrace parcels near this complex and have identified them as WAI 16B (just north and west of WAI 16A) and WAI 16C, just to the south of the pu'u and WAI 16A. On the 1904 Loebenstein map there is a house site located on the top of the pu'u and

although there are no visible surface remains of, both structures that appear on the map have been given feature designations (WAI 20H-main house, and WAI 20I-secondary structure).



Figure 14. Small hill under which the Wai'āpuka Tunnel was excavated. Associated irrigated terraces would have been located on the lower slope and in the foreground (photograph by Samuel Kamuela Plunkett).

Historical Background

The Wai'āpuka Tunnel is locally known as "The Kamehameha Tunnel" (Tomonari-Tuggle 1988:38), suggesting that it was built by or during the reign of Kamehameha I. The associated lo'i are also said to be "Kamehameha's taro patches" (Tomonari-Tuggle 1988:38). However, the tunnel's origins are unclear as its construction is credited to a variety of individuals or groups. On an 1888 sketch-map (see Figure 13) of the tunnel (adapted from Tomonari-Tuggle's 1988 report), L. Cabot attributed the tunnel to 'Umi-a-Liloa, an ali'i nui, or high chief, who reigned over Hawai'i Island during the 17th century. Other origins for the tunnel have been attributed to menehune, mythical beings said to be diminutive in size and sometimes identified as the original Polynesian inhabitants of Hawai'i. Menehune are also believed to be admirable craftsmen, responsible for building a cut stone irrigation ditch on the Island of Kaua'i. Because the technology of tunneling is associated with European and American planters, this tunnel is also attributed to J. Parker, a non-native man who was the land claimant of Land Commission Award (LCA) 511. Some believe that Parker or his descendants would have had to use modern, metal tools to build the tunnel and have had access to Euroamerican engineering knowledge in order to build the Tunnel (see Tomonari-Tuggle 1988; Schweitzer 2003; Uyeoka, et al. 2013; Williams 1919). Yet, Parker acquired this land from Kamehameha I in 1814, early in the post-European contact period and it seems likely that he would have given him undeveloped land. There is at least one other tunnel complex (WAI 34 and WAI 35) located off of Waikama Stream, although it is substantially smaller in size. Still, the tunnel was dug through bedrock and has irrigation ditches on either side that were cut through bedrock. This complex appears to have involved traditional technology in its construction. It seems likely that tunnels excavated through bedrock were known to Hawaiians prior to European contact in the late 18th century. Descendants of J.P. Parker continue to own parts of the original LCA parcel today on which the tunnel complex is located (Uyeoka 2013:271, 296).

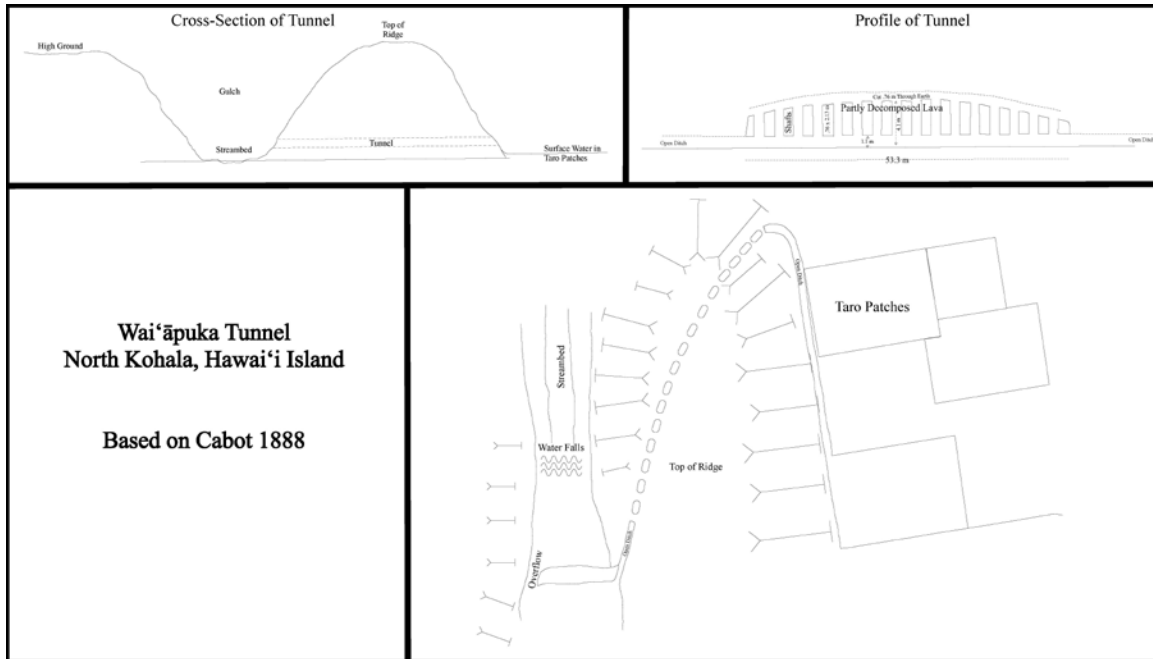


Figure 15. Schematic of Wai'āpuka Tunnel based on Cabot's 1888 drawing, showing number of shafts, a cross-section and plan view of tunnel, ditches, and irrigated terraces.

Documentation

The first historical documentation of the Wai'āpuka Tunnel was by Cabot in 1888 (Figure 13) although the drawing of the tunnel and its associated shafts appears schematic not representational. The Tunnel lo'i (WAI 16) are indicated on both the Lydgate and Loebenstein historical maps although their size and location differ somewhat on each map. Loebenstein's map also depicts the pathway of the tunnel and possibly two 'auwai, one heading east and south along the north face of the ridge and the other heading north along the west side of the lo'i complex. There are clear differences in the irrigated terraces between the Lydgate and Loebenstein maps, with a larger area devoted to lo'i on Loebenstein's map but fully contained within Parker's LCA boundaries, and the terraces extend farther to the south and to the east compared to the version prepared by Lydgate. Lydgate, on the other hand, shows the terraces clearly extending onto the adjacent, northern land parcel acquired by Inaiana during the Mahele. While neither the tunnel or lo'i are mentioned in the Native or Foreign Testimonies as part of Parker's LCA award, the northernmost terraces appear to be referenced in the testimony associated with Inaina's claim to the adjacent parcel. This and the fact that the main property where the tunnel and lo'i are located was given to Parker from Kamehameha I suggests that these features were already in place by the early 19th century, prior to the land's acquisition by Parker. That Kamehameha was responsible for the gift of the land suggests he was well aware of both the Tunnel and lo'i and the value they represented.

Beyond this history and physical characteristics of the Wai'āpuka Tunnel, however, the complex and its associated irrigated terraces are under-reported. Tomonari-Tuggle's (1988) overview of Kohala historic properties did not include additional mapping or archaeological documentation. She did however present the historical claims about the tunnel. We received permission from the

current landowners to document (but not conduct mapping) of the Wai'āpuka Tunnel complex. We have integrated our observations completed in 2013 with the various historical maps and the schematic drawing by Cabot to assess the nature of this engineering feat, irrigation transport system, and associated agricultural complex.

Setting

The geomorphological settings for the tunnel complex include the Waikama Stream channel which in this location flows directly over bedrock, a narrow east bank that leads to a shallow but steep, bedrock slope and above the slope a small hill or ridge through which the tunnel was excavated by means of connecting shafts. Cabot estimated the base of the ridge from the stream tunnel west entrance to the ditch that linked the tunnel opening on the east side of the hill to be about 175' (or 50 m) in length. The ditch channel excavated through bedrock from Waikama Stream to the exposed slope of the hill was at least 18 m in length. Based on Cabot's drawing and Loebenstein's map the direction of the tunnel from the stream-side is roughly north and slightly to the east. After the tunnel emerges from the hill slope it enters an irrigation ditch that diverges in two directions. The first of these ditches (WAI 20E) turns east and then slightly south (Figure 14) following the contour of the hill. This ditch is at least 25 m in length. The second ditch (WAI 20F), visible on Loebenstein's map is oriented to the north and follows the west side of the lo'i complex (WAI 16A). It would have been over 25 m in length. In total and including the tunnel section, there was more than 120 m of water transport channels excavated and dug as part of the Tunnel complex. Loebenstein's map also depicts a ditch (WAI 16B) that extends north of the WAI 16 lo'i complex. We have assembled a new map of the complex (Figure 14) using the tunnel portion of Cabot's sketch map and aligned it with the ditches depicted on Loebenstein map. This allows us to reconstruct the tunnel orientation and fit with the ditches at both ends of the tunnel. Together, the tunnel and the ditch extending south and east form a V-shape in plan view perspective.

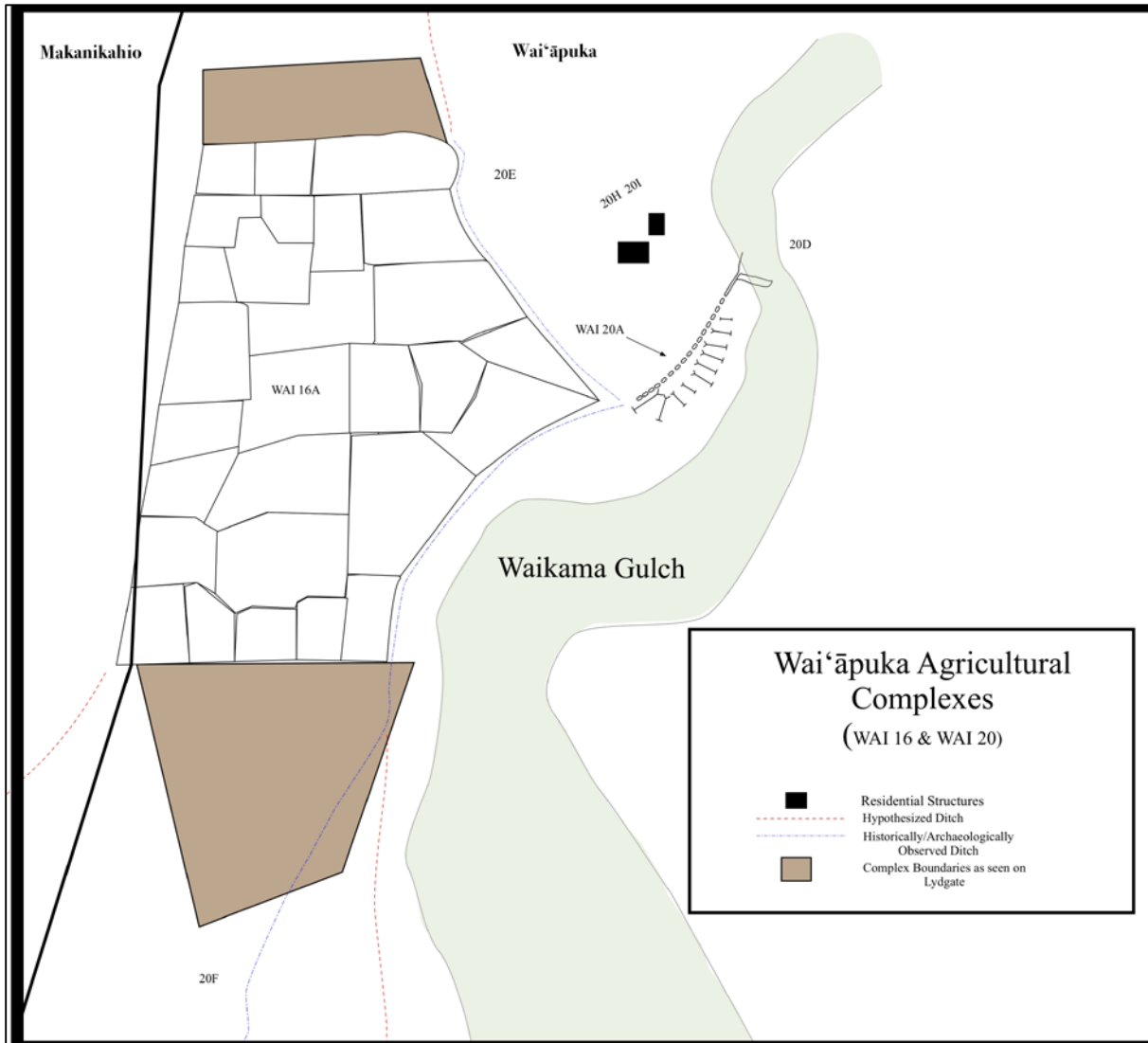


Figure 16. Reconstructed plan view map of Wai'āpuka Tunnel Complex, WAI 20 and WAI 16 and associated irrigation ditches.

Archaeological Features

The tunnel (WAI 20A) feature was constructed by excavating both along a slightly sloping grade through the exposed bedrock on the east slope of the stream and also by excavating as many as 19 (although only 16 are depicted on Cabot's map) vertical shafts that extend down to the same grade as the tunnel section beneath. The maximum depth below surface that the shafts were dug was estimated by Cabot to be 15' (or just under 5 m) from a point at the top elevation of the hill. Less than 1.00 m of this was soil; the remainder was dug through the bedrock basalt that forms the substrate throughout Kohala and the Hawaiian Islands. Because the hill sloped down towards its perimeter, the depths of the shafts decreased from the top of the hill on the Waikama Stream side outward towards the north and east. The tunnel itself was estimated by Cabot to be nearly 1 m in height.



Figure 17. Photograph of a collapsed shaft associated with Wai'āpuka Tunnel, showing approximate diameter and depth.

Out of the 16 to 19 shafts that are associated with the tunnel, we identified six shafts that were in good condition and several areas along the east section of the hill where they were collapsed or filled-in with rubble and soil (Figure 15). There are another five shafts, partly to mostly filled-in with rubble and soil perhaps, and four shafts that were engulfed by collapsed bedrock, largely obliterating their exact locations. In Cabot's drawing the vertical shafts are spaced relatively uniformly and close together, probably no more than 5 m apart at maximum. From our work in 2013, we suggest the shafts on the east side of the hill are spaced closer together and then the shafts are spaced farther apart moving west back towards the stream.

The *'auwai* (WAI 20D) that diverted water from Waikama Stream on the east bank of the stream began approximately 20 m above of the tunnel's entrance. This *'auwai* was dug at least partly through rock that formed the stream bedrock and the channel led from the stream to the entry of the tunnel (Figure 16). At the point where the ditch intersects the stream there is a branching of the stream channel on the west side. This appears to have been a second channel either to help slow the water flow and raise the water level for the Tunnel ditch. Alternatively, it may represent an effort to create an *'auwai* that would have brought water to the Nuili'i side of Waikama. The *'auwai* associated with the Tunnel is currently narrow due to sediment erosion into the channel

and the growth of vegetation, particularly roots surrounding the ditch. However, the condition of the 'auwai is rated as fair to good. Water from Waikama Stream does not currently flow from the stream into the 'auwai because sediments, vegetation, and rock fall have built up over time blocking the flow of water.



Figure 18. Photograph of 'auwai (WAI 20D) leading from Waikama Stream to the entrance of Wai'āpuka Tunnel.

About 9 m from Waikama Stream the 'auwai was angled towards the tunnel entry and here the stream and 'auwai change in elevation and direction: the 'auwai continues northeast towards the base of the slope and the stream flows over a small waterfall and into the pond below (WAI 20C) also known as Kamehameha's Pond. A portion of the 'auwai channel was built of rock and then apparently later in time was reinforced with cement or mortar. At point about 7 m from the tunnel entrance, there is a rock wall on the west side of the 'auwai with some cement (Figure 17). The rock wall is approximately 5.8 m in length and about 0.4 m wide. This rock wall leads to an obstruction, also containing some cement, approximately 1.5 m from the tunnel entrance into the face of the bedrock slope, creating barrier to entering the tunnel. (WAI 20B) The barrier is about 2.9 m across with a height of about 1.0 m (Figure 17). This wall was likely constructed when the lo'i fields (WAI 16) were abandoned and graded over for sugar cane cultivation. It is not clear when this occurred, certainly after 1904 when the Loebenstein map was compiled that showed the lo'i terraces still under traditional cultivation.



Figure 19. Photograph of barrier wall at east entrance to Wai'āpuka Tunnel.

The modified pool area, known as Kamehameha Pond is approximately 20 m downstream from the ditch along Waikama Stream that feeds the Wai'āpuka Tunnel complex. The pond measures 10 x 10 m and is approximately 2 m deep. There are a number of petroglyphs, at least one of which is an anthropomorphic image (Uyeoka et al. 2013, along the pond's bedrock borders. There is a small cave at the northeast corner of the pond.

On the northeast end of the tunnel, the last shaft that remains visible is a shallow excavation although bedrock is visible at its base. This and the other shafts just upslope from it are covered in vegetation, both guava (*Psidium guajava*) and Christmas berry (*Schinus terebinthifolius*). Approximately 1 m north of the last shaft there are two smaller shafts, only about 30 to 40 cm in depth. To the north of the last shaft there is a shallow "ditch", about 20 cm in depth that likely represents the former 'auwai. This ditch bifurcates, with one section (WAI 20E) extending to south along the east side of the hill above the lo'i of WAI 16 and the second ditch (WAI 20F) leads north and downslope on or near the west side of WAI 16.

The portion of the ditch extending along the north and east contour of the hill is still faintly visible and was traced for about 10 to 15 m. Below the ditch, along the base of the hill and extending in an easterly direction is a shallow "ridge slope". This entire area was likely converted into terraces for irrigated agriculture. This area of potential terracing likely continued to the south, extending the area of lo'i beyond what was mapped by Loebenstein in 1904. Owners of the neighboring property report terraces on their land, likely connected to WAI 16.

A second ditch (WAI 16B) is depicted on Loebenstein's map along the west side of the terrace complex again tracing the contour of the landscape that slopes to the east. Slightly elevated earthen berms of the edges of the former lo'i plots can be barely seen here, but are clearly visible in LiDAR imagery for this area (Figure 19). We have reconstructed possible locations for two other ditches (), the first of which would have traced a path along the upper east slope of Waikama Stream and which would have watered WAI 16B and possibly extended down slope to WAI 21, another irrigated agricultural complex that was recorded by Loebenstein. The second reconstructed ditch would have extended to the north and east of WAI 16A to a small ephemeral drainage that is associated with an irrigated terrace complex (MAA 3) recorded by Lydgate and identified as Auau, a section of lower Makanikahio 2 Ahupua'a.

WAI 16A is the primary complex of irrigated agricultural terraces in Wai'āpuka associated with the irrigation tunnel (WAI 20) ascribed to Kamehameha. The terraces were mapped by Lydgate in 1881 and then again by Loebenstein in 1904, suggesting they were in continuous use after European contact and until the area was converted to sugarcane cultivation in the 20th century. These terraces are not visible on the surface today but are detectable with LiDAR imagery Figure 19() as a waffle-like pattern on the ridge slope immediately east and north of the WAI 20 hilltop.

The extent and area covered by WAI 16A is depicted somewhat differently in the Lydgate and Loebenstein maps. Lydgate has the north portion of the terraces extending into what was the LCA award to Inaina from the LCA property of Parker. He also shows terraces placed closed to the upper slope above Waikama Stream. The Loebenstein map shows the east boundary of WAI 16A corresponding to Parker's LCA boundary, well beyond what Lydgate mapped. This is also the boundary between Wai'āpuka and Makanikahio 2. The LiDAR image of WAI 16A matches the plan view configuration of the terraces depicted in Loebenstein. Total area of WAI 16A was between 2.0 and 2.5 ha based on the maps by Lydgate and Loebenstein. It is one of the largest ridge top irrigated complexes documented thus far and when the likely extensions of it are considered, especially to the south, its area would have likely exceeded 3 ha.

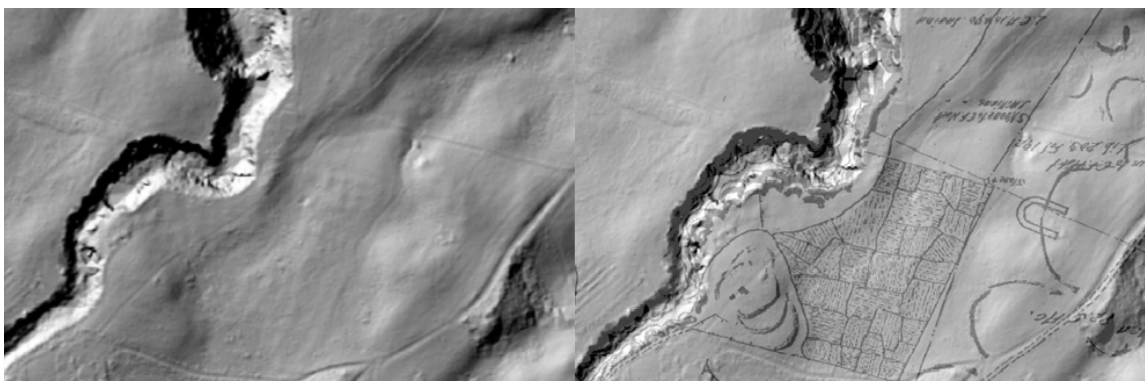


Figure 20. Maps depicting WAI 16A, irrigated agricultural terraces adjacent to the Wai'āpuka Tunnel as illustrated on the Loebenstein map and the LiDAR image. Note that LiDAR image shows "waffle-like" grid extending to top of Waikama Stream slope.

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

The LiDAR image also depicts two smaller terrace complexes (Figure 19), here identified as WAI 16B, to the north and west of WAI 16A, and WAI 16C to the south on the adjoining property just above Waikama Stream. WAI 16C is likely a contiguous extension of the main terrace complex and overlaps with the section of the irrigated terrace complex that was depicted on Lydgate's earlier map of 1881. The WAI 16B complex is not shown on either historical map but corresponds to the features identified by the current property owner. Because this complex lies at an elevation somewhat above WAI 16A it is likely a separate array of irrigated terraces, although irrigation water from it may have flowed down slope to WAI 16A.

It is likely that substantial subsurface deposits associated with the fields identified as WAI 16A, 16B, and 16C still exist and could be documented through excavation or further remote sensing with ground penetrating radar. Subsurface deposits could include pond field soils and charred mulching materials that are preserved below the cultivation zone associated with sugarcane. Additionally, remnants of the terrace borders, either foundations of rock retaining walls or earthen fill, may be preserved.

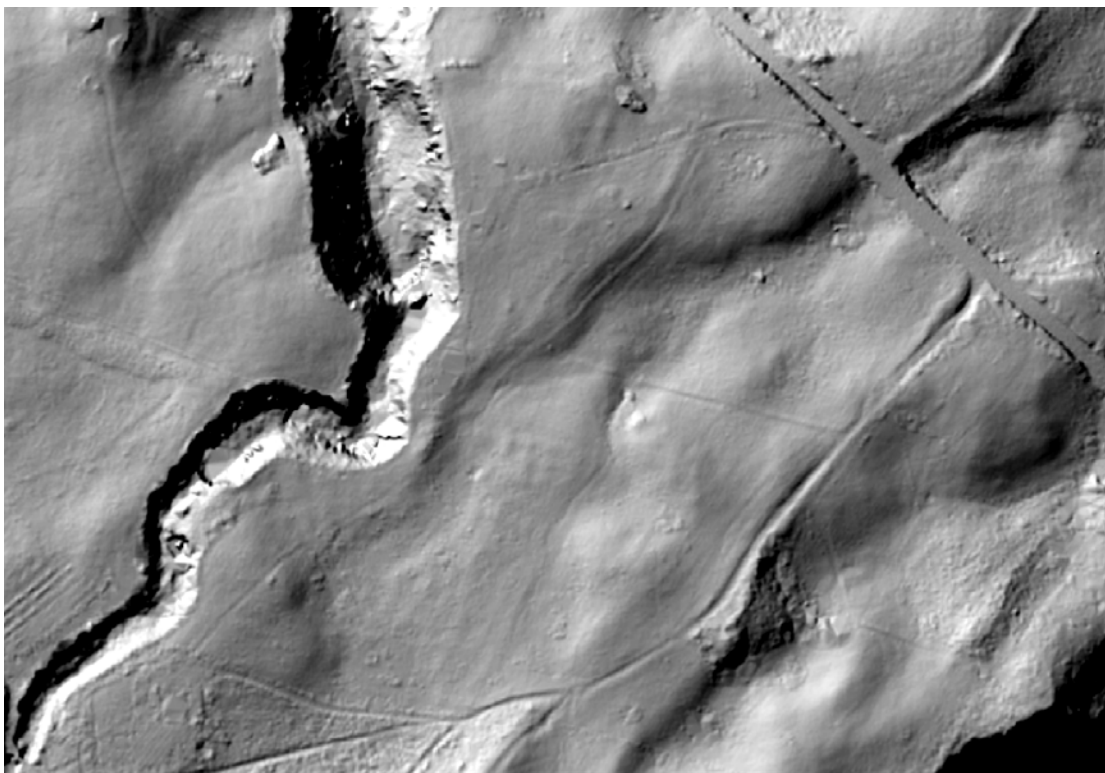


Figure 21. LiDAR hill slope imagery showing WAI 16, lo'i complex associated with Wai'āpuka Tunnel (WAI 20). Note remnant terraces identified as WAI 16B and WAI 16C to the south (mauka) and to the west and north (makai) of WAI 16A.

Lydgate's map has WAI 16A lo'i continuous with WAI 21 the lo'i complex located north of WAI 16 on LCA plot 10490 (Uyeoka et al. 2013: 265). This property is currently owned by the Chilton family. Lobenstein's map however, does not show WAI 16A and WAI 21 as contiguous, but rather depicts an 'auwai that links the northern end of WAI 16A with the southern end of WAI 21.

Wai'āpuka Tunnel Technology and Dating

In her description, Tomonari-Tuggle (1988) notes that some people believed the Wai'āpuka Tunnel was built after European contact because it must have required metal tools and Western engineering to construct a feature of its size and complexity (1988:38). However, in the early 19th century, the missionary William Ellis describes efforts by Kamehameha to construct tunnels through bedrock for transporting waters (see Uyeoka et al. 2013: 63). One way to distinguish Western from traditional Hawaiian efforts to dig irrigation tunnels or ditches would be to examine waste materials from excavations and to the sides of ditches or tunnels for signs of metal tools. While recording the Wai'āpuka Tunnel we looked for waste material of bedrock and soil that would have been excavated and piled nearby. Such piles have been noted adjacent to historic tunnels excavated during the period sugar cane cultivations. We found no spoil piles in the vicinity of the tunnel at either end, although there may be some evidence of small piles on the pu'u ridge top. We also looked for any indications on the tunnel side-walls that metal tools were used in its excavation. Metal tools such as picks, chisels, or shovels leave distinct marks when used to excavate through bedrock. These include the removal of relatively regular, and smooth sections of rock materials such as are visible on the tunnels associated with the Kohala Ditch. No metal tool marks could be determined identified on the tunnel walls either by the stream entry or at the base of any of the well-preserved shafts (Figure 20). Thus, there is no archaeological evidence that the Wai'āpuka Tunnel was constructed using Western technology (i.e., metal tools). Its association with a lo'i complex that was in turn associated with a series of lo'i complexes and 'auwai suggest construction with traditional Hawaiian technology prior to the introduction of metal tools.



Figure 22. Entry to Wai'āpuka Tunnel showing excavation through bedrock of the tunnel passage way.

The construction of Wai'āpuka Tunnel does represent a substantial engineering feat. The placement of the vertical shafts and their excavation to the same elevation as the tunnel required a good knowledge of landscape engineering. Most likely the tunnel was excavated in a sequence

beginning with shafts or holes dug closest to the point at which it was designed to emerge from the east side of the ridge. These shafts would have been relatively shallow and based on our observations they are spaced only about 1-1.5 m apart. As the tunnel was excavated to the south and west, the shafts became progressively deeper because of the slope of the hill increased the elevation of the surface of the land. Once a shaft was dug to the correct depth it would have been excavated horizontally in one or two directions, to the south and west towards the exposed bedrock above the Waikama Stream channel. In the opposite direction tunneling would have connected back to the last shaft dug. The series of vertical shafts had to be positioned to intersect the base of the tunnel, at an increasing grade (so that water would flow), and then ultimately extending to the bedrock slope but connected to the stream from which water was diverted.

This would have required the ability to measure and compare the exact elevation where the tunnel would direct water from the stream to the opening in the bedrock and also where the tunnel would emerge from the hill above the location where lo'i patches could be constructed and watered from the ditch and tunnel. Not only would elevation need to be exactly measured, but along the pathway of the shafts a grade sufficient to move water would have needed to be maintained. Finally, the direction of the tunnel needed to be maintained so that it would extend under the top of the hill or ridge intersecting the entrance at the stream-side and the point where water could be diverted to the lo'i patches.

WAI 16 and WAI 20 are functionally related complexes designed to transport water from Waikama Stream to the ridge above it to the east and then onto a series of irrigated agricultural terraces that extend down slope and to the north along a shallow ridge slope. These two complexes are likely linked in time, although it is possible that some irrigation of WAI 16A might have occurred before construction of WAI 20. But the excavation of WAI 20 is clearly linked to WAI 16, and to a series of other irrigated agricultural complexes located down slope from the tunnel. These complexes are linked to irrigation ditches, some of which are depicted on historical maps and others whose existence we have hypothesized. Water not only flowed from Waikama Stream through the tunnel to agricultural plots in Wai'āpuka but also east into Makanikahio 2, across an ahupua'a boundary. This type of irrigated agricultural system has been documented elsewhere in this area, wherein water was transported across drainages, dropping in elevation, and linking a series of agricultural complexes over a larger natural and cultural landscape.

[Agricultural Irrigation Complexes \(WAI 21, 23, 39\) Associated Ditches, and Habitation Features](#)

Samuel Kamuela Plunkett, Michael Graves, Kekuwa Kikiloj, Kelley Uyeoka, and Joseph Birkmann

[Agricultural Irrigation Complex and Habitation Features \(WAI 21\)](#)

WAI 21 represents an agricultural complex on the Chilton family property, located north of WAI 16 and south of WAI 23, an irrigated agricultural complex on the north side of the Akoni Pule Highway. This complex is linked by one or more irrigation ditches to the agricultural terrace complex (WAI 16) associated with the Wai'āpuka Tunnel (WAI 20). Moreover, it is linked to WAI 23, an irrigated agricultural complex farther downslope. Lobenstein's map shows the geographic relationships

between WAI 16/20 WAI 21, and WAI 23 (Figure 21). The LiDAR image, while it does not depict the WAI 21 complex, does match the location of a ditch (WAI 20B) that flowed northward from WAI 16A, through WAI 16C, and into WAI 21. Both WAI 16B and WAI 21 are located within the LCA awarded to Inaina (also known as Niaiana). Immediately adjacent to the north of Inaina's parcel are those of Paku and Kamalii.

Critical to analyzing Lobenstein's map is to note the line that connects WAI 20 to lo'i complex WAI 21. This line has been designated feature WAI 20B. The LiDAR analysis discussed for WAI 16 supports the possibility that these complexes were connected by water coming out of Wai'āpuka Tunnel if it remained on a higher elevation than WAI 16A-B. WAI 21 an irrigated agricultural complex is located just north and down slope from WAI 16. Thus both complexes were irrigated from water coming out of Waikama Stream through the Wai'āpuka Tunnel. In view of this, it is interesting to note that one of the translations of Wai'āpuka is "water coming out" (Uyeoka 2013: 213) suggesting a reference to the tunnels and ditches in this ahupua'a. As noted above, the earlier Lydgate map has WAI 21 and WAI 16 contiguous and/or continuous across the slope. According to the ethnohistorical record this lo'i and ditch complex (LCA – 10490) belonging to Inaina contained 20 lo'i and 1 'uala patch (Uyeoka 2013: 265-267). There is one dry land terrace depicted on Figure 21, possibly the sweet potato patch.

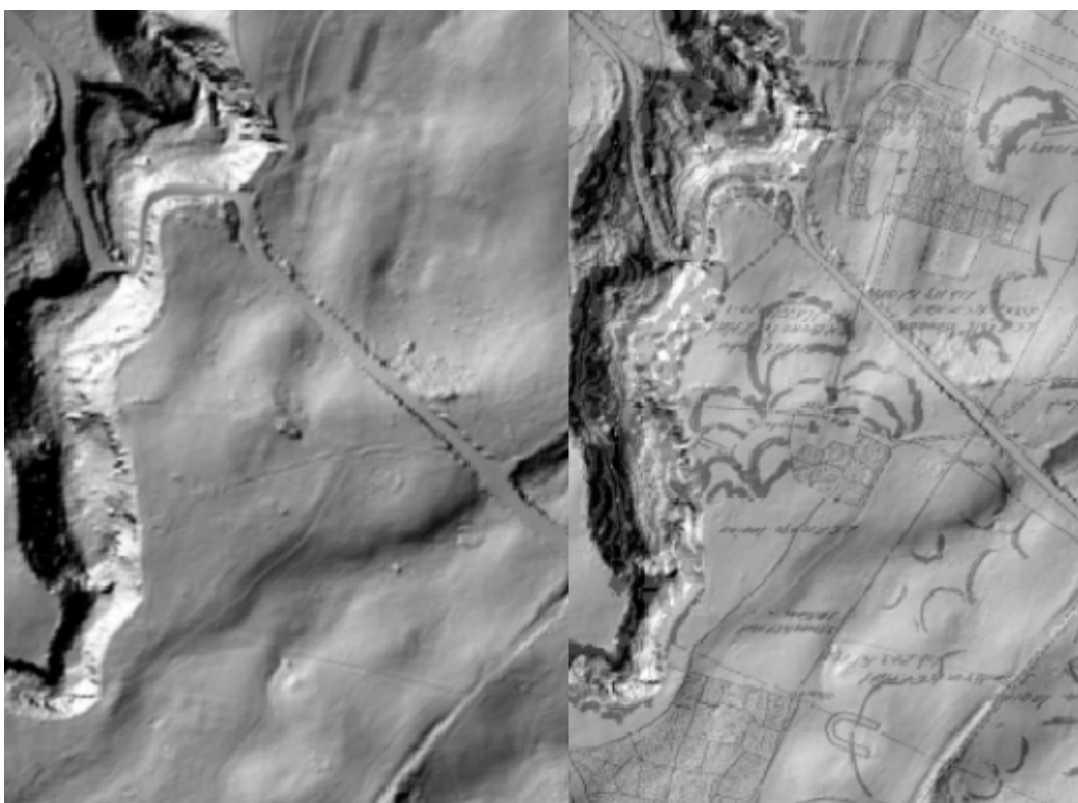


Figure 23. WAI 21, irrigated agricultural terrace complex depicted on Loebenstein map and barely visible on LiDAR imagery. Note possible irrigation ditch extending from the northwest corner of WAI 16A to WAI 21 shown on Loebenstein map.

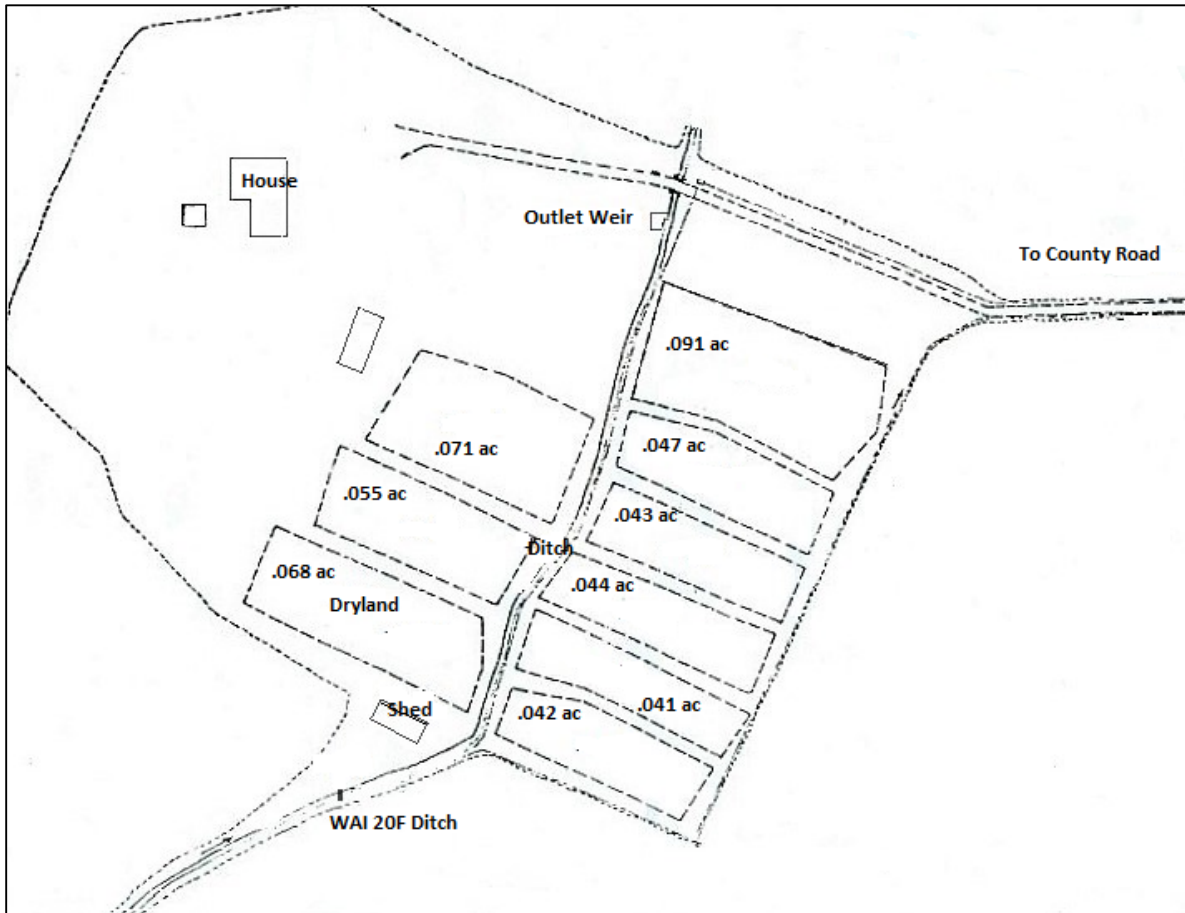


Figure 24. 1934 survey map of lo'i and 'auwai by Union Mill & Plantation of WAI 21, LCA 10490, Wai'āpuka. This plot is currently on land owned by Greg Chilton.

The LCA plot formerly owned by Inaina is currently owned by Kohala resident Greg Chilton. Due to time constraints we were unable to obtain access to survey this agricultural and habitation complex. However, on the last day of fieldwork we were able to meet briefly with Mr. Chilton. During this meeting Mr. Chilton provided us with a 1934 survey map (Figure 22) of his property done by Union Mill & Plantation. This map shows an irrigation ditch flowing through the middle of an agricultural terrace complex with a series of lo'i on either side. This ditch extended northward through the lo'i and then flowed downslope and likely crossed the road into the property and then continued across the Akoni Pule Highway. A "weir outlet" is identified on this map. The map shown in Figure 21 corroborates the Loebenstein map and ethnohistorical records as the LCA award 10490. Note the presence of a house on both the Loebenstein and 1934 Union Mill maps in approximately the same location. These lo'i were in use as late as the mid-1930s, prior to the terraces' conversion to sugar cane or private ownership. Irrigation water for these terraces had to come from the Wai'āpuka Tunnel irrigation system, perhaps supplemented by other water sources that originated farther upslope in Makanikahio 2 and in Wai'āpuka. The total cultivated area of this complex is 0.50 ac (0.20 ha), with plots all averaging 0.04-0.09 ac. At least one of the plots was identified as dry land; it appears to be slightly upslope from the irrigation ditch. This combination of rainfed and irrigated plots is mentioned in the Native testimonies for several of the LCA awards in Wai'āpuka. Given the generally low soil fertility in areas with more than 2000 mm of rainfall in

windward Kohala (Palmer, et al., 2009) this suggests dry land cultivation was augmented by mulching and/or by longer periods of fallow between years of cultivation.

The map of WAI 21 shows at least one point where excess water was directed downslope from the terrace complex. This ditch would have crossed the road in likely watered the eastern portion of WAI 23, one of the lowest elevation, ridge lands irrigated agricultural complexes that we have documented. It is possible that a second ditch extended along the upper east side of Waikama Stream to the west of WAI 21 and would have fed the western portion of the WAI 23 complex.

[Agricultural Irrigation Complex, Ditch, and Habitation Feature \(WAI 23A, WAI 23B\)](#)

WAI 23 represents the last in a series of irrigation complexes along the east ridge slope above Waikama Stream.

The lo'i of WAI-23 received their water from ditches that flowed through or around WAI 21, the irrigated agriculture complex just south (upslope), on the mauka side of Pule Akoni Highway. There are four LCA awards connected to WAI 23. These plots belonged to: Paku (LCA 10856), Kamaiali'i (LCA 8616B), Nihoa (LCA 10489), and Pi (LCA 10865) (Uyeoka 2013: 265-267). They are estimated to contain an area of about 1.0 ha.

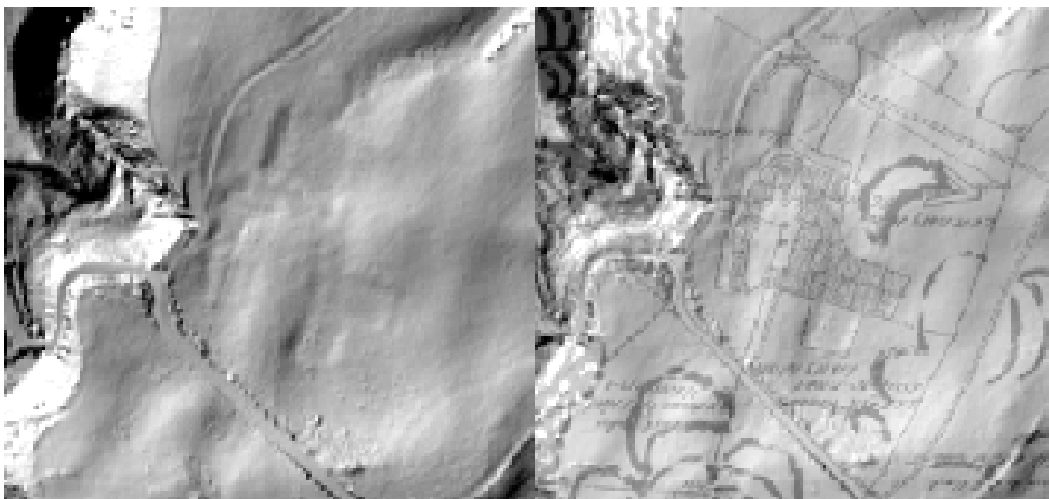


Figure 25. Irrigated agricultural complex, with outline from Loebenstein (1904) and LiDAR of the same area (WAI 23A, WAI 23B).

This complex was first identified on the 1904 Loebenstein map (Figure 22). The site is in poor condition as the area was graded over during the sugar cane era. It is currently being used to graze cattle. The site is bordered by Waikama Gulch on the west with a modern cattle fence line running through it. The fence is a modern division most likely installed by modern ranchers and runs South to North through Kamaiali'i and Nihoa's LCA plots. This fence subsequently divides WAI 23 into east (WAI 23B) and west (WAI 23A) portions. During the 2013 H2ARP summer field school only the western portion of this complex was documented. The eastern portion of this complex will be mapped at a later time. WAI 23A is approximately 150 meters long, and 50 to 70 m wide depending on; the bend of the modern Jeep road, slope contours, and possible locations of a past dry land agricultural field. The site includes four possible lo'i whose sizes range between 50–120 m². The site was mapped using tape and compass mapping, and GPS points were also collected.

There are no rock retaining walls or prominent rock features on the surface of this site due to grading. Hand excavations were not recommended due to the condition of the site. However, a backhoe excavation was performed at the northern border of this site where buried stacked stone resembling a lo'i retaining wall or an 'auwai embankment was uncovered. Charcoal was collected from under the bottom course of stone and is pending analysis.

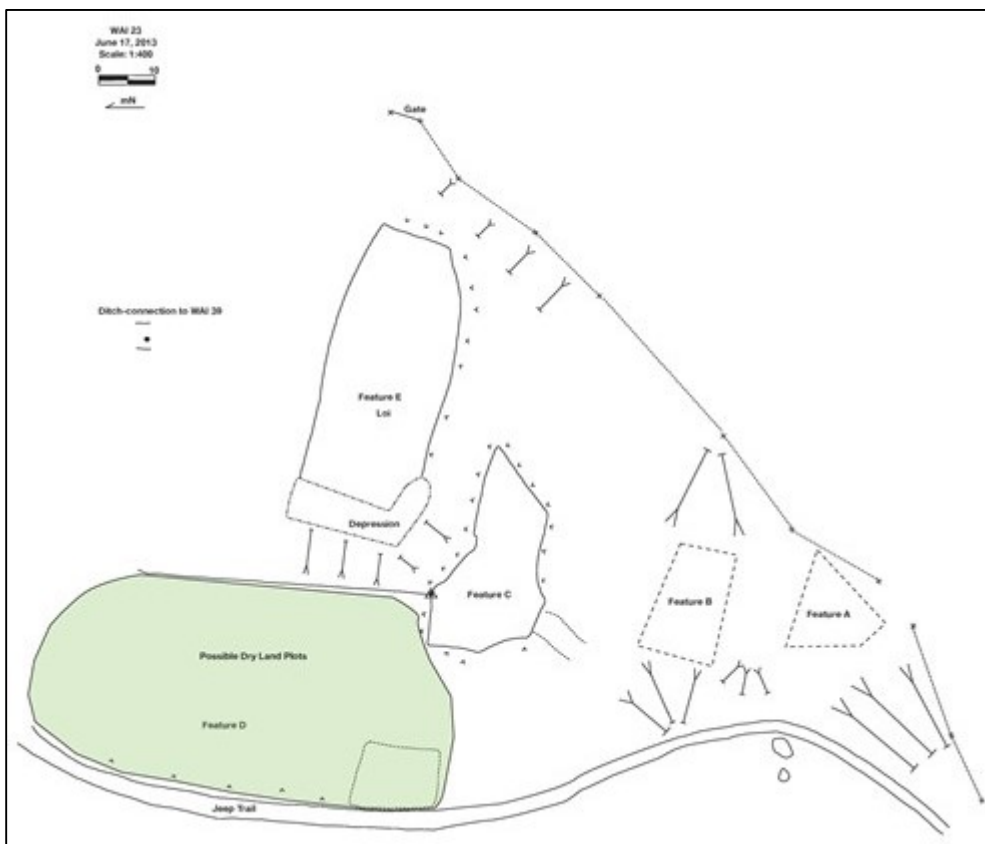


Figure 26. Current map of irrigated agricultural terraces in former cane lands (WAI 23A). Most of the individual lo'i are no longer recognizable on the ground (but note comparison to LiDAR image of same location).

Agricultural Irrigation Terraces, Possible, Ditch, and Gully (WAI 39)

WAI 39 is an agricultural complex (Figure 24), including an irrigation ditch located in a gully located between two ridges. This relatively shallow drainage is oriented along a southwest to northeast axis and extends approximately 440 m. The drainage most likely would have been irrigated as it connects to the irrigation ditch on the north end of WAI 23. Both lo'i and 'auwai are for WAI 23 on Loebenstein's 1904 map. This gully and ditch system is associated with the LCA parcels awarded to Pi (10865), Kaluahi (8713), and Kaipukane (8814) (Uyeoka 2013: 265-267).

Feature A is the ditch which running through the gully, would have been feed by water draining out of WAI 23. Feature C represents possible wetland terraces that most likely would have existed on the more gradual western slope of the gully. Both the terraces and ditch are difficult to see because of the historic alterations done on the land (i.e. grading for sugar cane and current cattle). While the actual location of lo'i and 'auwai is difficult to determine ethnohistorical data for Kaluahi- LCA 8713 confirm that this land contained eight lo'i mo'o (taro field belonging to tenant) and one garden (Uyeoka et. al. 2013). Feature D is a berm off to the furthest northwest portion

of this complex. It lies just west of where the 'auwai (feature A) would have flowed off the cliff. It is approximately 20 cm high marking the transition between two possible terraced agricultural fields.

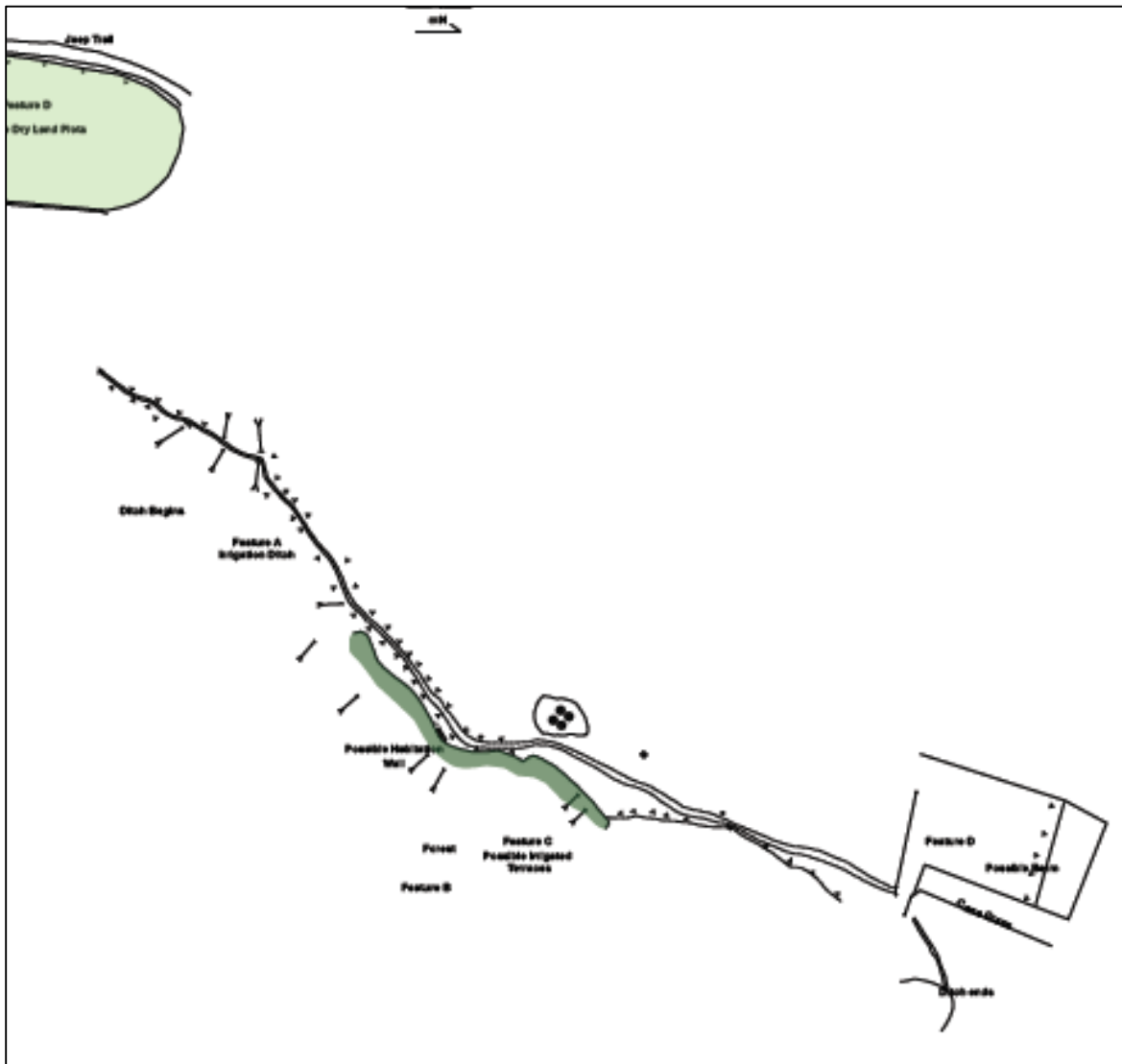


Figure 27. Overview map of irrigated agricultural complex (WAI 39), including upper 'auwai, gully, and lower (cliff line) 'auwai features. A possible dry land field plot is also illustrated

Feature B is a possible habitation site located on the eastern slope across from Feature C (possible wetland terrace). Cane grass dominates the area currently, with areas of heavy lantana as well. Vegetation is predominately invasive. On the eastern slope Feature B's elevation is higher than the potential terraces on the more gradual eastern slope, which makes its location an appropriate site for overseeing the production of the fields below. Today the actual ditch is not visible; however, LiDAR imagery (Figure 25) again shows elevation differentials and the most probable path for water to drain. Today the ditch can be seen closer to the cliff line where it terminates as this gully still serves as drainage during heavy rains.

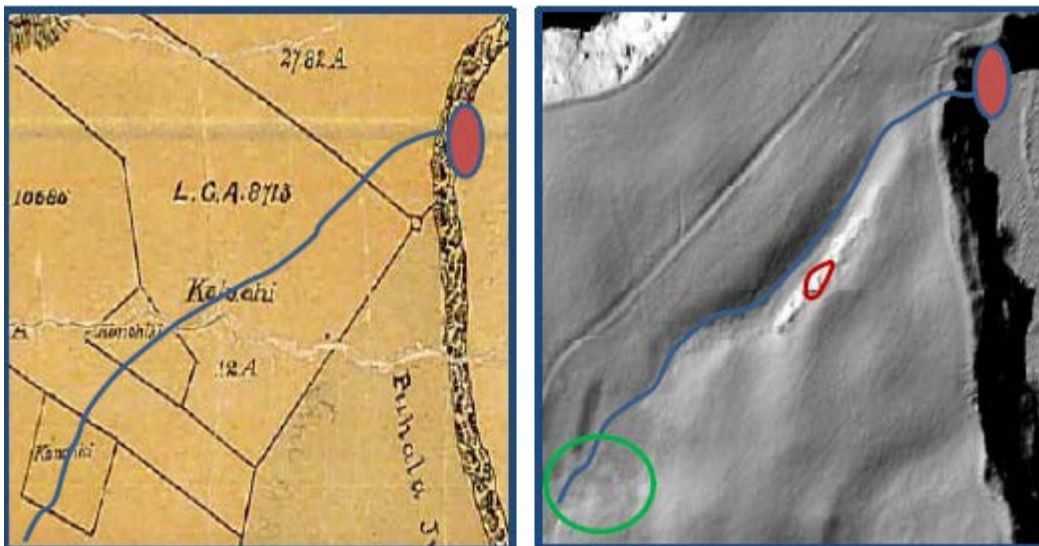


Figure 28. Lydgate map (1881) and LiDAR image of makai Wai'āpuka archaeological features including the auwai section just above the cliff line (from Plunkett 2013).

Managed or Cultivated Trees (WAI 40) and Habitation Feature (WAI 7), makai Wai'āpuka

Ruth Aloua and Michael Graves

WAI-40 is a hala (*Pandanaceae*) grove located at the tip of cliff line above the ocean on the small peninsula at the north end of Wai'āpuka (see Figure 26). Neue Bay is located to the west below this cliff and to the east the tip of a small projection of land is identified as 'Ākoako Point. The hala grove is currently located on land that is owned by Kamehameha Schools; these lands were previously surveyed for the project and then again in 2013). The hala grove extends across the cliff line from the west to the east and then south beyond the boundary that separates Wai'āpuka from Makanikahio 2. Hala trees are widely dispersed throughout the area, growing predominantly in clumps of 2-3 trees, and sometimes- individual trees growing alone (Figure 27). Additionally, fallen, dried trees indicate that several hala trees have died and leafless stumps in the area suggest that other trees are dying (). Along the west side of the west side of the cliff, there is a small habitation feature (WAI 7) defined by a paving of rocks and a number of volcanic glass and basalt flakes nearby. This feature was previously documented by HARP archaeologists (McCoy et al 2008; Graves et al. 2012).

The hala grove was identified on Lydgate's 1881 map, thus a cartographer documented a hala grove that grew in the area (Figure 25) that was probably more extensive than what currently exists. On this historical map, the hala grove is referred to as the "Puhala Grove" and the "Puhala Jungle." The historical map illustrates that the grove once began at the northwest corner of Wai'āpuka near Neue Bay, wrapped around 'Ākoako Point, and extended southeast towards Makanikahio 1 and Pololū. It is possible that the hala grove contains remnants of the same hala grove documented by Lydgate. On the trail down to Pololū valley there are a number of places where hala is also growing extensively, suggesting the grove was managed, might have included other useful taxa in the past, and likely extended across parts of the Pololū slope. Valley and gulch slopes (especially upper slopes) elsewhere may have supported hala that is today absent or rare.



Figure 29. Google Earth aerial image of historic hala grove (WAI 14) along the cliff line in Waiāpuka at 'Ākoakoa Point

In addition to the hala, *there are also several other native plants growing in the area like: kipukai (*Heliotropium curassavicum*), akoko (*Chamaesyce*), coastal naupaka (*Scaevola sericea*), pōhuehue (*Ipomoea pes-caprae*), and milo (*Thespesia populnea*). While surveying the ridge lands, the field school students spoke with Kamehameha School employees as they were heading to the coastal lands. The employees informed the field school students that they were conducting a re-vegetation project on the Kamehameha School coastal lands. Thus, it seems that some of these plants may have been recently planted in the area. For example, the two ground vines, 'ākulikuli (*Sesuvium portulacastrum*) and kipukai are growing *near the pali* edge with fiber mats located near them. To prevent erosion, employees of Kamehameha Schools recently planted the vines and placed fiber mats along the pali to prevent erosion.*



Figure 30. Remnant hala grove (WAI 40) makai Waiāpuka.



Figure 31. Dead or downhlala trees (WAI 40), makai Wai'āpuka at 'Ākoakoa Point.

Ritual and Agricultural Complex, with Pond and Irrigation Ditch (WAI 35)

Ruth Aloua and Michael Graves

This complex was located and mapped in 2012 (Graves et al 2013). It is located within and along the back cliff line of a small secondary drainage east of Waikama Stream in mauka Wai'āpuka. This gully is located just north (down slope) of the confluence of 'Ōpaepilau and Waikama Streams. It is comprised of an agricultural complex that contains a bedrock cut ditch (extending out from a small tunnel), associated ritual feature, small terrace, retaining wall, pond, and rock shelter (see Figure 29); for a more in-depth discussion see Graves et al. 2012). Within the area, there are approximately 75 *mai'a* (*Musa x paradisiacal*) trees that are growing as single trees or in clumps of 2-3 trees. The tallest trees are located along the east cliff side growing up to a height of 15 meters (Figure 30). The smallest trees are approximately 1 meter tall and are growing throughout the area. Since some trees are bearing fruit, it seems probable that some receive sufficient sunlight, water, and nutrients. Additionally, none of the trees display intentional harvesting practices, like cuttings. The lack of fallen fruit suggests that local residents in the area harvest the fruit for subsistence. The size of the grove also suggests that the grove is an old grove that was not recently planted.

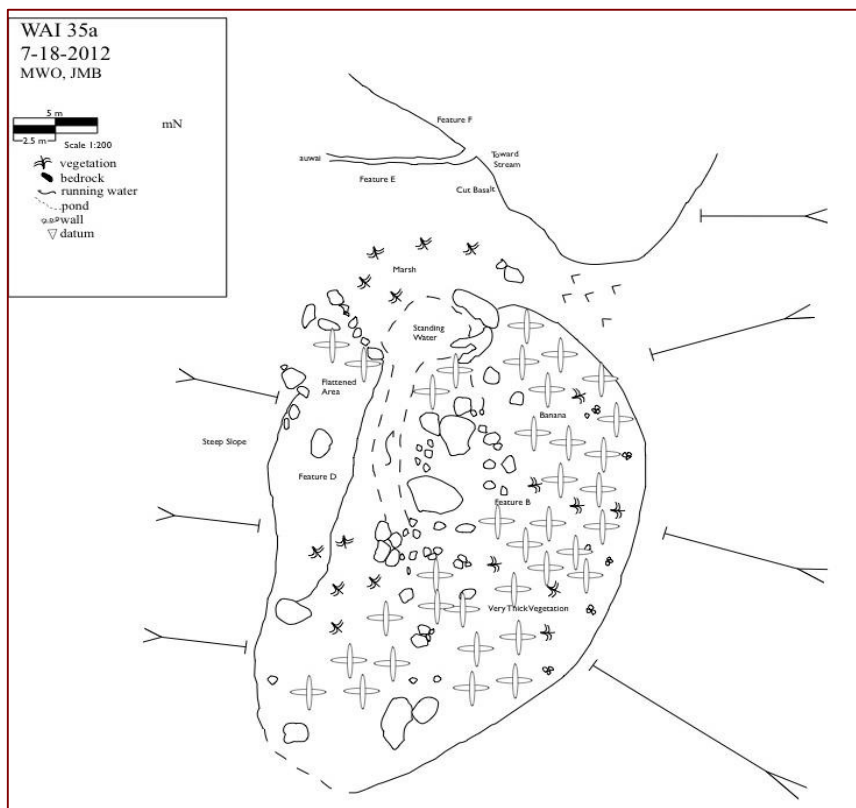


Figure 32. Map of WAI 35, illustrating the site and the *mai'a* grove located within and along the talus slope.

Other native vegetation that is growing in the area include *kī* (*Cordyline terminalis*), *noni* (*Morinda citrifolia*), and *'awapuhi* (*Zingiber zerumbet*) that are growing at the base of WAI-35, Along the top of the slope and cliff line above the pond the vegetation is dominated by *'ōh i'a* lehua, and ferns. Some non- native vegetation growing at the base of WAI-35 includes: Christmas berry, strawberry guava (*Psidium cattleianum*), agave (*Agave sisalana*), kahili ginger (*Hedychium gardnerianum*), and avocado (*Persea Americana*), and macadamia nut trees (*Macadamia*

integrifolia). Of these non-native vegetation, the most invasive and that appear to pose a high threat to the native varieties the Christmas berry, strawberry guava, and kahili ginger. They are considered a high threat because these trees are blocking sunlight from the understory of the forest or are widespread in the area even in those shaded by trees.



Figure 33. Large, mature mai'a (banana) tree grove along east talus and cliff of WAI 35.

Possible Habitation or Other Architectural Feature (WAI 38)

WAI-38 is a possible habitation or ritual/religious feature (Feature A) defined by a low enclosed wall, and includes a small mound (Feature B) that may have functioned as a burial (Figure 31). This small complex is located in mauka Wai'āpuka, in the forested zone and within the catchment of

THE HAWAI'I HISTORICAL AND ARCHAEOLOGICAL RESEARCH PROJECT: 2013

'Ōpaepilau Stream. The complex is situated just east of an impermanent secondary drainage that contains a series of barrage terraces (WAI 31) and at least one habitation feature; the drainage is about 500 m in length and enters 'Ōpaepilau just within the forested zone at about 1000 ft asl . Feature A is a potential house site or religious feature that measures approximately 9.6 m in length, 7.1 m in width, with stacked rock walls between 1 and 1.7 m high (as measured from the exterior grade). The structure is built on a gentle slope which trends eastward. Due to the slope and trees growing on virtually all of the walls, they have partly collapsed either outward or inward. The west wall has inward collapse with some kī (*Cordyline terminalis*) growing along the northern portion of it. Four large 'ōhi'a lehua (*Metrosideros polymorpha*) trees are growing out of the northwest corner causing considerable disturbance. The north wall has outward collapse and invasive vegetation growing alongside it. The east wall has some outward collapse but has the best integrity compared to the other walls. Wall height measurements were taken off the northern portion of east wall, which has little disturbance. The southeast corner of the structure has what appears to be the entrance and has some water worn paving on the interior. The paving area likely extends into the interior although vegetation has made this assumption impossible to confirm. The south wall is very eroded with both outward and inward collapse due to a large 'ōhi'a lehua tree growing out of it.

The structure is likely traditional, possibly dating to a period prior to European contact as there are no historic modifications or artifacts and the land has not been cleared or graded (it is above the area used for sugar cane cultivation). Feature B is a mound located 10.2 m north (down slope) of Feature A. This feature may be a burial mound; however, the center of the structure is void of rock, suggesting there is nothing contained within it. It is unknown what other function it may have served. The structure has been built on a north slope and has a rectangular plan view but the south portion of structure is oriented towards Feature A. Outward collapse has occurred on all sides, perhaps due to invasive vegetation growing directly on top of mound. The center of the structure is clearly mounded and the north end appears to have been more clearly stacked. The stacked area is not faced and is made up of five courses. The south edge of the structure is built on more leveled ground and has some collapse at its west end. The feature's height was measured at the center of the feature where piling of rock is more noticeable despite the natural slope of land. There is a shallow drainage located about 10 m east that extends past Feature A as well as Feature B and which comprises the uppermost section of the WAI-31 impermanent drainage. The drainage is not indicative of recent water flow. There were no surface artifacts found at the site. The land surrounding the drainage in this area is relatively flat and the soil cover appears to be substantial. Overall, Feature A is in good condition.

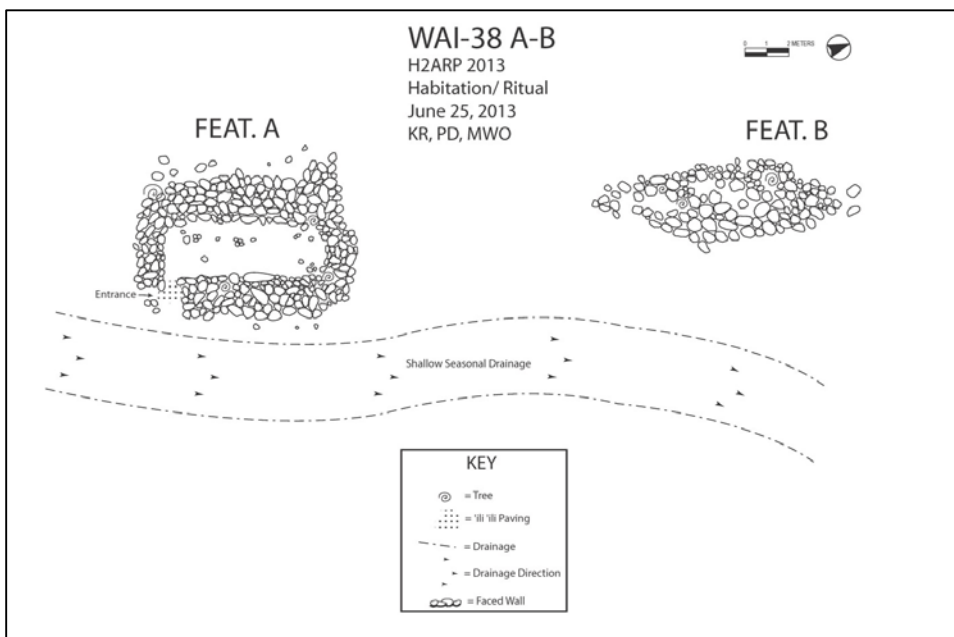


Figure 34. WAI 38, a small walled enclosure with associated rock mound, mauka Wai'āpuka.

The Makai Wai'āpuka-Makanikahio Irrigated Agricultural System

Samuel Kamuela Plunkett, Michael Graves, Joseph Birkmann, Kahealani Walker, Kelley Uyeoka, and Kekuewa Kikiloi

We have documented several irrigated agricultural complexes from historical maps and archaeology surveys, and portions of irrigation ditches that were identified both on maps, archaeological surveying and excavations. Where irrigation ditches have not been previously documented we also hypothesize where such features might be located. Here we link these complexes and features together into a single unit, the Makai Wai'āpuka-Makanikahio Agricultural System.

Ridge and Stream Drainage Topography in Relation to Traditional Hawaiian Irrigated Agriculture in Windward Kohala

Windward Kohala, particularly in the eastern gulches surrounding Wai'āpuka are characterized by a topography in which stream channels have incised drainages that extend roughly north (mauka) to south (makai). The overall gradient of the ridge lands of windward Kohala provides a relatively gentle slope as it “falls seven km (4.5 mi) from the 1220 m (4000’) elevation to the 300 m (1000 ft.) high vertical cliffs which mark the windward coastline” (Tomonari-Tuggle 1988: 5). Further, the ridge lands between stream drainages consist not of multiple geological terraces separated by steep slopes and a central sharply delineated ridge line. Rather, stream drainages are variably incised, although in most areas from the stream bottom to the top of the main ridge section is usually no more than 200-300’ (75-100 m) in elevation. This likely occurred because of interaction between high rainfall and the late Pleistocene age of the underlying volcanic substrates (150-600 kya) have generated erosion forming V-Shaped valleys but with relatively little subsidence and

infilling for the gulch areas of windward Kohala. In some sections of drainages the drop in elevation of the stream channel is moderate and the upper slopes of gulches leading to ridges may be no more than a few meters above the stream channel. We have noted, but not yet systematically mapped such occurrences in several of the eastern gulches. They represent prime locations for potentially constructing irrigation ditches that can effectively move water from streams out of the stream bed and onto the ridge lands through the force of gravity flow of water in ditch channels.

Two other topographic features both facilitate and complicate the transport of water from streams down ridge lands. The ridge lands between gulches are often broad (relative to the size of the narrow stream channels and gulches) and slope towards the south, i.e., the coast. Punctuating these “ridge slopes” are secondary drainages that have developed and which are usually more common and of greater overall length at higher elevations. These secondary drainages “interrupt” the southward flow of surface water accumulations after rainfall along ridge slopes back into the stream and gulch catchment.

The resulting topography thus provides opportunities for irrigation ditches where ridge lands and stream channels correspond in elevation to transport water from the streams onto agricultural terraces constructed on the broad ridge lands that slope gently to the south. This created additional arable land for kalo and other forms of cultivation. While this topography is not unique Kohala, apparently Hawaiian farmers in this region recognized the potential of increasing what would otherwise be a limited environment for irrigation agriculture.

The array of secondary drainages that flow into the stream valleys do not generally support free-flowing water, although they are often areas where springs occurred. Such areas can be used for rain fed agriculture and intermittent irrigation as rainfall runoff collects within such gullies. However, if irrigation water can be brought into secondary drainages from locations farther upslope, such areas can be also modified for more permanent irrigation with barrage terraces—retaining walls that are placed perpendicular to the axis of a drainage in the gully bottom lands.

Within this environmental and climatic context, Hawaiian farmers engineered networks of irrigation and agricultural terraces into systems of production that extended cultivation onto lands where it was not traditionally expected to occur—along the ridge “top” lands and within the secondary drainages. The remnants of one of these systems has been located in the lower, makai part of Wai'āpuka. It formerly directed water flow from Waikama Stream on the western border of the ahupua'a towards the ridge lands to the east (and possibly included water from Waiakalae Stream in upper Makanikahio to the east directed to the west into ridge lands that ultimately included those of Wai'āpuka).

Ridge Lands, Slopes, Stream Channels, and Engineering Irrigation Systems

A key component in the makai Wai'āpuka -Makanikahio agricultural system was to identify at least one location where water was moved out of the Waikama Stream channel and onto the

surrounding ridge lands. The Wai'āpuka Tunnel effectively meets this requirement since the location when the tunnel exited the hill top slope east of Waikama, waters flowed into at least two distinct irrigation ditches and then on to the lo'ī complex identified as WAI 16A (see Figure 35). This is probably not the only water supply for this agricultural system; there are irrigation systems on the Wai'āpuka ridge lands or within Makanikahio secondary drainages that might have supplemented water from the Tunnel complex.

Wai'āpuka Tunnel is no small feat of engineering and labor. The tunnel meets our expectation of ridge land irrigation as it was built at a location where Waikama stream and the table lands are relatively on the same elevation. A relatively short distance north or Makai of this point the elevation of the channel in which Waikama Stream flows, drops dramatically in relation to the ridge lands on either side of the stream. Transporting water out of Waikama onto the ridge lands at any point downstream of the tunnel would have been improbable and impractical. WAI 16A and 20 are located at the only point where water can be diverted out of Waikama Stream above its terminus in Neue Bay.

Figure 35 depicts the generalized topography of the Makai Wai'āpuka and Makanikahio and illustrates what we have come to call "ridge slopes" (Graves et al. 2013). Two ridge lines occur relatively parallel or adjacent to each other, (depending on depth and breadth of topographical depression between them), down slope of WAI 16A/20 and there are at least two more that are located farther east onto Makanikahio lands. We believe Hawaiians took advantage of these ridge lands to engineer the locations of and directions taken by 'auwai. In short, lo'ī were placed within these ridge slopes' environs and 'auwai were constructed on the side slopes just above but also at the bottom of lo'ī complexes. This took advantage of the gravity flow of water down slope in both irrigation channels and across terraces complexes (from one level to the next). One can think of these as symbolic representations of water flow within stream catchments, where the banks of streams catch water and the variations in stream channel elevation drop mirrored how Hawaiians built their network of 'auwai and lo'ī complexes

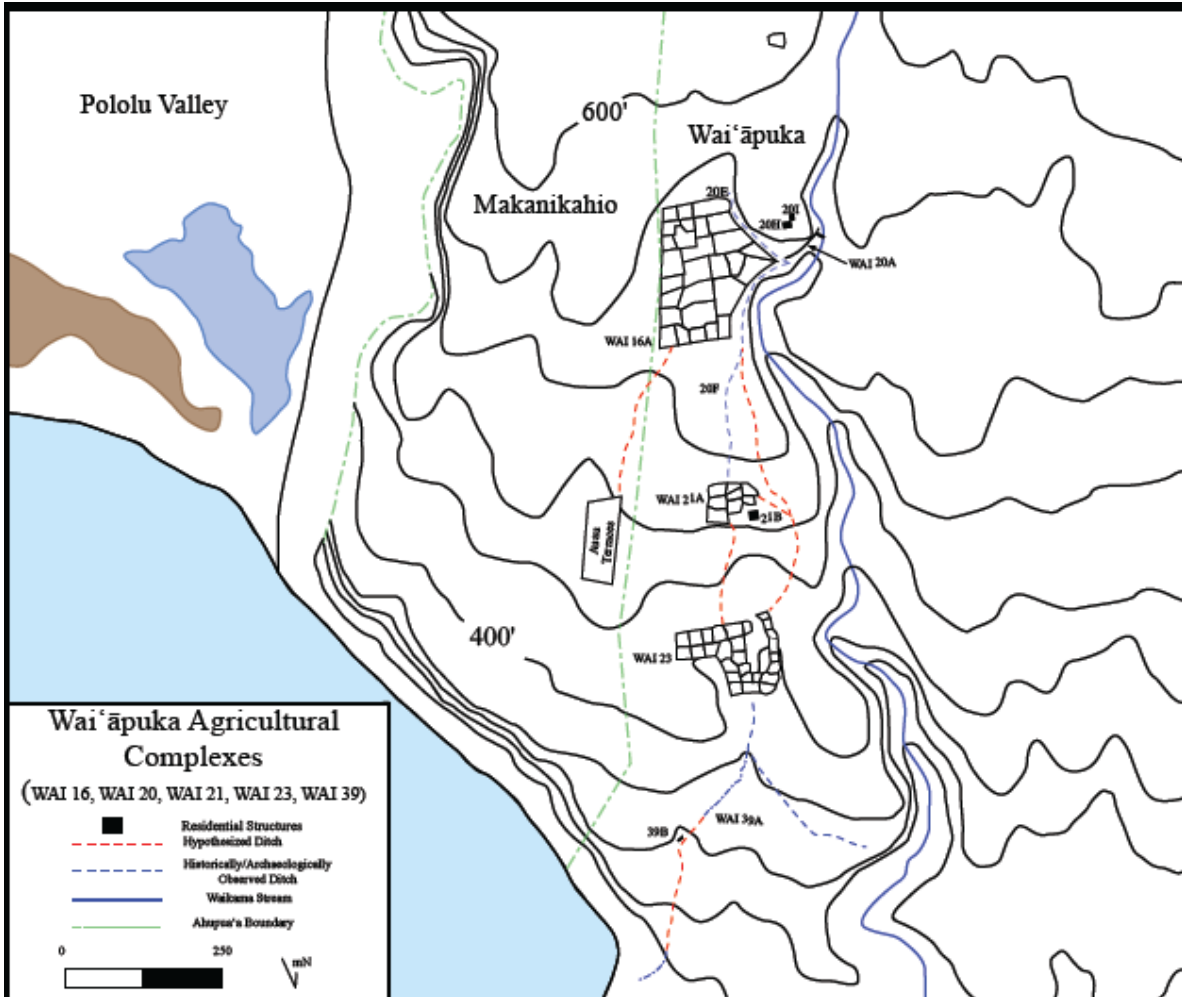


Figure 35. The Makai Wai'āpuka-Makanikahio Agricultural System in windward Kohala.

From the Wai'āpuka Tunnel complex at least two and possibly three irrigation ditches extended farther down slope. One of the ditches headed southeast across the ahupua'a boundary with Makanikahio and onto a series of terraces that are associated with "Auau" and shown on Figure 35. This term is used inter-changeably both as 'ili 'āina as well as ahupua'a in native accounts. Farther downslope of the Auau complex there is a short gully, now filled in with graded sugar cane deposits, but which may have also been irrigated and could have supported agricultural terraces down to the cliff edge.

Elsewhere, one or more 'auwai would have led downslope and to the north onto or alongside WAI 21 the second lo'i complex described previously. Figure 36 is a photograph of the landscape looking downslope from the Wai'āpuka Tunnel complex to WAI 21. Note how the lands slope to the north along a modest gradient on these ridge lands. The 'auwai shown on the right is depicted on Loebenstein's (1904) map; the second 'auwai is suggested both by LiDAR imagery and by the need to transport water to the west side of WAI 21 in order for it to reach a portion of WAI 23, the third lo'i complex in this series.



Figure 36. View looking north from Wai'āpuka Tunnel showing the "ridge slopes" of lower Wai'āpuka and the possible directions of auwai supplying water to the WAI 21 complex.

From WAI 21 water moved through one or more ditches to irrigate terraces located at WAI 23A and WAI 23B. This is the northernmost of the ridge lands' lo'i complexes in Wai'āpuka; elsewhere there are small discrete lo'i complexes along Waikama Stream to the west on both Niuli'i and Wai'āpuka lands. At three "konohiki" plots are associated with WAI 23 based on historical maps and LCA native testimonies. The lower most of these is located on the north end of WAI 23 and there is an 'auwai extending north from this plot down slope and into a small gully (Figure 37).



Figure 37. View of direction that 'auwai from WAI 23 would have taken into WAI 39, the Makai gully agricultural complex in lower Wai'āpuka.

Taking into consideration the topography of Wai'āpuka it is clear that Hawaiian agriculturalists planning and engineering a lo'i complex (and system) on ridge lands would have taken into consideration the locations and spatial relations among ridge slopes and secondary drainages. Except for WAI 20B, a portion of the Wai'āpuka Tunnel complex all other 'auwai and lo'i in this system lie in or in between ridge slopes. Because the lowest point along a ridge slope may not always follow a sufficiently steep downhill gradient, the overall landscape does and 'auwai could have been constructed along the sides or slopes of these ridge tops to transport water from one complex to the other. Again, Hawaiian engineering for irrigation agriculture, when the goal was to connect distinct complexes into a single system, would have needed to establish the location of each lo'i complex in relation to others and to transport routes for irrigation ditches to take. This required the simultaneous solution of both locational (elevation, and two-dimension) considerations for lo'i and directional (various elevations along a downward gradient) for 'auwai.

The Makai Wai'āpuka -Makanikahio Agricultural System could not have been reconstructed this far without the combination of many different sources of information such as historic maps, ethnohistorical sources, LiDAR and photographic imagery, and surface inspection for archaeological remains. The ethnohistorical information shows that this system reflects the organization of both intra- and inter-community resource needs, as well as those between ali'i or konohiki and maka'āinana. The historical and archaeological data suggest the scale of this agricultural system. It spans at least one kilometer in distance from the Wai'āpuka Tunnel to the cliff line at 'Ākoakoa Point. Total arable land would have been at least 4-5 ha, about the size of the marsh lo'i complex in lower Pololū Valley.

Makanikahio 1 and 2 (MAA) Ahupua‘a Study Area

Joseph Birkmann, Samuel Kamuela Plunkett, Mark Oxley, Michael Graves, and Ruth Aloua

The territory encompassed by these two ahupua‘a represents the easternmost gulches or drainages of windward Kohala (Figure 32). To the east lies the valley and large ahupua‘a of Pololū. Portions of the western boundary of Pololū extend beyond the top of the upper slopes of the valley to include a section of the adjacent ridge top south (mauka) of Kapaloa Stream to the boundary with Kehena. Makanikahio 1 abuts Pololū on the west and Makanikahio 2 abuts Wai‘āpuka on the east and Makanikahio 1 on the west. The lands of Makanikahio, particularly the makai section of Makanikahio 2 are also sometimes identified as “Auau” in native testimonies and on the Lydgate map. Auau functioned minimally as an ‘ili aina and perhaps as an ahupua‘a. It is difficult to make any further distinction at this time. In earlier maps of ahupua‘a boundaries (e.g., Loebenstein 1904), the mauka edge of Makanikahio extended south beyond the current boundaries depicted on most maps to a place name known as Kalehu. This point is also mentioned in the Ahupua‘a Boundary Testimony (Lyman 1871). No boundary is currently shown between Makanikahio 1 and 2 because it is rendered differently on various maps (e.g., Iao 1910; Loebenstein 1906).

We have designated historical and archaeological sites with the prefix MAA in the study area of Makanikahio 1 and 2. Four drainages flow across this study area: ‘Ōpaepilau, Waiakalae, Kapaloa, and Kauhaikulepe. ‘Ōpaepilau flows into the Waikama Stream catchment to the west. Waiakalae, Kapaloa, and Kauhaikulepe all enter lower Pololū Valley from different points along the west upper slope. Waiakalae and Kapaloa support perennial streams above the Pololū slope. Kauhaikulepe does not currently flow, although springs occur within it and it would also have received water flow from an irrigation ditch (MAA 4A) that would have transported water to the front of Pololū Valley in the vicinity of the marsh area.

For the purposes of this report, the section of Makanikahio that HARP researchers have studied is depicted in Figure 28 and will be referred to as Upper Makanikahio 1. Prior to 2011, HARP researchers had not ventured into either Makanikahio ahupua‘a (except to locate MAA 1 at Pu‘u Kilauea), nor had we previously surveyed forested zones above the former sugarcane lands and the boundary formed by the Kohala Ditch. We did not anticipate there would be many archaeological sites preserved in the forests above the former sugarcane lands nor did we think the cleared lands would contain sites. The results of the 2011 survey suggest why such preconceptions should be examined. We found a number of new and unique archaeological complexes in the forested zone of Makanikahio 1 and 2, and immediately downslope in former sugarcane lands and in Kauhaikulepe Gulch.

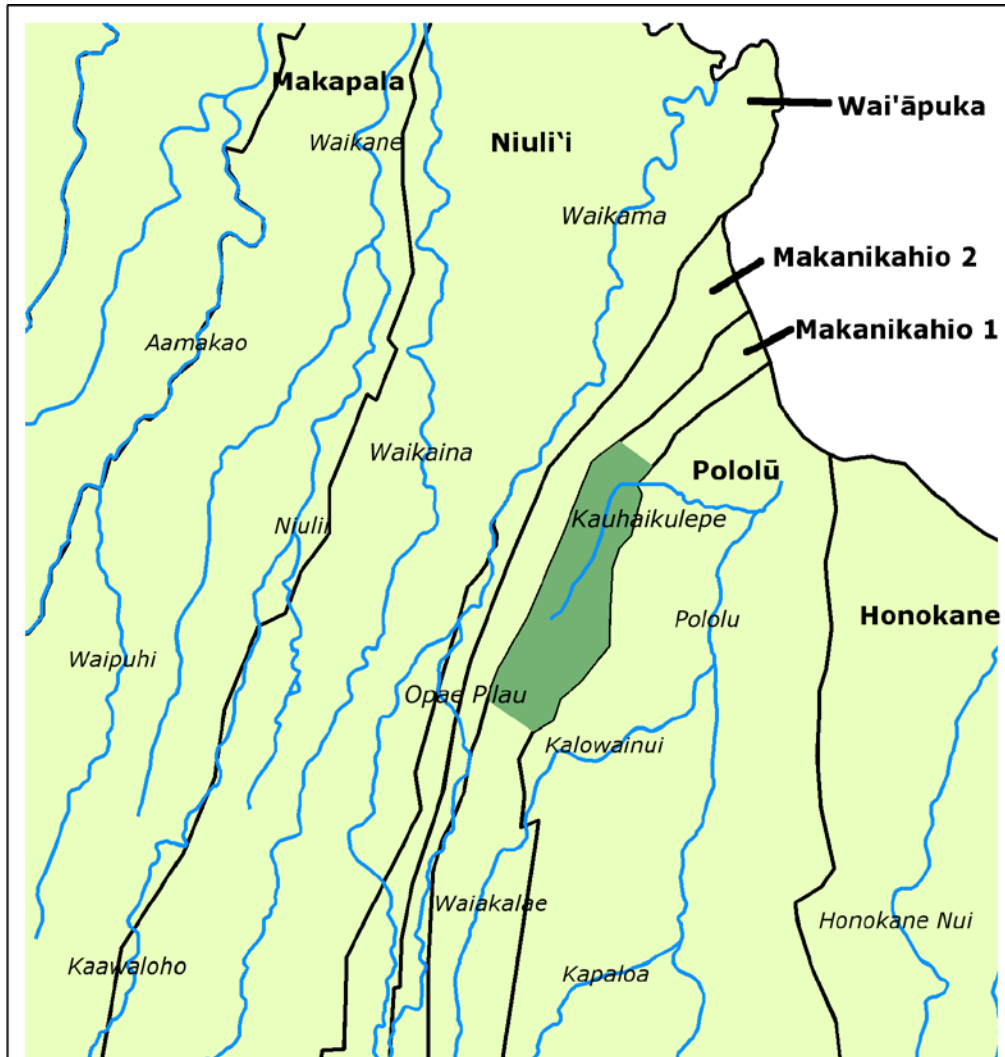


Figure 38. Upper Makaanikahio 1 and 2 Ahupua'a study area in windward Kohala. Note this map needs to be corrected for the names of streams and drainages c

A total of 9 archaeological complexes have been identified in Upper Makaanikahio 1 and 2 (MAA) Ahupua'a. Only one of these, MAA 1, had been previously recorded (Tomari-Tuggle 1988) and its location is depicted on the 1904 Loebenstein map as a small hill or pu'u at the boundary between Wai'āpuka and Makaanikahio 2. The boundary apparently falls near the base of the pu'u to the west. This site is visible in a historic photograph of the area (Schweitzer and Gomes 2002 and cover page for this report). A second complex, MAA 3, an irrigated terrace complex is shown on the 1881 Lydgate map in lower Makaanikahio 1 at the top of a small drainage that extends north to the cliff line and near the location known as Auau.

MAA 6, another irrigated terrace complex, is depicted on the 1904 Loebenstein map and was re-located in 2011 just below the forest line in Makaanikahio (Figure 33). The Pololū slope lies immediately to the east of this complex. Most likely this complex lies within Makaanikahio 2, based on the historical LCA award to Kaea that included this complex and identified as being located within this ahupua'a. While the

terraces were still detectable at MAA 6, all of the rock-faced retaining walls had been removed and the area graded for sugar cultivation. A test excavation in one of the terraces revealed buried pond field soils in association with a concentration of charcoal, confirming its use for the cultivation of kalo (or some other irrigated cultivar). The charcoal sample was dated to between cal AD 1400-1650.



Figure 39. Irrigated agricultural complex, MAA 6 at top of Kauhaikulepe Gulch on property assigned to Kaea in the mid-19th century (Loebenstein 1904).

In the forested area that begins on the south end of MAA 6 we located an intact irrigation ditch (MAA 4A). This ditch follows the west facing slope of the land and originated more than 250 m to the south on the west side of Waiakalae Stream (Figure 34). The ditch was visible on the surface and in some places was cut through bedrock to a depth of between 1 and 1.5 m. It effectively transported water from one drainage system with permanent water flow to a series of small, irrigated terraces, ending at MAA 6. We also suspect that water from MAA 4A was diverted onto the upper west slope of Waiakalae to irrigate swidden fields that are visible today as clearings within the ōhi'a lehua (*Metrosideros polymorpha*) and guava (*Psidium guajava*) forest. We also discovered and mapped a branch of MAA 4A that transports water to the west (MAA 4B and WAI 18) and into a drainage channel with barrage terraces (WAI 31) that ultimately flows into 'Ōpaepilau Stream. Excess water from the MAA 4A section of the irrigation ditch would have drained into Kauhaikulepe Gulch from MAA 6; this gulch originates immediately west and north of the agricultural complex in the clear former sugar can lands. It extends more than 750 to the north and east where it flows into lower Pololū valley just above the coast. Historic maps of Kauhaikulepe Gulch identified named locations within it (including MAA 6) and surrounding it to both

the east and west. The uncertainty regarding Kauhaikulepe Gulch is whether it is located within Makanikahio 1 or 2. Historic sources suggest it lies completely within Makanikahio 2 but there is archaeological evidence presented below for what appears to be a boundary wall on the east side of the gulch. This would suggest that much of Kauhaikulepe belonged in Makanikahio 1. It may not be possible to resolve this matter but the location of the gulch with respect to its associated ahupua'a is important because much of its length (more than 750 m) could have been cultivated, both along the bottom drainage and along its slopes. It thus presented a sizeable area for irrigated agriculture and dry land gardening as well as arboriculture.

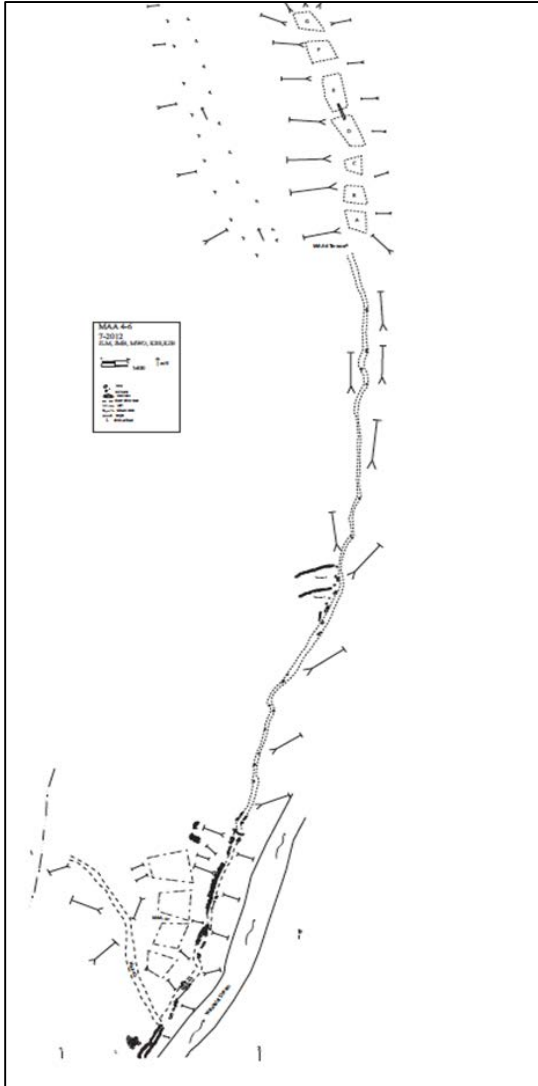


Figure 40. Map of MAA 6, an irrigated agricultural terrace complex in the former cane fields above Kauhaikulepe Gulch in upper Makanikahio, along with the lowermost section of MAA 4A, an agricultural irrigation ditch with associated terraces and cleared areas/

In the forested area that begins on the south end of MAA 6 we located an intact irrigation ditch (MAA 4A). This ditch follows the west facing slope of the land and originated more than 250 m to the south on the west side of Waiakalae Stream (Figure 30). The ditch was visible on the surface and in some places

was cut through bedrock to a depth of between 1 and 1.5 m. It effectively transported water from one drainage system with permanent water flow to a series of small, irrigated terraces, ending at MAA 6. We also suspect that water from MAA 4A was diverted onto the upper west slope of Waiakalae to irrigate swidden fields that are visible today as clearings within the ōhi'a lehua (*Metrosideros polymorpha*) and guava (*Psidium guajava*) forest. We also discovered and mapped a branch of MAA 4A that transports water to the west (MAA 4B and WAI 18) and into a drainage channel with barrage terraces (WAI 31) that ultimately flows into 'Ōpaepilau Stream. Excess water from the MAA 4A section of the irrigation ditch would have drained into Kauhaikulepe Gulch from MAA 6; this gulch originates immediately west and north of the agricultural complex in the clear former sugar can lands. It extends more than 750 to the north and east where it flows into lower Pololū valley just above the coast. Historic maps of Kauhaikulepe Gulch identified named locations within it (including MAA 6) and surrounding it to both the east and west. The uncertainty regarding Kauhaikulepe Gulch is whether it is located within Mākanikahio 1 or 2. Historic sources suggest it lies completely within Mākanikahio 2 but there is archaeological evidence presented below for what appears to be a boundary wall on the east side of the gulch. This would suggest that much of Kauhaikulepe belonged in Mākanikahio 1. It may not be possible to resolve this matter but the location of the gulch with respect to its associated ahupua'a is important because much of its length (more than 750 m) could have been cultivated, both along the bottom drainage and along its slopes. It thus presented a sizeable area for irrigated agriculture and dry land gardening as well as arboriculture.

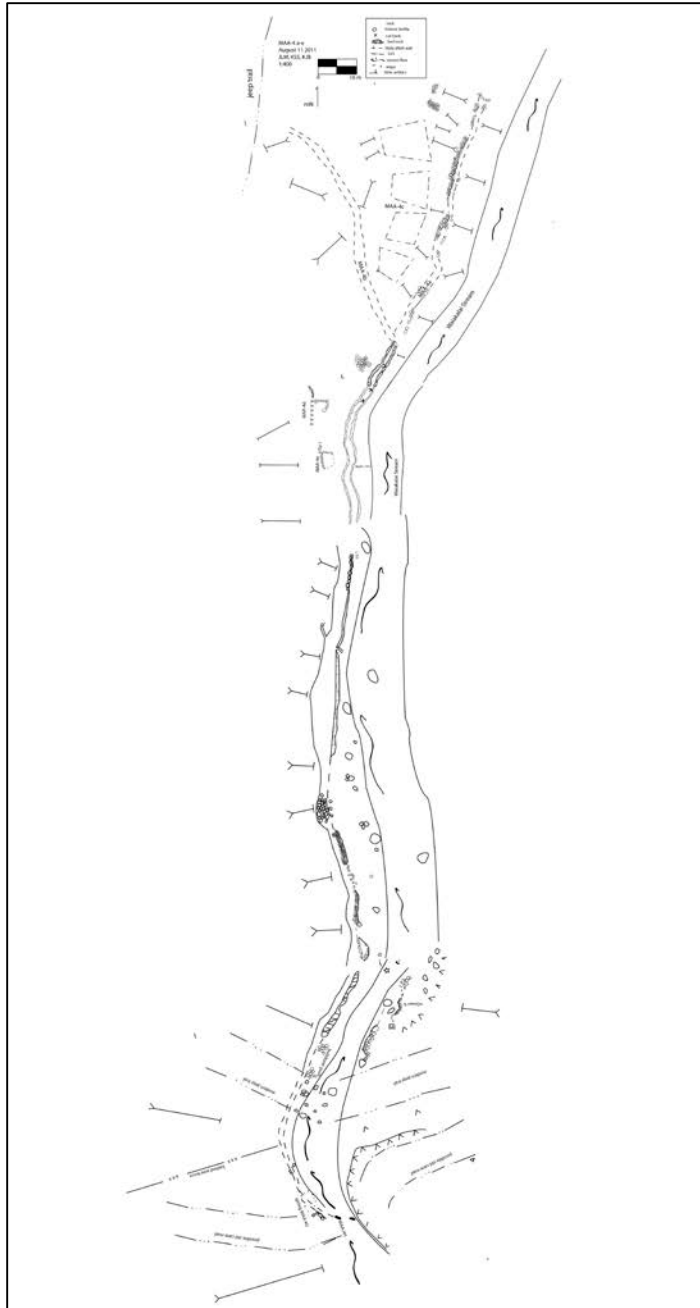


Figure 41. Map of the upper, southern section of MAA 4A, an irrigation ditch that extended off of the west side of Waiakalae Stream in Upper Makanikahio 2 Ahupua'a.

Historical, Archival, and Archaeological Survey and Mapping Results: Makanikahio 1 and 2

Archaeological research in 2013 in the Ahupua'a of Makanikahio focused on Kauhaikulepe Gulch. This gulch connected at its southern, upslope end with MAA 6, an irrigated agricultural complex we had

previously documented, and it extended downslope more than 750 m to a point just above the upper Pololū slope. Previously, we had noted poorly preserved archaeological remains (as MAA 2) in the upper portion of the gulch but they were not overgrown and located towards the upper, southern end of the Gulch. In 2013, we turned our focus to the north, lower end of the gulch where based on a historical map kalo plots were said to be located along its bottom in one or more locations.

Agricultural Barrage Terrace System (MAA 12)

MAA 12 is a barrage agricultural terrace system with a minimum of 15 features (A-O) that extend down the secondary drainage of Kauhaikulepe Gulch (Wall 1926) located in the ahupua'a of Makanikahio 1 or 2. The gulch is located just to the west of Pololū Valley. MAA-13, a possible (ahupua'a or other) boundary wall-alignment and additional associated features, is located on the eastern ridge line overlooking the gulch/site. We should note that the distinction of numbered complexes within the gulch is largely arbitrary and based on preservation of the agricultural and other archaeological materials within the gulch along with areas we could access most easily and direct. We imagine these complexes would have been distributed more or less continuously across the entire gulch. The lower portion of MAA 12 is mostly open, with the surface covered with many loose cobblestones and smaller vegetation. MAA 12 does have a number of noni (*Morinda citrifolia*) and kukui trees (*Aleurites moluccanus*), some of the latter being quite large and mature see Figure 36).



Figure 42. Top view of a kukui grove within lower Kauhaikulepe Gulch in Makanikahio Ahupua'a.

MAA 12 represents a series of barrage terraces, low terraces, and slope retaining walls, not always in very good shape because of extensive water erosion in the gully bottom.

Towards the south (mauka) end, the gulch narrows as the elevation increases and vegetation becomes increasingly dense. Where the gulch begins to narrow, the archaeological features are dispersed across sections of the gulch bottom and there are some intact slope retaining walls as well as terrace retaining

walls, in relatively good condition (compared to the lower elevation terrace retaining walls where side slope and terrace retaining walls were largely eroded or blown out). Many of the terrace retaining walls are 2 to 3 courses in height and utilize both cobblestone and boulders (some of them being in situ boulders) in their construction. For the intact slope retaining walls (both on the east and west sides of the gully), many are constructed with small to medium sized cobbles with courses ranging from 3 to 6. As the site gains elevation, the gulch thins out and the slopes become much steeper and ultimately results in the terraces becoming smaller in size/area. At this point the soil also gives way to bedrock, including a possible upright stone at the bottom of the exposed bedrock. Based on how the bedrock sits, it is likely that most of this area was never cultivated (Features I through L). Most of the areas that could have been utilized for cultivation were likely irrigated with water (Features A, B, D, F, G, H); however, there are two terraces (Features C and E) that are raised above the gulch bottom that could have been used for non-irrigated agriculture or other activities (including habitation).

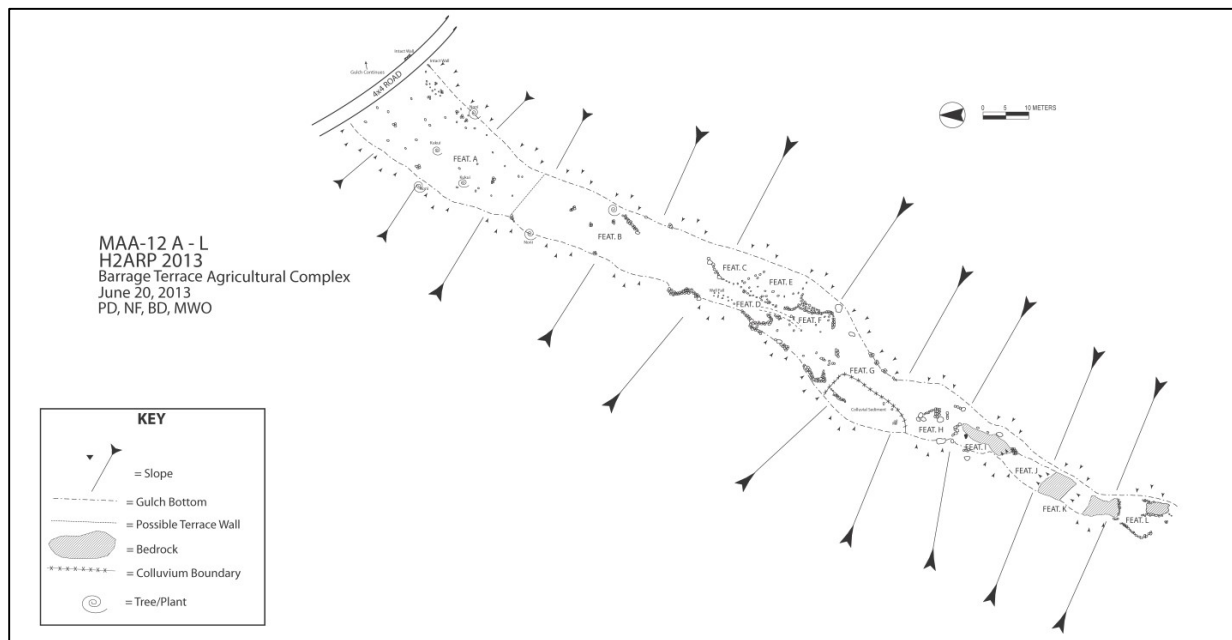


Figure 43. Map of MAA 12, an irrigated and dry land agricultural terrace complex, along with managed zones of tree-cropping within Kauhaikulepe Gulch.

MAA-12 was mapped in two separate sections within Kauhaikulepe Gulch with an unmapped area in between consisting of approximately 75 meters of steep, narrow and heavily vegetated gulch. The two mapped sections of MAA-12 were connected through the associated points of MAA-13, which extends above both sites along the upper eastern trending ridge slopes. The survey mapping ended with feature O however, this site survey encompasses a very small portion of the archaeological features in this gulch; the gulch as well as additional terrace (and other) features continue to the south (mauka) until site MAA-6 is reached. It is very likely that MAA-4 (an irrigation ditch used to feed MAA-6) is feeding water directly into this gulch, and eventually watering the features mentioned in this description. Overall, the condition of this site is fair to good. While there are walls still intact in several locations, many have completely eroded away. At feature G, for example, slope wash and erosion has deposited significant amounts of sediment (colluvium) on the west side of the terrace.

Possible Ahupua'a Boundary Alignment and Wall (MAA 13)

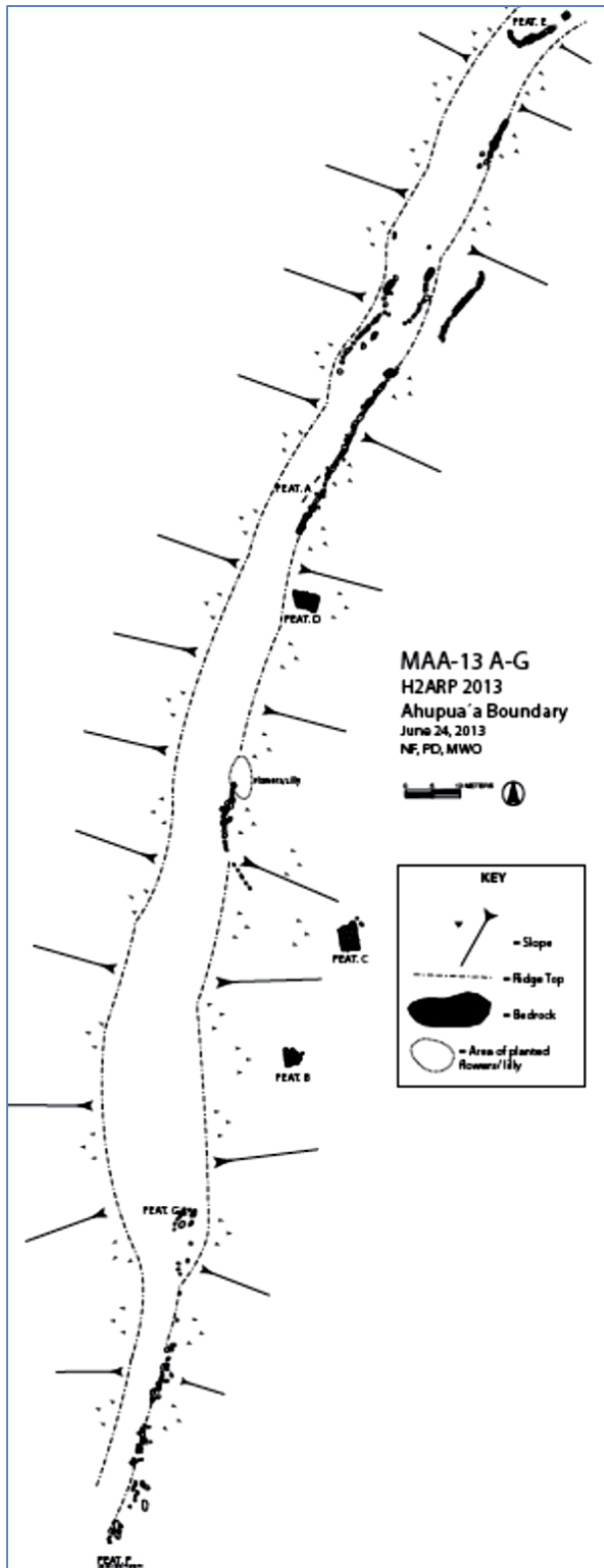


Figure 44. Map of MAA 13, showing rock alignment and retaining wall along with associated masonry features on the east upper slope of Kauhaikulepe Gulch.

MAA 13 (Figure 38) is a discontinuous boundary wall (Feature A) with six associated features (Features B through G). This may be part of the ahupua'a division between Makanikahio 1 and Makanikahio 2. Alternatively, it could represent a trail or a smaller 'ili section of land within Makanikahio. The site is located on the top of the eastern ridge above the Kauhaikulepe Gulch. The upper and lower mapped sections of MAA 12, agricultural complexes/ barrage terrace system, are located in the gulch below. The ridge/ boundary wall (Feature A) is constructed an alignment, or small retaining wall or in a few sections wall on top of retaining wall. Its total length is approximately 275 m with the wall not exceeding 60 cm in width (the flattened ridge line does not exceed 13 meters in diameter). It is likely that this wall continues farther upslope on the east side of Kauhaikulepe. We stopped mapping it at a location where the east ridge slope had been excavated by machinery over a length of about 30 m. Thus, the upper end of the feature is arbitrary and not necessarily indicative of the total extend of this boundary alignment and wall complex.

There are two sections of wall that are in good to excellent shape. The largest and most intact portion is located on the east facing side just to the north of Feature D; this section of wall extends approximately 30 m in length and is faced and stacked in four courses. The second, most intact wall is located just to the north of Feature F; this wall is constructed from one to three courses. There are multiple areas of exposed bedrock on the ridge line that make it difficult to discern what is intentionally placed wall and what is natural bedrock used as part of this feature/complex. It is possible that some of the bedrock was modified for wall construction or other uses. There are three features located on the east facing slope; each with its own unique architectural design. Due to the size and placement of these features, they are believed to be burials. Feature B is a stone mound that is located on the lower portion of an eastern slope. The stone is piled in an oval/ D shape with mostly small to medium sized boulders. Feature C is a large rectangular mound that has been constructed largely of boulder. The feature is located on the lower portion of an east facing slope. Feature D is a stone platform located at the start of an east facing slope. Two additional mounds (features B and C) are located to the SE. This particular feature is unique to the other features in that it is a platform (while Feat B and C are stacked/piled mounds).

Despite the fact that all three possible burial features are located along and/or on the east slope, they are in excellent condition and have very little evidence of wall collapse. Feature E is a C-Shaped enclosure wall near the upper slope that may have functioned as a habitation, shelter or other function. The area to the northwest of the wall is clearly flattened and may have served as the habitation or other activity area; Invasive vegetation is very dense in the leveled area making it difficult to clearly discern any additional features. It is possible that the wall is an extension of the ahupua'a boundary wall (feature A); however, the feature is located on the west side of the slope and feature A is primarily seen on the eastern side of the slope. The wall is constructed of stacked cobble and boulder with the incorporation of exposed bedrock. On the opposite side of the site, Feature F is a faced platform that may have function as a possible habitation or ritual site. The feature sits atop the ridge bordered by a slope into Kauhaikulepe Gulch to the west. The walls consist primarily of large cobbles and small to medium sized boulders stacked and faced in 3 to 8 courses. A large retaining wall is located on the west portion of the feature, facing the gulch. The east facing wall is much shorter with only one to three courses. It is possible that the surface of the platform is paved with cobbles. There is non-native

vegetation present such as Christmas berry and ironwood. Feature G is a poorly preserved oval shaped, single course stone pile/mound. There is a possibility that there is more structure buried beneath the soil. This feature is northeast of Feature B (mound) and south of Feature F (platform). Vegetation includes non-native introductions including ironwood and guava. This feature may have served as a boundary marker or a small enclosed structure. Overall, this site is in fair to good condition. While Features B through F are in good to excellent condition, Feature A would be considered fair due to its discontinuous nature and Feature G would be considered to be in poor condition since it is difficult to discern what it is.

Placed together MAA 12 and MAA 13 functioned as an integrated cultivation zone of irrigated and dry land cropping that included substantial management of trees as well. There is evidence from MAA 12 for possible habitation and ritual features, suggesting it was the location of a former Hawaiian household. The association of the gulch complex with the possible ahupua'a boundary wall of MAA 13 is illustrated here (Figure 40). Inspection of the location of the boundary wall shows that it corresponds in location with a projected boundary between Makanikahio 1 and Makanikahio 2, along the eastern slope of Kauhaikulepe Gulch.

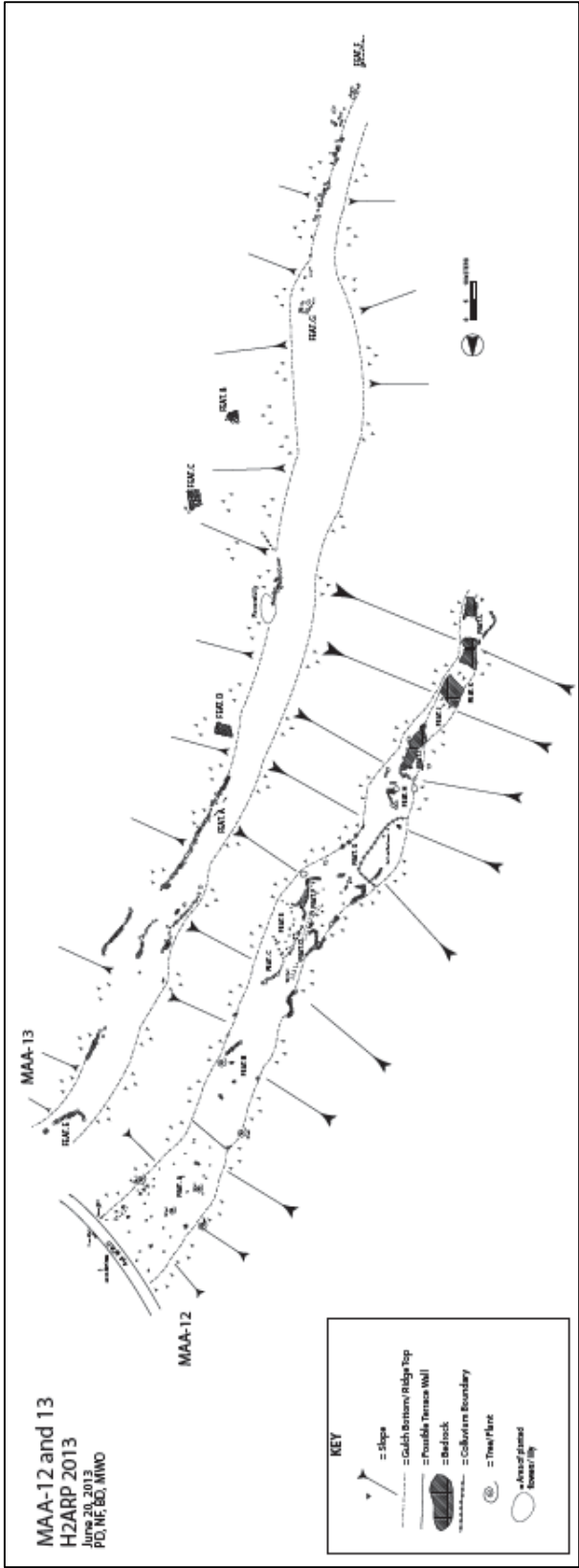


Figure 45. MAA 12 and MAA 13, a related agricultural and habitation areas adjacent to a possible ahupua'a boundary wall complex.

Managed Tree-Cropping Complex Consisting of Kukui and Hala Trees (MAA 14), Kauhaikulepe Gulch

MAA 14 is an arboricultural agricultural complex located on the bottom and western slope of Kauhaikulepe Gulch (Figure 41). It is not spatially distinct from MAA 12 but the number and complex of trees that produced products for native Hawaiians was such that we gave it a separate feature designation. Some of the native vegetation that is growing in the area includes a forest of kukui, several hala trees, and numerous kī and noni trees. Each of these species seems to be growing in general areas throughout the gulch, known as Kauhaikulepe.



Figure 46. View from west of kukui grove within Kauhaikulepe Gulch on its west slope.

There are approximately 82 kukui (*Aleurites moluccana*) trees that have interwoven branches, which are growing near the center of the gulch, mostly on the bottom of the drainage. The tallest trees extend to a height of approximately 10-15 meters, while the smallest trees are less than .5 meter tall (Figure 42). The largest kukui tree stump measures a diameter of approximately 2 meters round. The smaller trees, which are just beginning to be established, are growing near the base of the older trees (Figure 43). This kukui grove was the thickest grove observed in the entire area and is observable from a distance of 150 meters from the ridge lands.

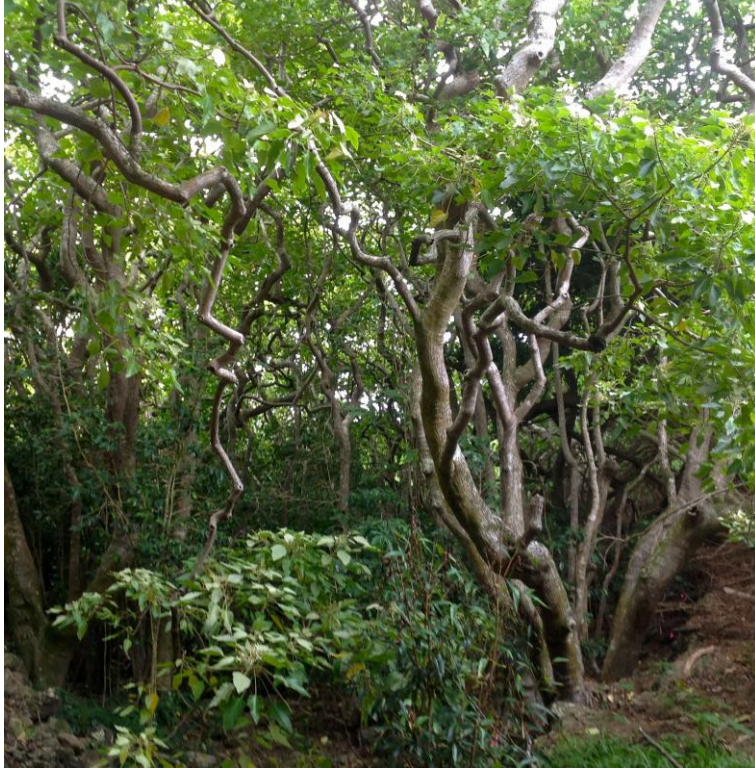


Figure 47. Representative view of complex of kukui nut trees growing within Kauhaikulepe Gulch.



Figure 48. Newly sprouted kukui nut trees growing within the MAA 14 complex.

Three small groups of hala trees that contain 2-3 individuals are growing directly along the west sides of the gulch. While two of the hala clumps seem to be in a relatively healthy condition, growing at a height of approximately 10-15 m. A third group of hala growing at the southernmost end of the gulch appears in poor health and there are a number of dead individuals lying on the slope. Fallen stems and branches that were observed during the survey support this interpretation. The branches contain green and brown leaves, which indicate that parts of the trees have recently fallen. The stump is dried out. Hala leaves are not being harvested because all of the trees contain a wealth of dried and newly fallen leaves that are in thick layers beneath the trees. Typically, if harvesting is taking place, gatherers clear these leaves to gather the newly fallen leaves - these are the most desirable.

A kī grove is growing along the east and west banks of the gulch and in areas where introduced plants have not yet taken over. On the east bank, in addition to the kī, sparse vegetation exists. However, on the west bank, a dense wall of introduced ginger is growing along the upper portion of the gulch. Here, on this west bank, the ginger out competes the kī. A similar occurrence is taking place farther north, near the lower portions of the gulley; a thick forest of coffee is growing into the area. At this junction, where the coffee and kī intersect, the coffee seems to out-compete the kī.

The Kauhaikulelpe Complexes in Relation to Mauka Makanikahio and Coastal Pololū

Here we attempt an initial reconstruction of the Kauhaikulelpe and Makanikahio agricultural complexes in relation to coastal Pololū Valley. This second system of interconnected agricultural complexes originates in the uplands of Makanikahio, drawing water initially from the stream known as Waiakalae, whose flow originates in the Kohala mountains near the boundary of the ahupua'a of Kehena and extends for approximately 2.4 km before flowing over the top of the Pololū slope into the Valley below. What follows is the reconstructed system of irrigation and agriculture that begins in the upper elevation of Makanikahio and extends to the coastal marsh in Pololū.

This system began with the MAA 4 complex where the main bedrock cut irrigation ditch of MAA 4A begins at the stream and is enhanced by a natural spring above the ditch located near the mouth of this Feature. These fed water to several small, dispersed agricultural complexes and associated habitation features before intersecting with MAA 6, the irrigated agriculture complex at the upper edge of former cane lands to the north. A second ditch, MAA 4B, diverts water from the Waiakalae catchment into a secondary drainage that ultimately flows into the Waikama Stream catchment to the west in the ahupua'a of Wai'āpuka. In addition several small ditches or overflow channels connected to Waiakalae itself and MAA 4A have been identified, though no terraces have been found. Open areas of forest seen along these channel suggest they could be former swidden plots. Often agricultural conversions decrease soil fertility and thus take longer to replenish forest stock. In terms of total distance, MAA 4A extends approximately 500 m from its upper point to the bottom of MAA 6 (Graves et al. 2011). MAA 4 shows a mixture of traditional and Post-Contact age construction techniques (i.e., cement or mortar, along with glass bottles in the ditch). Nevertheless, association with traditional terraces and habitation features suggests a Pre-contact interpretation followed by historic modification.

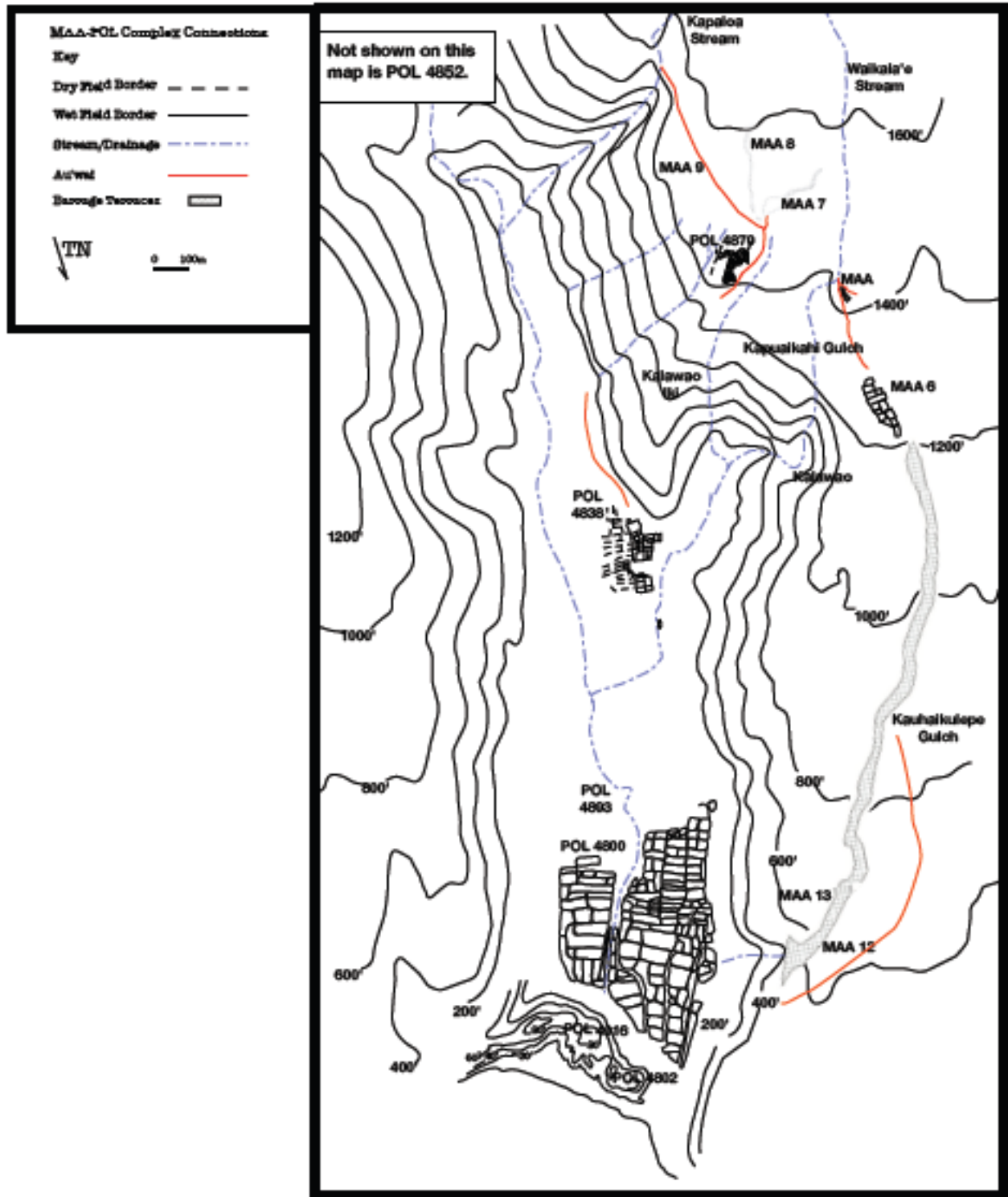


Figure 49. Reconstructed irrigation and agricultural system linking upper Makanihāhō to lower Pololū (from Birkmann, 2014).

Fed by water transported through MAA 4a, MAA 6 is an agricultural complex approximately .55 hectares in size, located on the tablelands of Makanikahio and depicted on both Loebenstein's 1904 and Wall's 1926 maps. Inclusion of this complex on these maps indicates these terraces were still in use into the early 20th century. The terraces lay outside the forest and are thus within the lands once used for historic sugarcane production. They exist now only as a series of identifiable earthen embankments and flat surfaces (Graves et al. 2011). Surveys by H2ARP have also uncovered the possible presence of additional terraces inside an area of dense vegetation along the west side of the MAA 4A ditch, along with the terraces that occur at the juncture of MAA 4A and MAA 4B.

Irrigation water from MAA 6 would have fed the terraces and then been drained into the nearby Kauhaikulepe Gulch. The head of this gully lies just upslope of MAA 6 flowing approximately 1.5 km north before draining into the valley below. Inside the secondary drainage are a series of barrage terraces and retaining walls used for both the planting of crops and the slowing of water. Stacked stone walls in some areas exceed 1.5 m in height. Preservation is poor in most areas, likely due to flood events after the complex was abandoned as well as the removal of vegetation during the conversion of the area to sugar cane cultivation. This pattern has been observed at other secondary drainages that once supported a number of barrage and other agricultural terraces within channels and along slopes. The remnants of barrage terraces can sometimes only be made out at one or the other of their end points where stacked rock is located just outside of the main channel. Several small terraces that appear to be located just above the water level may have been used for purposes other than pond field agriculture. Along the east slope of Kauhaikulepe, near the location where it would drain into Pololū is a discontinuous wall, retaining wall, and alignment feature, MAA 13. This feature has been interpreted as a possible ahupua'a boundary wall, given its close match with the location of the historical ahupua'a division between Makanikahio 1 and 2. There are at least six associated features on the eastern slope and a small terrace that may be a residential feature lies at the top of the ridge line near the southern end of the ahupua'a wall. The wall extends approximately 275 meters in length and ~60 cm wide consisting of 1-4 courses depending on area. The remains of a possible irrigation ditch have been found that extend along the west slope of Kauhaikulepe, beginning at a point about midway down the gully where the surrounding ridge line dips down to the gully channel. This ditch flows along a nearly parallel path to the gully but extends and extends beyond the end of Kauhaikulepe, then turns east and would have rejoined the gully where it intersects the upper west slope of Pololū. It is also possible that water from this ditch was diverted to the west through a secondary channel and would have fed the complexes associated with Wai'apuka described previously.

Water from Kauhaikulepe flowed down the eastern ridge of Makanikahio 1 and into Pololū Valley providing irrigation resources to the largest agricultural complex in the valley, POL 4800. Located just inland from the large coastal sand dune POL 4800 is a mixed wetland/dry land complex encompassing six ha (Field and Graves 2008). More than 125 agricultural features were noted by Tuggle (1976) during his original survey. Though the use of this area for rice cultivation in the 19th century makes the identification of traditional Hawaiian agricultural practices difficult, Tuggle notes that limited excavations in the area uncovered evidence for both wet and dry Hawaiian agricultural deposits throughout the complex. While stream water collecting behind the dunes transported below the bed of

Pololū stream was utilized for wetland and irrigated agriculture in the area, research conducted by H2ARP (Birkmann 2014) suggests that water from Kauhaikulepe drainage also supplemented irrigation in this area as well. There are several other ravines along the upper western slope of Pololū that may have fed water to the marsh lands of POL 4800; at least one of these is a named spring (Pipi Spring) seen on historic maps in Makanikahio 1. Duran et al. (2013) examined the Ramon Property in lower Pololū Valley and concluded that the agricultural terraces associated with that location and depicted on Tuggle's 1976 map would not have been irrigated by the marsh or by flood waters from the incised section of the stream. Rather, they had to have 'auwai fed by water flowing through ravines on the south end of the Ramon property to the terraces in order for them to have regular access or irrigation water. There are currently no dates directly related to the marsh terraces themselves, though they occur in close proximity to several residential features and deposits that Tuggle excavated along the inner, north facing side of the dune. These materials were recently dated by Field and Graves, and the earliest occupation of the dune area extended back to cal AD 1200-1250. The expansion of the marsh-based agricultural complex in lower Pololū to include sections farther inland, such as those on the Ramon property, likely occurred later in time after AD 1650.

This system of irrigation and agriculture links the ahupua'a of Makanikahio and Pololū. Although the water of Waiakalae Stream drains into Pololū Valley, much of that water would have been lost to agriculture because it sinks into an incised stream bed well below the valley bottom lands. Hence, diverting water from Waiakalae to Kauhaikulepe Gulch and into the lower valley marsh complex would have supplied additional water at slightly higher elevations for expanded irrigation agricultural associated with the marsh. These waters would have provided an additional and predictable supply of irrigation to the coastal marsh complex.

Resources and Territories in Hawaiian History: A GIS-Based Study of Windward Ahupua'a

Nicholas Ferriola, Michael W. Graves, Joseph Birkmann, and Kekuewa Kikiloi

As part of the research program in 2013, one of the students, Nicholas Ferriola began research in the summer that he extended through the fall of 2013 (Ferriola and Graves, 2013) and spring of 2014 (Ferriola, 2014) as a study of resources and ahupua'a land areas for windward Kohala. His findings are summarized and slightly revised here.

In order to examine the role of resource distribution on community or ahupua'a territories, we first have to consider the region as whole. North Kohala can be separated into a leeward (western), dry side, and a windward (eastern), very wet and lush side. This climatic difference, coupled with the remnant geological substrates across the region results in different physical environments that in turn lend themselves to very different subsistence practices. This was especially notable in terms of how agriculture was developed and organized as not all ahupua'a functioned entirely independently of their neighbors. A lack of abundant surface water resources on the leeward side affected the types of crops grown, the nature of agricultural production, and the potential for population expansion in ways that did not occur on the windward side. Geologically, the leeward side also had significantly less potential

for erosion and incision in the rock which created so many of the streams and gulches on the windward side, meaning wetland agriculture could be more prominent. Additionally, through investigation of borders the idea has been proposed how the ahupua'a of Kohala were, over time, divided into smaller units (Ladefoged and Graves, 2006:268). Later they (Ladefoged, Lee, and Graves, 2008) suggested the original units were based on major geological and climatic features that affected agricultural potential proposed the possibility of a maximum effective community size, and decisive political factors as possible reasons for subdivision.

The means for examining the potential subdivision of larger into smaller community territories in leeward Kohala employed a comparative perspective based on a series of criteria that were thought to reflect linkages between communities (e.g., shared names) and the way in which locations of their territorial boundaries indicated a relative temporal ordering of land subdivision (e.g., whether boundaries extended the top of the Kohala Mountains where they would have abutted their windward counterparts or where they bifurcated along the major axis of an east-west trending boundary).

This analysis applies a similar, simpler approach to understanding the relationship between resources and community territories on the windward side of North Kohala. This research departs from the previous study by Ladefoged and Graves by its use of proxy measures of resource abundance (rather than agricultural potential) on the subsequent direction of ahupua'a sub-division into territories of different size and resource holding potential. Here we analyze coastal access and available surface freshwater sources on land areas associated with each windward ahupua'a. Surface water, due to its abundance, the result of higher rainfall, on the windward side introduces an additional level of complexity because the number of streams and their extensive, but variable, watersheds means some territorial boundaries incorporate multiple drainages that may cross from one ahupua'a to another. Other territories incorporate a single, extensive, and substantial watershed (e.g., Honokāne). Others had much less surface water available for cultivation, had smaller overall land areas or the water occurred in locations where agricultural productivity would have been reduced. Because traditional Hawaiian water rights were strictly enforced, the amount and predictability of water available to different communities could vary by location and geography. This will potentially make for a complex situation in regards to inter-ahupua'a relations.

The coastline of each ahupua'a was also estimated and was considered a proxy measure for access to and the quality of marine resources within each ahupua'a. Here, we employed a weighted measure of coastal access that included actual length as well as the nature of the coastline (i.e., embayments, tall cliffs). This, much like surface water availability showed considerable variability across the region's communities. There were a few ahupua'a territories with little or no coastline. Nunulu-nui, Nunulu-iki, Pu'uokamau, and Maulili are entirely landlocked, and all of those except Maulili "cap" other ahupua'a being exclusively in mauka regions. A few territories with rather less surface water had larger than expected coastal access, and there were two ahupua'a with both substantial surface water and coastal access resources. In general, however, larger ahupua'a communities tend to have larger amounts of coast or surface water, or both.

Land area was used as a proxy for total resource holding potential and population size for each ahupua'a. Area is also a likely proxy for arable land in a given ahupua'a. Because of the known cultivation of dry-land crops in addition to the wet lo'i we could not presume that a lack of irrigation meant no agricultural activity was present. The study by Palmer et al. (2010) does suggest that the soils on the former shield volcanic lands of windward Kohala were depleted in nutrients, certainly relative to their leeward counterparts. This is a function of a rainfall threshold at about 2000 mm annual rainfall. The specific composition of the land would be significant in refining the model as irrigated farming would be more productive, but at it turns out irrigated plots were developed on the ridge slopes of windward Kohala in a manner unexpected from other previous irrigation studies in Hawai'i.

This study is limited in its chronological assessments of territorial subdivision across ahupua'a. For the earliest or the linked multiple communities, we use the terms 'okana or āpana ahupua'a, neither of which is entirely satisfactory. They do reflect our desire for an appropriate terms to describe either the grouping of land division units (e.g., 'okana) or the division of a single land unit (e.g., āpana) but there is no ethnohistorical evidence that these terms were in fact used emically by Hawaiians for early, larger sized community-based land divisions. We employ them here heuristically, so that we have some means for distinguishing the hypothesized early territories from that that were documented ethno-historically and mapped during the mid- to late-nineteenth century.

By modeling resource production this study will paint a picture of how well situated the various windward ahupua'a were in relation to each other, as well as seeing how they might have needed to rely upon each other to make up for deficiencies and make use of abundance in one or the other of the two resources we modeled. We expect that most ahupua'a in windward North Kohala maintained the traditional shape, reaching from mauka to makai, but as 'okana or āpana ahupua'a subdivided, this impacted the likely self-sufficiency of some communities or it encouraged the deployment of new strategies for gaining access to agricultural resources.

'Okana or Āpana Ahupua'a

We begin by positing five original 'okana or āpana ahupua'a (Figure 47) for windward Kohala. These territories were created by employing the criteria adopted by Ladefoged and Graves (2006), with the additional criterion that original, early boundaries would reach from the mountain to the coast on both the east and west sides of these territories. Also, the mauka boundary for the such ahupua'a needed to "fit", that is, comprise what appears to be a single boundary, not otherwise sub-divided. For convenience we have labeled the 'okana or āpana ahupua'a by one of the constituent communities that comprise one of the ethno-historically named ahupua'a. For comparison, in leeward Kohala, Ladefoged and Graves "identified" nine early, original territories. That early territories would scale in this fashion is not surprising; generally leeward ahupua'a are larger than windward ahupua'a because terrestrial resources are less "dense".

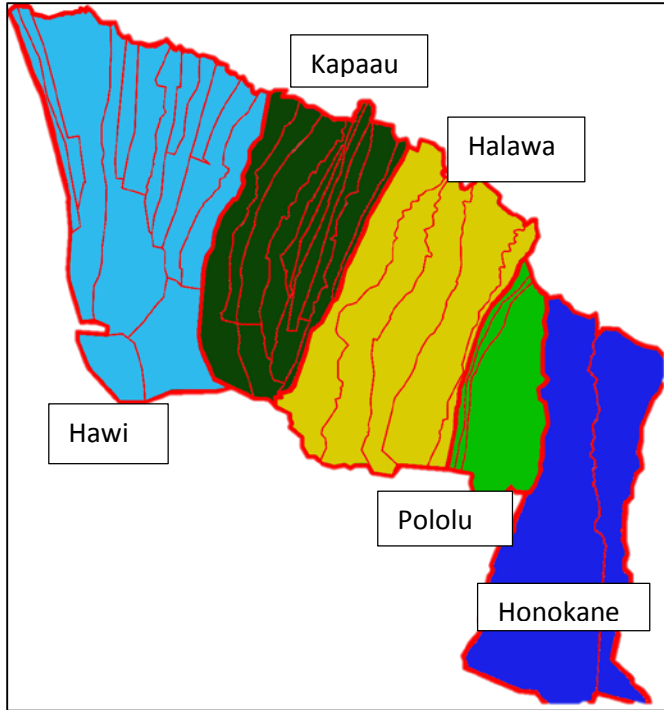


Figure 50. Windward Kohala ahupua'a grouped into five hypothesized 'okana or āpana ahupua'a based on criteria developed by Ladefoged and Graves (2006).

We compared the relative effects of coastal resources versus available surface water on the size of the early 'okana or āpana ahupua'a by comparing measures for each against the total area of the hypothesized original territories. The first comparison involved the total estimated surface water catchment (measured by total length of all of the stream drainages where water flowed) against area (Figure 48). While the correlation is significant ($r^2=0.44$), it is not as strong a predictor of total land area as is the weighted coastal length measure (Figure 49) with an r^2 of 0.94 for the 'okana or āpana ahupua'a.

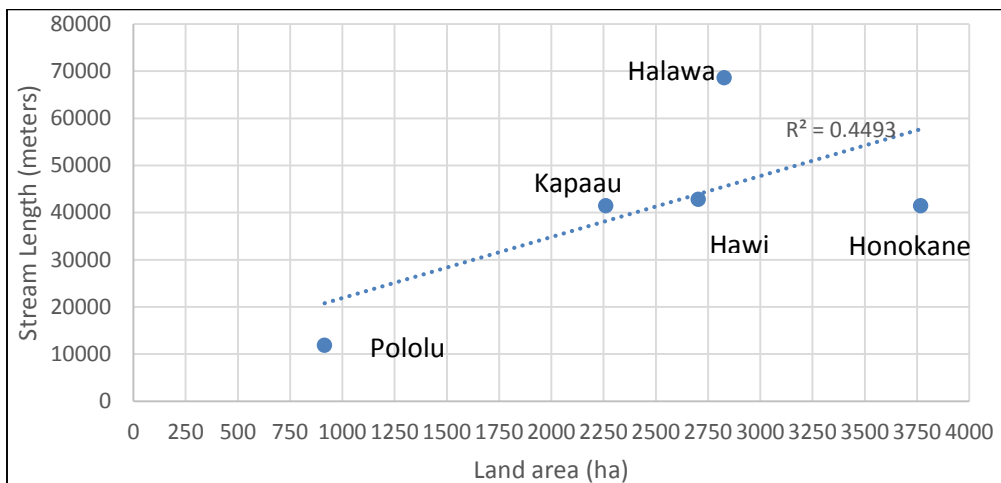


Figure 518. Correlation of total stream length against land area for the five 'okana or āpana ahupua'a in windward Kohala.

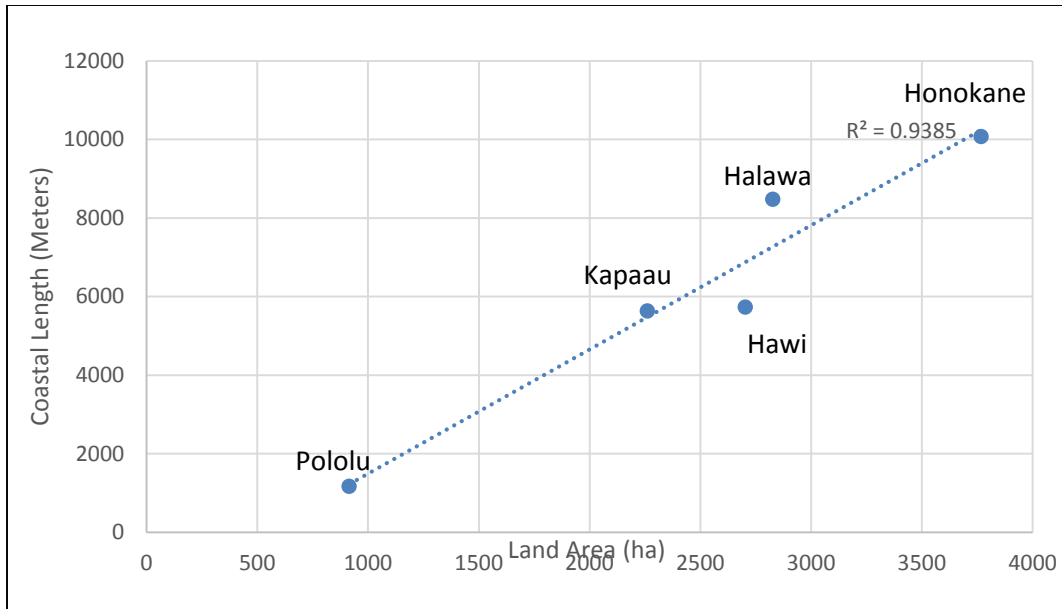


Figure 52. Correlation of total weighted coastal length against land area for the five 'okana or āpana ahupua'a in windward Kohala.

This may highlight the relative importance of having sufficient coastal access and resources when areas of windward Kohala were established by their earlier communities. Surface water from streams was important but the correlation is not as strong. Note the relative order of the five 'okana or āpana ahupua'a remains the same with Pololū the smallest of these five grouped ahupua'a, and Honokāne, the largest. These are the two easternmost land divisions within Kohala; the remaining three land groupings would have been intermediate in size and resources.

Ethnohistorical Ahupua'a Resource Holding Potential

A full analysis of the ways in which and the effects of land sub-division on the hypothesized original communities of windward Kohala will need to wait for another time. However, here we show a map of all later, named ahupua'a of windward Kohala that shows some of the direct effects of land partitioning over time (Figure 50). First, the correlations of total stream length or the weighted coastal measure with total land area are less robust and there is considerably more variability. Second, the two easternmost ahupua'a of Pololū and Honokāne appear to remain most like their original reconstructed territories; they appear to have gone through fewer partitions of land division at the scale of the ahupua'a than the other three 'okana or āpana ahupua'a. As a result they were both not only among the largest ahupua'a but had the largest total stream length and weighted coastal measure. The eastern gulch ahupua'a likely derive from the original "Halawa" 'okana or āpana ahupua'a, with the exception of Mekanikahio 1 and Mekanikahio 2, which appear to have been originally linked with the "Pololu" 'okana or āpana ahupua'a. Wai'āpuka a is a likely sub-division from the "Halawa" grouping. All five of the ethno-historically known "Halawa" gulch ahupua'a (from 'okana or āpana ahupua'a to Wai'āpuka) appear to either have sufficient coastal access or surface water sources, or both (although 'A'amakāō has little coastal access and Wai'āpuka falls among the smaller group of ahupua'a in terms of land area).

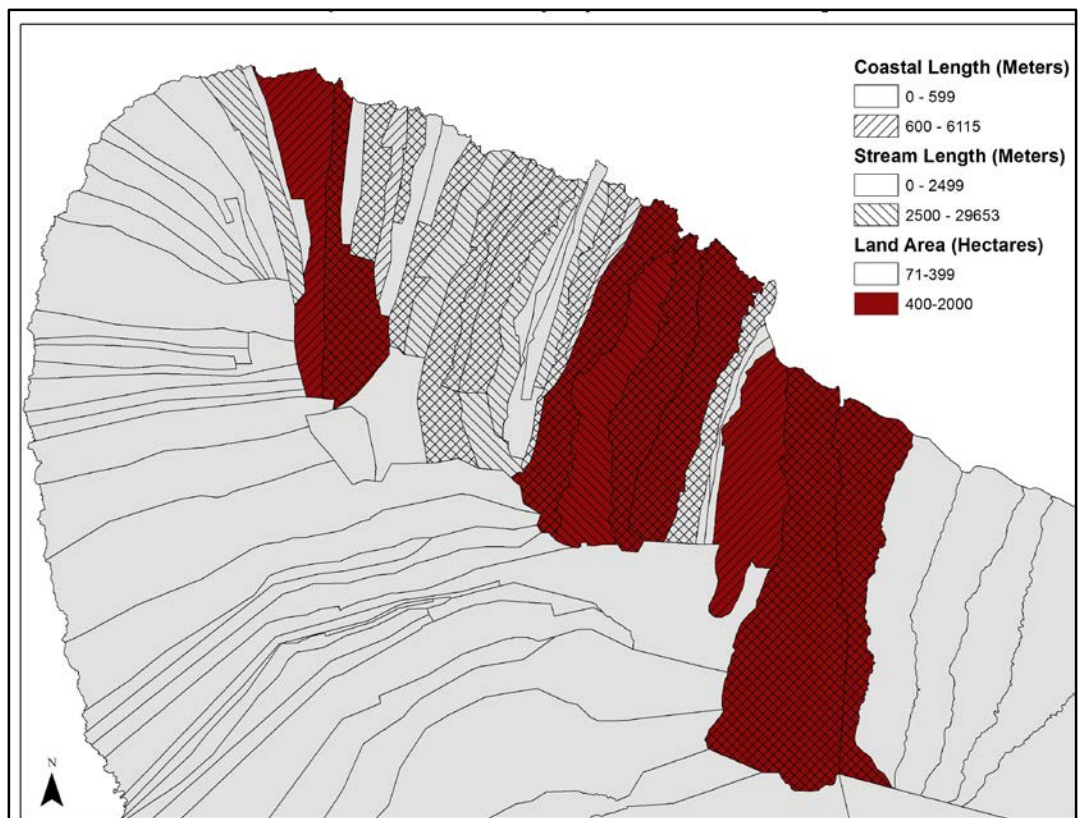


Figure 53. Windward Kohala ahupua'a by land area, total stream length of associated drainages, and weighted coastal access (from Ferriola 2014).

It is among the westernmost ahupua'a that the most partitioning of land appears to have occurred. The Kapa'au Group is made up of 11: Napapa'a, Halelua, Apuakohau, Kukuiwahulia, Pueke, Maulili, Hala'ula, 'Iole, 'Ainakea, Nunulu-nui, and Kapa'au. The Hāwī Group is made up of 14 ahupua'a including: Honopueo, Ohanaula, La'aumama, Puehuehu, Kapu'a, Honomaka'u, Pāhoa, Hāwī, Ka'auhuhu, Kāhei, Hualua, Kealahewa, Nunulu-iki, and Puuokamau. With two exceptions these ahupua'a all fall among the smallest in windward Kohala, although several do have high resource holding potential in terms of coastal and surface water resources. This appears to be pattern that continued around the tip of the Kohala peninsula and extending to the northernmost of the leeward ahupua'a.

What are the effects on communities that lived in the smaller ahupua'a or those that were land-locked or which had little surface water access? Here we can only point to what we have found in Wai'āpuka, Makanikahio 1, Manankikahio 2, and Pololū. Agricultural systems were developed that passed across distinct drainage catchments, or transported water from higher elevations to lower locations where arable land could be found (or developed). Some of these systems are described in this report for Wai'āpuka and Makanikahio, and for the two Makanikahio ahupua'a and Pololū. Water transport and the development of ridge irrigated agricultural complexes reduced the differences in overall productivity (in the case of Wai'āpuka with its more extensive series of ridge top lo'i complexes) or linked related communities where water abundance in one was used to supplement reduced surface water in another by the use of existing secondary gullies (as water transport mechanisms) or the construction of 'auwai

that extended more than 500 m in length and were cut through bedrock in some places (as in the case of Makanikahio)

An analysis at this scale and resolution cannot resolve all of the questions regarding varying adaptations made to resource differences by traditional Hawaiian communities, but it does help to identify locations where research into practices involving resource sharing would have often been mutually beneficial. In other words the documented ethnohistorical, historical, and archaeological materials involved in the 2013 training program not only introduced students to the techniques used for documentation but they have aided in the identification of the various ways communities and groups managed their resources late in prehistory and then into the modern historic era.

Summary of 2013 Training and Research Program

Historical and Archaeological Training

Seven students, five native Hawaiians and two undergraduates from the University of New Mexico, participated in the 2013 Summer Historical and Archaeological Training Program in Kohala, Hawaii Island. This program took place during the month of June and consisted of three components: 1. Training in historical methods and archival techniques including the use of oral traditions, histories, recorded narratives, Native Hawaiian newspapers, land records, and historical maps; 2 Archaeological field methods and archival techniques including survey, mapping (with both instruments and tape and compass), documentation and site descriptions, photography, and the use of archival archaeological documents from previous fieldwork in the area; and 3. development, implementation, and completion of a research project that would include both historical and archaeological information. This program was ambitious, to say the least. It was also a source of some frustration to the student participants, particularly the research project they were tasked with completing as both an oral, illustrated presentation in late June (and then again in October) as well as a completed research paper.

Training in Historical Methods

The portion of the 2013 program devoted to historical methods took place, for the most part, during the first two weeks of June. An introduction to these historical materials was designed to familiarize students with windward Kohala and its native inhabitants. A variety of primary and secondary historical source materials was developed for this project by Kikilo'i and Uyeoka (particularly Uyeoka et al. 2013).

Uyeoka's report for Kamehameha Schools' lands in Kohala includes primary information on a number of historic records associated with Wai'āpuka. In particular, Uyeoka et al. provide listings of all the LCA and Grant land awards, along with native and foreign testimonies where those were available for Wai'āpuka. These materials were used to train students in the use of 19th century land awards by having students assume the identity of the different individuals who received awards in the lower part of Wai'āpuka. This exercise demonstrated to students the relationships among the awardees, the differences in the lands they received (and the means by which they did so). Uyeoka's report also includes both native and

foreign testimonies on the Wai'āpuka Boundary Commission; this established the ahupua'a's boundaries with respect to neighboring communities and also identified long term residents of the area whose knowledge was key in mapping these boundaries. She provides a listing of place names for Wai'āpuka including named lands. A number of long term Kohala residents were interviewed who had links to the lands of Wai'āpuka.

Kikilo'i developed a number of archival materials prior to the 2013 training program that were uploaded to a dropbox account and shared with all of the program's staff and students. This included the following:

1. 38 different registered historic maps (PDF and TIFF formats) in the Hawai'i State Archives that include the study area but also various other areas within and across windward Kohala and at different scales. These maps included Iao's 1910 map of LCA awards from the ahupua'a of Paa'o to Awini in Kohala; Lydgate's 1881 map of land ownership in windward Kohala from Kauhola to Makanikahio; Loebenstein's 1904 map of the Niuli'i Plantation that covered properties from Makapala-Amakao through Makanikahio. The significance of many early maps is that they show traditional agricultural areas that were still in place (and probably in use) at the time the map's data was collected. Place names are included on some of the maps as well as depicting the primary and secondary streams and drainages. Thus, they represent a collection of historical and geographic information.
2. 13 primary historical accounts of Kamehameha I that are linked to Kohala in different ways.
3. A 1835 census for Hawaii Island that includes the windward Kohala ahupua'a from a native Hawaiian language newspaper, Kumu Hawaii, a native Hawaiian newspaper.
4. The Kohala Index of named individuals in relation to Land Grant awards.
5. The North Kohala index of named individuals in relation to LCA awards.
6. The Waihona database of named individuals for Kohala LCA awards.
7. A series of native testimonies for LCA awards in Makanikahio, Makapala, Niuli'i, and Pololū. Wai'āpuka testimonies are included for Wai'āpuka in Uyeoka et al 2013.
8. Several mo'olelo pertaining to Kohala
9. All of the north Kohala Tax Key Maps from Hawai'i County
10. Examples of an obituary and probate court testimony from the Kingdom period.
11. Ahupua'a Boundary testimony for Niuli'i, Ulupa'alua (within Niuli'i), Makanikahio, Makapala, and Pololū. Uyeoka's report includes the testimonies for Wai'āpuka.

Kikilo'i and Uyeoka also demonstrated on-line archival resources from various State and County offices and that are available on-line. For this exercise we used the computers at the Kohala Library that are linked to the internet.

After students were acquainted with the 7 main LCA awards from Wai'āpuka, they were taken out to the location of these properties, attempted to identify boundaries based on historic in the field, and discussed the different kinds of resources, improvements, and materials that each of the land awards

might have offered their owners. Cultural information included within the historical documents was identified, such as place names, 'ili names, the names of individuals (and their recorded histories that associated them with the claimed lands), the number and location of agricultural plots, directional orientation used to establish locations of land parcels.

Students were assigned several readings that incorporated historical documents or summaries and then as a group would discuss these studies terms of methodologies employed, and the theoretical and cultural perspectives represented, particularly in relation to contemporary Native Hawaiian historic perspectives.

As students developed their research projects and identified historical materials or documents they would use, they used their training to assemble these materials, developed illustrations or other visual devices to represent the information from historical sources, and integrated the historical information into their studies and findings. This included the use of place names, identification of land awards and associated archaeological sites, the identification of konohiki or local chiefs for Wai'āpuka who were identified in the historical texts and awarded properties in Wai'āpuka. One student worked on a land award made in lower Pololū Valley that has stayed in the hands of the original family members' descendants.

Training in Archaeological Methods and Archaeological Archival Materials

Two areas were selected for archaeological training, the first in the makai section of Wai'āpuka and the second in a mauka section of Makanikahio, centered on Kauhaikulepe Gulch. Students were also granted access to a property in makai Wai'āpuka that contained the Wai'āpuka Tunnel and its associated irrigated terraces. The makai area of Wai'āpuka was selected because there were historical records of land awards during the Mahele period to Native Hawaiians (and one foreigner) and these were accompanied by testimonies and other documents that pertained to land use, habitation, and the relationships between individuals claiming lands. There were also historical maps that showed the locations of former house sites and agricultural plots and in a few instances the possible locations of irrigation ditches that fed water into and then drained out of the agricultural complexes. The archaeological research involved the use of remote sensing data as well as archaeological inspection of the lands to see if these historically documented features still could be identified and mapped.

The mauka section of Makanikahio was selected because Kauhaikulepe Gulch was connected to a previously documented irrigated agricultural site, MAA 6 on its upper, southern end. Historical maps suggested excess water from MAA 6 could have flowed through the gulch and would have been available for irrigation within the bottom portion of the gulch. The gulch extends for more than 750 meters, and thus it presented a sizeable area for potential cultivation. The gulch also flows into the lower Pololū Valley just above the large irrigated complex located in the former marsh behind the sand dunes that front the ocean.

Students were also given training in the use of archival archaeological and historical documents as part of the research program of H2ARP. These included the development of a regional GIS of ahupua'a boundaries, associated historical and archaeological sites or properties, the use of LiDAR imagery to

detect and confirm the location of historical properties, the use of archaeological data, maps, and site records from Tuggle's study of Pololū Valley in the 1970s, and the use of previously recorded archaeological complexes within Wai'āpuka for the study of managed plants and trees associated with these complexes.

Student training in archaeological field methods included survey, mapping of archaeological complexes, and documentation of those complexes using field forms. Field documentation was done via iPads and site maps were scanned and then entered into the database for each complex and put together electronically into a single map of each complex. Photographs of archaeological features and the surrounding landscape and environment of Wai'āpuka and Makanikahio was also used for documentation.

In archaeological training, we emphasize non-invasive means of documenting sites. No excavation was done during the 2013 program given the limited amount of time we had for fieldwork. We did hire a backhoe to conduct trenching in two areas to see if we could identify subsurface or buried agricultural features, primarily irrigation ditches. In one area where subsurface features were found, students mapped the wall profiles created by the back hoe shovel. Possible ditches and stone retaining walls were found in one of the trenches confirming both the preservation of these features in some contexts and their relationships to historically documented agricultural sites. A charcoal sample was obtained from the trench excavation in makai Wai'āpuka in the vicinity of WAI 39, an irrigation ditch that had been previously mapped.

In October 2013, members of the staff from UNM and one of the students from the program returned to the study area in Makanikahio and Wai'āpuka to conduct additional survey of Kamehameha Schools land and complete test excavations in Kauhaikulepe Gulch in locations where rock walls or retaining walls had been located. The goal of these test excavations was to obtain charcoal remains from beneath walls that could be identified to plant taxon and then used for radiocarbon dating.

Students were encouraged to identify an archaeological component to their research projects. This could involve data directly developed as part of the H2ARP fieldwork conducted in windward Kohala since 2006 or they could use archival archaeological information from previous research projects that had documented historical properties. The purpose in having students employ both historical and archaeological information in their research projects was to challenge them to assess the information value of either resource for their project's research problem and goals. In cases where the information was congruent or complementary (non-overlapping) this strengthened the overall project, although students were taxed to figure out in what order and what relation to present the varying sources of information. In a few cases students' research concluded something different than had been previously thought or published. Cases where archaeological and historical data did not match, students were challenged to assess those differences. In most cases, the differences could be attributed to conventional ideas (mostly in archaeology) about the nature of Hawaiian culture, society, agricultural practices and relationships to one another.

Kohala Community Outreach

This was the first year that we attempted to actively engage with the windward Kohala communities and residents in several activities. All three co-directors, especially Uyeoka, knew individuals or local organizations from previous work in the area or ties to families.

We participated in the Kamehameha Day festivities held in Kapa'au on June 9th. This included the creation of exhibition materials such as historical maps and two archaeological posters that pertained to windward Kohala. Students and staff manned the booth at the Community Center during the afternoon, meeting local residents, gaining contact information, and describing the training and research program.

Fred Cachola, a former Kamehameha Schools' administrator who grew up in windward Kohala and has returned to live in the area gave the students a tour of several important historical sites in north Kohala that are associated with Kamehameha or other events in the history of the area. Fred is involved in several different organizations that have preserved the historic properties on lands in Kohala and he has long studied the history of Kamehameha.

We interacted with and consulted other property owners in Kohala including Bill Shontell land manager for Surety Kohala. For several years Surety has supported access to their lands by H2ARP. Bill is also a long time resident of Kohala and knows the lands and its people well. We met with Bill at the beginning of the program where all students were introduced to Surety's cultural and historical efforts and preservation and conservation, especially on the Forest lands in windward Kohala.

We initiated contact with the current, local property owners for the land parcel where the Wai'āpuka Tunnel complex is located. We received permission from the property owners to access this property, observe the condition of the tunnel and other cultural features. One student developed this for her research project. Her findings were shared with the family members, one of whom attended the presentations given at the Center for Hawaiian Studies at UH Mānoa in October, 2013.

We visited the former Bond Estate, now owned by the Bennett Dorrance and where a local group of Hawaiians had recently restored a lo'i complex that had been historically documented along the upper portion of Pali Akamoa Stream in 'Iole Ahupua'a.

We visited Puanui, a leeward ahupua'a (also owned by Kamehameha Schools) to learn more about the effort to experimentally grow sweet potato in various upland locations where the dry land Kohala field system was located. We also toured a portion of mauka Kehena on Parker Ranch land, the ahupua'a that borders many of the windward Kohala ahupua'a on their inland, mauka side.

We hosted a film crew from Kamehameha Schools who interviewed staff and students regarding the summer training program. Staff and students were interviewed by the crew regarding their work and goals for the program. This video was shown on a community television network in Honolulu.

We were hosted by local resident, Nani Svendsen on her restored lo'i property near Keokea along Niuli'i Stream, where she described the process of restoring the lo'i complex and her family's historical association with the property and with windward Kohala. This lo'i complex had been previously mapped

by the field training program and a large scale map of the lo'i and other improvements were presented to Nani and her family. We provide her with copies of our reports each year in electronic format.

At the end of the field season on June 28th, we hosted a Ho'ike for the Kohala community at the Kohala Inter-Generational Center where all seven students described their research projects and presented their findings to an audience of more than 50 people. We hosted a meal and refreshments for the community and offered our thanks for the opportunities provided to the program and students to learn about Kohala, its history and people.

In October 2013, the Hawaiian students gave oral presentations of their research projects at the University of Hawaii at Mānoa. That same weekend, all seven students (including those from New Mexico and California) and staff attended (or prepared materials for) the Annual Meeting of the Society for Hawaiian Archaeology and made oral presentations and four posters describing their research. We invited Fred Cachola to attend the SHA conference in October where students gave presentations or prepared posters on their research projects from the summer 2013 and he provided a commentary on the 2013 program towards the end of the Conference.

Finally, all seven students submitted final written versions of their research projects at the end of October 2013. Two students, Samuel Kamuela Plunkett and Nicholas Ferriola developed their summer projects into independent student projects for their respective universities: UH Mānoa and the University of New Mexico. A listing of the student projects follows.

Student Research Projects

Working with the professional staff, students selected projects to research as part of the program. These students, their projects, presentations or posters and research abstracts or introductions were as follows:

1. Ruth Aloua (B.A., Anthropology, University of Hawai'i-Hilo, Graduate student in Archaeology, Simon Fraser University, Burnaby, British Columbia), "***Investigating the Potential for Arboriculture in Wai'āpuka***", Poster at the Society for Hawaiian Archaeology Annual Conference, October 2013. Ruth completed her second year of graduate training in 2014 at Simon Fraser University.

Abstract: The study of *arboriculture* – the cultivation and management of trees, shrubs, and vines – is a topic that has received varied levels of attention by researchers throughout Oceania. Such studies conducted thus far have focused on investigating broad topics that focus on understanding the development of subsistence system models in Southeast Asia and the Pacific, to more specific topics, that attempt to identify evidence for cultivation and translocation of cultigens in specific areas. Within Hawai'i, in the districts of North and South Kohala, there has been little research that has focused on understanding arboricultural practices that may have once existed in the area. Although a considerable amount of research has focused on investigating the dry- and wet-land agricultural systems for the past fifteen years, thus far, the investigations in these areas have not yet studied the potential for arboriculture practices in Wai'āpuka. In this project, I investigate the potential for arboriculture in Wai'āpuka.

2. Paul Duran (BA, History, University of New Mexico), *“Resource Availability and the Ramon Family Complex in Pololū Valley, North Kohala, Hawai‘i Island”*, Poster at the Society for Hawaiian Archaeology Annual Conference, October 2013. Paul applied for and was accepted in the Applied Archaeology Master’s Program at New Mexico State University. He will begin in the fall 2014

Abstract. Pololū Valley, North Kohala, Hawai‘i has a vast and intricate wealth of cultural remnants and practices. This valley is located in northeastern Hawai‘i Island and shared an important source of agricultural practices where the Ramon family’s property is located. The Ramon family is considered to be the “Last Family in Pololū Valley”. We can see distinguishing features along their landscapes such as terraces for cultivating taro and engineered walls and drainages from springs that fed into the lo‘i patches. Research has shown us that there was an intricate relationship shared between Hawaiians and their lands.

3. Nicholas Ferriola (BA, History, California State University-Sonoma, Undergraduate student in Anthropology, University of New Mexico), *“Resource Modeling for the Ahupua‘a of North Kohala, Hawaii: How Cultural Borders Define Regional Ahupua‘a Self-Sufficiency”*, Poster at the Society for Hawaiian Archaeology Annual Conference, October 2013. Nicholas completed a year of independent study and will complete his BA in Anthropology at UNM as part of the honors program. His honors paper will be an extension of the research he began in the 2013 training program.

Abstract: Subsistence resource production is the most essential part of human survival in any society, and higher population density means intensified forms of subsistence are increasingly necessary. In Hawai‘i this corresponded to two primary domains: agricultural and livestock production (land based), and marine resource exploitation (sea based). In most areas of the Hawaiian Islands, access to the sea and the various resources from mauka to makai (mountain to sea) was enshrined in the traditional cultural territories known as ahupua‘a whose borders “ran like a wedge from sea to mountains”. The ahupua‘a also traditionally included a watershed that ran through it making the entire area theoretically self-sufficient. Despite this ideal, various factors contributed to variation from this ideal with some ahupua‘a being highly abundant in some resources while either completely lacking in, or simply being deficient in others. In this study I examined how this ideal specifically applied to the windward side of North Kohala moku, and whether the area’s traditional communities would in fact have been self-sufficient given the historically known ahupua‘a borders.

In order to examine the resources, we first have to consider the region as whole. North Kohala can be separated into a leeward (western), dry side, and a windward (eastern), very wet and lush side. This climatic difference, coupled with the remnant geological substrates across the region results in different physical environments that in turn lend themselves to very different subsistence practices. This was especially notable in terms of how agriculture was developed and organized as not all ahupua‘a functioned entirely independently of their neighbors. A lack of abundant surface water resources on the leeward side affected the types of crops grown, the nature of agricultural production, and the potential for population expansion in ways that did not occur on the windward side. Geologically, the leeward side also had significantly less potential for

erosion and incision in the rock which created so many streams on the windward side, meaning wetland agriculture was more prominent. Additionally, through investigation of borders the idea has been proposed how the ahupua'a of Kohala were, over time, divided into smaller units. It was theorized that the original units were based on major geographic features, and also proposed a possibility of a maximum effective community size, and decisive political factors as possible reasons for subdivision. Their studies on the leeward side of North Kohala, demonstrating a connection between ahupua'a name similarities, the obvious bifurcation of particular territories from others, and combining factors proposing likely prior forms before later subdivision allowing for the process to be sequenced based on these concepts.

In this study I will develop and apply a similar approach to understanding the relationship between resources and community territories on the windward side of North Kohala. This research departs from the previous studies because I will be looking into how the resources themselves may have impact these subdivisions of larger to smaller territories, and how these subsequent subdivisions in turn affected access to critical resource. Because a subdivision of territories will necessarily correspond with a reduction in self-contained resources this in turn may have a negative impact on the ideal self-sufficiency of ahupua'a from prior, larger, forms. In this study, I will analyze coastal access, land area, and available freshwater sources. Surface water, due to its abundance, the result of higher rainfall, on the windward side will introduce an additional level of complexity because the number of streams and their extensive, but variable, watersheds means many territorial boundaries incorporate multiple drainages that may cross from one ahupua'a to another. Because traditional Hawaiian water rights were strictly enforced, the amount and predictability of water available may vary by location and geography. This will potentially make for a complex situation in regards to inter-ahupua'a relations. By modeling resource production this study will paint a picture of how well situated the various windward ahupua'a were in relation to each other, as well as seeing how they might have needed to rely upon each other to make up for deficiencies. It is my expectation that while the bulk of ahupua'a in windward North Kohala did maintain the traditional shape, reaching from mauka to makai, as the ahupua'a subdivided further their self-sufficiency diminished leaving territories dependent on relations with neighboring ahupua'a to survive.

4. Tara Manaea del Fierro (BA, Anthropology, University of Hawai'i-Mānoa), "***Challenging the Role of the Konohiki: A Case Study***", Presentation at the Society for Hawaiian Archaeology Annual Conference, October 2013 and at the Center for Hawaiian Studies, University of Hawai'i-Mānoa, October 2013. Tara worked for Cultu'ral Surveys Hawaii, an archaeological consulting firm in Honolulu in 2013-14 following the training program in Kohala.

Abstract: This study challenges our current understanding of the role of konohiki in pre-contact times through the analysis of the archaeological records and historical Land Commission Award (LCA) documents gathered for the ahupua'a of Wai'āpuka, in Windward Kohala. Examination of LCA documents (awards, native and foreign registers, and testimonies) within this discrete area of the ahupua'a and in the context of its ancient resources suggests that at least four konohiki, or land stewards, shifted roles and enacted different strategies of management within a short

period of time in the mid-1880s. Thus, this prompts one to question our current understanding of the traditional concept of Hawaiian *konohiki*. It also provides insight as to what additional questions might be asked in future research of the ethno-historical and archaeological records in Hawai`i.

5. Samuel Kamuela Plunkett (Undergraduate student in Anthropology, University of Hawai`i-Mānoa) “*Water and Relation in Wai`āpuka: Combining Ethnohistory and Archaeology*”, Presentation at the Society for Hawaiian Archaeology Annual Conference, October 2013. Kamuela completed a senior research paper under the direction of Graves and graduated with a BA degree in Anthropology from UH Mānoa in 2014. He was admitted to the Public Archaeology Masters Program at the University of New Mexico where he will begin his studies in the fall 2014.

Abstract: To date, archaeologists have written much about the agricultural systems of Hawai`i. Patrick Kirch and Timothy Earle made significant contributions through the study of pre-contact valley/ and alluvial plain lo`i (irrigated pond field taro cultivation) systems during the late 1970’s and early 1980’s. Study of dry land agriculture, specifically of the Leeward Kohala field system increased during the 90’s producing archaeological maps, LiDAR imagery, soil analyses, and sociopolitical/ territorial hypotheses. Needless to say, much has been documented of valley and alluvial plain irrigation, as well as dry land, rain fed agricultural systems.

However, what might the archaeological record reveal about pre-contact irrigation systems on ridge lands between streams or other drainages, or what are sometimes called *kula* zones? In Windward Kohala, specifically in the adjacent ahupua`a of Pololū, Makanikahio 1 and 2, and Wai`āpuka, the Hawai`i Archaeological Research Project has been studying the way in which Hawaiians moved water down and across the landscape to irrigate agricultural terraces. Findings of this project in Makanikahio and Wai`āpuka (Site MAA 4A and 6, MAA 4B and WAI 18, 31) suggest that at higher elevations (1,300 – 1,500 feet above sea level), Hawaiians moved water across territorial boundaries by digging ‘auwai (ditches) leading from a natural perennial stream through dry or intermittent flowing (if unmodified) gullies and “ridge slopes”. Findings of H2ARP 2013 also suggests that water in Wai`āpuka was pulled out of Waikama Stream onto table land lo`i without being diverted back to its source before terminating off the cliff face into the sea. These findings challenge the classic notions of ahupua`a resource management (i.e., subsistence sufficiency), and allow room for questioning previous theories of Hawaiian territoriality. This evidence promotes the idea that researchers should take into consideration that possible regional diversifications of generalized summations about Hawaiian irrigation do exist in the archaeological record.

The classic image of a valley-based ahupua`a and its lo`i systems usually depicts high steep valley walls with an agricultural plain between them. This image includes a perennial stream running from uplands to ocean. This stream would then irrigate terraced lo`i built alongside the stream via side drainages or ‘auwai. This imagery also takes for granted that water diverted for lo`i irrigation in the upper part of the valley would re-enter the stream it originated from lower in the ahupua`a before it entered the ocean.

In Wai'āpuka and its adjacent territories (Makanikahio 1 and 2, and Niuli'i) we see almost the inverse of a valley landscape in that ridge lands are separated by relatively small streams in gullies (except Makanikahio 1 that is bordered by Pololū valley on its eastside). In the case of Wai'āpuka, its archaeological irrigation record is anomalous compared to valley irrigation systems in that irrigated water does not always return to its stream source and may not remain its own catchment, drainage, or territorial land division (ahupua'a). In effect water movements in these ahupua'a display regional irrigation practices that diverge from the classical image of valley ahupua'a water and resource management.

This research project focuses in on lower Wai'āpuka and the water relationships between four agricultural complexes each believed to contain lo'i and related features. These complexes were first researched ethno-historically by looking through *Kohala I Ka Unupa'a: Kohala of the Solid Stone* – a compilation of Wai'āpuka Land Commission Awards (LCA) obtained by individuals during the Mahele era (mid 19th century) of the Hawaiian Kingdom. The LCA testimonies and historic maps researched correspond to the four individual agricultural complexes of this project and clearly reveal the existence of pond field agriculture on ridge lands. This paper will discuss how these four agricultural complexes were rediscovered, mapped and documented. Based on the evidence found during H2ARP, this paper also attempts to explain how these individual complexes were connected by 'auwai (irrigation ditches). The connectivity of these complexes into an agricultural system provides the foundation for future research concerning ridge land water movement engineering and intra- and inter-community cooperation.

6. Kau'ilani Rivera (BA, Anthropology and Hawaiian Studies, University of Hawai'i-Hilo, Incoming Graduate student in Applied Archaeology, University of Hawai'i-Mānoa), "***Ola Ka Inoa: Analysis of Place Names throughout the Ahupua'a of Wai'āpuka***", Presentation at the Society for Hawaiian Archaeology Annual Conference, October 2013. Kau'i Rivera completed her first year of the Applied Archaeology Masters Program at UH Mānoa and is conducting field research in American Samoa during the summer 2014.

Abstract: Hawaiians are well known for the intimate relationships they created and maintained with the 'āina and their strategies employed for resource sustainability. Land areas were divided into social political units, and all areas regardless of size and dimension were considered to have a functional role towards productivity and maximizing efficacy of land use. After peeling back the layers of foreign cultural construct that currently exists on Native Hawaiian lands, what remains is a vision of what used to be and what can be. Each land area has a specific name that not only adds to the richness of the cultural landscape, but builds the identity of those who live on the land as well. Within the ahupua'a of Wai'āpuka in the district of Kohala iloko (interior Kohala), there are numerous documented cultural locations that still exist on the landscape, whose names suggest meaning and function in regards to traditional land use. This windward portion of Kohala is of special interest, because it was once a heavily inhabited region, as exhibited through a number of historical land documents that were codified in the mid 1800s. Interestingly, this particular land area is now almost completely vacant of any evidence of previous occupation with

the exception of a few houses in the mauka portion. The land sections located within this ahupua'a and their individual names create the basis of this paper as it seeks to reconstruct and enhance the traditional landscape through identifying these places, their relative location, and their significance to the people that once lived there as derived through translation and interpretation.

This paper emphasizes the Hawaiian perspective of *kaona* and the idea of multiple truths, which is essential in interpreting names and Hawaiian words in general. These numerous translations demonstrate the vibrancy of Hawaiian language and the fact that homonyms may refer to a variety of interpretations, which would seem as potentially conflicting definitions in English, yet in Hawaiian it typically means all of the different definitions simultaneously, show the complexity of the language and the layers of meaning. Research that has been priorly conducted pertaining to place names has had a tendency to focus more on either the general importance of place names or larger social political land units. My project slightly differs from these previously completed projects because it looks at land divisions and landforms within an ahupua'a on a micro-scale, which is not commonly done. Typically we understand the socio-political hierarchy as island, moku (district), then ahupua'a and don't necessarily take the time to gain a greater relationship with the places within an ahupua'a, however it is through this intimate relationship with the land that we can gain a greater identity of ourselves as well as who we come from. I am interested in seeing how the naming of these smaller divisions of land supports the importance of knowing and understanding various translations and interpretations of place names and how the use of these names supports identity development.

7. Kehealani Walker (BA, Anthropology, University of Hawai'i-Hilo, Incoming Graduate student in Anthropology, California State University-Northridge), "*Wai'āpuka Tunnel*", Poster at the Society for Hawaiian Archaeology Annual Conference, October 2013. Kehea began but did not complete her first year in the Master's Program at CSU-Northridge.

Abstract: The Wai'āpuka Tunnel, known locally at the "Kamehameha Tunnel", is located in the ahupua'a of Wai'āpuka, Kohala and provides a model example of engineered irrigation. It is unique in its construction and is the only tunnel of its size and magnitude, however, there has been only limited research and documentation on it. The first documentation was a sketch map in 1888 by L. Cabot and it was later reported on in 1988 by Tominari-Tuggle. After researching available resources that reference the Wai'āpuka Tunnel, there is recognition of speculation on the tunnel's existence-when was it built and by who? In seeking to understand these questions, this project focuses on learning more about the tunnel's construction and expanding on what has already been shared about its existence using ethnohistorical, archival, and archaeological data.

Student projects were on the whole successful. Each project presents original research that combines archaeological and historical findings. Students began these projects when they first arrived in early June and in late June they presented short, 10 minute power-point presentations at the Ho'ike . Then in October students presented their research at one or two conferences, either as power-point illustrated presentations or as large scale posters. Several of the Honolulu-based students gave presentations on

October 10th at Ho'okahe Wai, Hooulu 'Aina at the Hawaiian Studies Center organized by Dr. Kekuewa Kikiloi. On October 12th all of the 2103 field training students and staff attended the annual Society for Hawaiian Archaeology Conference at the Bishop Museum, Atherton Halau, in Honolulu, where three students gave presentations and four students presented posters they had made for the conference. Three of the students, Paul Duran, Ruth Aloua, and Kehealani Walker won prizes for the best posters at the conference.

The findings from these projects also are incorporated into this report and the students are listed as co-authors.

Historical and Archaeological Findings

To briefly summarize, our work documents historic and prehistoric land use and organizational practices in a portion of windward Kohala. Much of this information was unknown, scattered, or informal and as a result much has been learned and gained by the 2013 training program funded by Kamehameha Schools. It built on several years of previous research, largely archaeological and supplemented by some historical accounts and maps as well. Some of our findings are still tentative or suggestive, yet others are now fairly well established and they certainly challenge conventional archaeological beliefs about customary land use in windward Kohala. Given the limited amount of land that was within the valley bottoms and along coastal regions, archaeologists assumed that irrigated agriculture in windward Kohala was small in scale, scattered around (the equivalent of being unorganized or unrelated), and confined to individual drainages or catchments.

This is not the case. There were a number of prehistoric agricultural innovations based on traditional Hawaiian farming practices that occurred in parts of windward Kohala. We know these primarily from the easternmost gulches and valleys of the area and they may not be generalizable farther west or into adjacent districts (e.g., Kona). However, we doubt that developments in Kohala were unique or not adopted elsewhere where conditions permitted. We have discovered a number of instances in which irrigation ditches were cut into bedrock across ridge tops, along slopes, and adjacent to streams and secondary drainages. The engineering of these ditches would have been substantial as there is no direct line of sight from water source to agricultural terraces. Some of these ditches extend well over 500 m in length, challenging conventional views about irrigation technological organization in Kohala. We have now documented at least three instances in which irrigation systems cross drainages and traditional ahupua'a boundaries. These appear to have been achieved prior to European contact in the late 18th century.

The tunneling through bedrock to create irrigation water transport is likely to be a Hawaiian innovation that could predate the arrival of Europeans. Evidence collected from the Wai'āpuka Tunnel supports a conclusion that it was constructed with traditional Hawaiian tools and methods that are similar to what in use prehistorically, before the arrival of Europeans or Americans to Hawai'i. We have found a small separate section of irrigated ditch tunneling again along Waikama stream, at about 1100 ft asl. The ditch cuts through bedrock before entering the north end of a ridgeline that separates Waikama from a small secondary gully to the east. The tunnel is about 5 m long and when it emerges on the east end of the

ridge is becomes a ditch cut into bedrock and then extends into the drainage of the secondary gully. While there is evidence of both historical and contemporary use of this ditch and tunnel (as well as Kamehameha's), the evidence suggests both were excavated with traditional Hawaiian tools. There was no evidence that the ditch and tunnel were constructed after European contact nor would it have required engineering skills not otherwise available in Hawai'i.

All of the irrigation systems that transport water over considerable distances and across land and cultural boundaries reflect cases in which areas where surface water that was more abundant up slope and at higher elevations was diverted to locations where stream water was lacking or impermanent. These systems would have linked what are seen as separate ahupua'a or communities by shared water resources. Even within a single ahupua'a, these systems would have linked households with land holdings in different portions of the community. Water supplies at higher elevations and/or where it occurs in permanent streams were diverted to locations where it was needed and could be used to expand agricultural production. It demonstrates a degree of intra- and inter-community cooperation and integration, not to mention engineering knowledge and application.

In the case of Makanikahio, which is a land resource-limited ahupua'a, given its small size and restricted coastal access, its water resources in Waiakalae were shared with neighboring communities in both directions— Wai'āpuka and Pololū. It seems likely that inhabitants of Makanikahio were trading water access for either direct land rights or for a portion of the agricultural production directly related to those shared water resources. This replicates a pattern observed among leeward Kohala ahupua'a of different sized adjacent communities in terms of variation in resource potential or predictability. The difference is we have not been able to yet identify a resource, other than agricultural labor, that smaller communities might have traded with larger ones in leeward Kohala given that the landscape is less variegated and contains little surface water to be moved, compared to the windward side.

Finally, the relations described here between water transport, agricultural complexes and systems, and cultural domains (of social organization) show that territorial units were organized at different scales and directionality of geographic overlap. This reflects an even larger (and perhaps more ancient) system of organization that in the eastern gulch section of Kohala likely spanned from Makapala eastward and included portions of Pololū. Total agricultural production, even after the late expansion, would not have matched the leeward Kohala field system but it was more predictable from year to year, and as such contributed to stabilizing the larger polity centered on Kona, Kohala, and Hāmākua and which was ultimately presided over by Kamehameha I.

Acknowledgements

This report reflects a field training program in Hawaiian history and archaeology that had multiple organizations and individuals involved in its success. We wish, first, to acknowledge Kamehameha Schools for supporting and funding both the field training and conference attendance for the students in the 2013 program. Within Kamehameha Schools, Jason Jeremiah, the Manager of Cultural Resources in the Land Assets Division for beginning discussions with us a few years ago about a training program for Native Hawaiian students who might wish to become professional historic resource managers and ethnohistoric or archaeological consultants in Hawaii. The 2013 program is the realization of those discussions and we thank him, and his superiors at Kamehameha Schools, Ulalia Woodside and Neal Hannahs for their support. We also acknowledge the permission granted by Kamehameha Schools for access to their lands in Wai'āpuka for this program.

Surety Kohala, one of the major land owners in windward Kohala, granted permission to work on its lands in Makanikahio and its owned and leased lands in Wai'āpuka. Bill Shontell, the Land Manager (and formerly Mike Gomes), has supported access to a variety of Surety land holdings in windward Kohala for all of our training and research since 2006. In doing this, the company has given us considerable latitude in how we implement our training programs. Bill has also encouraged us over the years to involve the Kohala community in our efforts, and we view the 2013 program as the first considerable outreach on our part to better connect with a variety of individuals and organizations living and operating in this region. We would also like to acknowledge the assistance of Sophia Schweitzer former historic resources manager for Surety

We have benefitted from the advice and support of a number of individuals and land owners in windward Kohala. Nani and Don Svendson have provided housing and access to their lands in Niuli'i. Nani has also let us visit her restored lo'i system in Keokea, a lower section of the Nuili'i Ahupua'a. Her restoration efforts and generosity to us for help and information are deeply appreciated. In 2013, we also received permission from the Scott May and his sister, Sandra Lawrence, descendants of John Parker, to access their land in Wai'āpuka and to make observations on the tunnel, ditch, and lo'i complex known locally as Kamehameha's Tunnel that was built on this land. The section of this report that describes our observations along with archival information on this property is the first time in more than 100 years that an effort has been made to synthesize this unique historic property. Kehealani Walker, one of the students in 2013, used this complex as the focus of her research report.

Over the years, we have talked with Greg Chilton and his family about their property in Wai'āpuka and the historic features that were recorded historically on the land. Again, we have synthesized the relationship of the lo'i complex and ditches that formerly existed on the Chilton property with the Kamehameha Tunnel complex and another lo'i complex further downslope on land owned by Surety Kohala. Thank you, Greg for a copy of the lo'i complex map; it is included in this report.

Each year since 2006, one of the first activities that students engage in has involved a tour of historic sites in Kohala by Fred Cachola, former educational administrator of Kamehameha Schools, and local

boy who grew up in windward Kohala, and possesses an abiding interest in its history and the preservation of historic properties throughout the district. Thank you Fred for your support and the introductions you have provided to us of other community members.

Both the Universities of Hawai'i at Mānoa and New Mexico contributed materially to this and earlier training programs in Kohala. The Ortiz Center for Intercultural Studies at the University of New Mexico provided funds for the UNM undergraduate students to attend the 2013 program. Both of those students are now committed to professional careers in anthropology. Neither had been to Hawai'i before and this learning experience was transformational for each of them. When it was realized at the University of New Mexico would not be able to administer this program, the Social Sciences Research Center and its Director, Velma Kameoka stepped in and agreed to manage this project after the field program ended. By doing so, the Center ensured the fiscal ability of the program to continue into the fall (and to see to it that all staff members were paid and that students received their stipends). The Chair of Anthropology at UH Mānoa, Dr. Christine Yano, gave her blessing to this program during the transitional interval.

References

- Allen, M. (1985). *Limited Archaeological Reconnaissance Survey of Kahua Ranch Coastal Survey: Ahupuaa of Kahua 1-2 and Waika Ahupuaa, North Kohala, Island of Hawaii*. Hilo: Paul H. Rosendahl, PhD, Inc.
- Aloua, R.-R. (2013). *Investigating the Potential for Arboriculture in Wai'āpuka*. Albuquerque: Hawaii Historical and Archaeological Research Program, University of New Mexico.
- Birkmann, J. (2014). *An Irrigated Agricultural System Linking Makanikahio and Pololū Ahupua'a , Hawai'i Island*. Unpublished MA Paper, University of New Mexico, Honolulu.
- Birkmann, J. (2014). *Soil, Water, and Sociality: Irrigated Agricultural Systems Linking Makanikahio and Pololū Ahupuaa, Hawaii Island*. University of New Mexico, Department of Anthropology, Albuquerque.
- Bonk, W. (1968). *The Archaeology of North and South Kohala from the Ahupuaa of Kawaihae to Upolu: Coastal Archaeological Surface Survey*. Honolulu: Department of Land and Natural Resources.
- Calugay, C. (2007). *A Landscape in Transition: An Analysis of Land Commission Awards in Leeward Kohala*. Honolulu: Department of Anthropology, University of Hawaii.
- del Fierro, T. (2013). *Challenging the Role of the Konohiki: A Case Study*. Albuquerque: Hawaii Historical and Archaeological Research Program, University of New Mexico.
- Duran, P., Morehouse, J., Oxley, M. W., & Graves, M. W. (2013, October). Resources Availability and the Ramon Family Complex in Pololū Valley, North Kohala, Hawaii Island. *Presented at the Annual Meeting of the Society for Hawaiian Archaeology*. Honolulu, HI.
- Dye, T. (2003). *Revised Archaeological Inventory Survey at Kaiholena Ahupuaa, North Kohala, Hawaii*. Honolulu: T.S. Dye & Colleagues, Archaeologists, Inc.
- Ellis, W. (1969 [1831]). *Polynesian Researches: Hawaii*. Tokyo: Charles E. Tuttle Company.
- Erkelens, C., & Athens, S. (1994a). *Archaeological Inventory Survey Kohala Plantation, North Kohala, Hawaii*. International Archaeological Research Institute, Inc. Honolulu: International Archaeological Research Institute, Inc.
- Erkelens, C., & Athens, S. (1994b). *Archaeological Inventory Survey of the Seaward Portions of Waiapuka, Makanikahio 1, and Makanikahio 2, North Kohala, Hawaii*. Honolulu: International Archaeological Research Institute, Inc.

-
- Espiritu, J. (2007). *Examining the Processes of Agricultural Intensification: A GIS Approach to Traditional Agricultural Systems in North Kohala, Island of Hawai'i*. Chicago: Department of Anthropology, University of Chicago.
- Ferriola, N. (2014). *Resource Modeling for the Ahupua'a of North Kohala Hawai'i: How Cultural Borders Define Regional Ahupau'a Self-Sufficiency*. Unpublished, University of New Mexico, Department of Anthropology, Albuquerque.
- Ferriola, N., & Graves, M. W. (2013, October). Modeling Resources in Windward Kohala. *Presented at the Annual Conference of the Society for Hawaiian Archaeology*. Honolulu, HI.
- Field, J. S., & Graves, M. W. (2008b). *Archaeological Investigations of Keokea Beach Park (TMK 5-3-01:16), Niulii Ahupuaa, District of Kohala, Hawaii Island*. Albuquerque: Hawaii Archaeological Research Project, University of New Mexico.
- Field, J. S., & Graves, M. W. (2008c). *Archaeological Investigations of Wainaiia Gulch, Iole and Halaula Ahupuaa (TMK 5-03-05:3), District of Kohala, Hawaii Island*. Albuquerque: Hawaii Archaeological Research Project, University of New Mexico.
- Field, J. S., Graves, M. W., & Stephen, J. (2008a). *Archaeological Investigations of Upper Halawa Ahupuaa (TMK 5-3-02:01 and 5-2-04:03), District of Kohala, Hawaii Island*. Albuquerque: Hawaii Archaeological Research Project, University of New Mexico.
- Field, J., & Graves, M. W. (2008). A new chronology for Pololu Valley, Hawaii Island: Occupational History and Agricultural Development. *Radiocarbon*, 50, 205-222.
- Field, J., Kirch, P. V., Kawelu, K., Connors, R., & Ladefoged, T. N. (2007). *Archaeological Survey and Excavations of Makiloa and Kalala Ahupuaa, Kohala, Hawaii Island*. Honolulu: State Historic Preservation Division.
- Field, J., Ladefoged, T. N., Sharp, W. D., & Kirch, P. V. (2011). Residential Chronology, Household Subsistence, and the Emergence of Socioeconomic Territories in Leeward Kohala, Hawaii Island. *Radiocarbon*, 53, 605-627.
- Graves, D., & Franklin, L. J. (1998). *Archaeological Inventory Survey Kahua Makai/Kahua Shores Coastal Parcels, Lands of Kahua 1 & 2, Waika, North Kohala District, Island of Hawaii*. Hilo: Paul H. Rosendahl, PhD, Inc.
- Graves, M. W., Oxley, M. W., Morehouse, J., Spurgeon, K., & Brown, K. (2012). *The Hawaii Archaeological Research Project (HARP) 2010-2011: Fieldwork in Waiapuka and Makanikahio 1 and 2 Ahupuaa*. Albuquerque: Hawaii Archaeological Research Project, University of New Mexico.
- Graves, M., Cachola-Abad, C. K., & Ladefoged, T. N. (2010). The Evolutionary Ecology of Hawaiian Political Complexity: Case Studies from Maui and Hawaii Islands. In P. Kirch (Ed.), *Roots of*

-
- Conflict: Soils, Agriculture, and Sociopolitical Complexity in Ancient Hawaii* (pp. 135-162). Santa Fe: School for Advanced Research Press.
- Graves, M., Field, J. S., & Espiritu, J. (2007). The Development of Agricultural Complexes in Pololu Valley, Kohala, Hawai'i Island. . *Paper presented at the 17th Annual Meeting of the Society for Hawaiian Archaeology*. Kona.
- Graves, M., Field, J. S., Vallante, T., & Issac, D. M. (2006). Dating the Human Occupation of Pololu Valley, North Kohala, Hawai'i Island. *Paper presented at the 16th Annual Meeting of the Society for Hawaiian Archaeology*. Kahalui.
- Graves, M., Oxley, M. W., Morehouse, J., Birkmann, J., & Hronich-Conner, M. (2013). *The Hawaiian Archaeological Research Project (HARP) 2012: 2012 Fieldwork in Kohala, Hawaii Island*. Albuquerque: University of New Mexico.
- Griffin, P., & Tuggle, H. D. (1973). *Lapakahi, Hawaii: Archaeological Studies*. Honolulu: Social Science Research Institute, University of Hawaii.
- Hammatt, H., & Borthwick, D. (1986). *Archaeological Survey and Excavations at Kohala Ranch North Kohala, Hawaii Island*. Honolulu: Cultural Surveys.
- Handy, E., & Pukui, M. K. (1958). *The Polynesian Family System in Kau, Hawaii*. Wellington: The Polynesian Society.
- Hommon, R. (1986). Social evolution in ancient Hawaii. In P. V. Kirch, *Island Societies: Archaeological Approaches to Evolution and Transformation* (pp. 55-68). Cambridge: Cambridge University Press.
- Iao, J. (1910). Map of North Kohala, Paoo to Pololu, Hawaii. Honolulu: Territory of Hawaii.
- Kikiloj, S. (2012). *Kūkulu Manamana: Ritual Power and Religious Expansion in Hawai'i: The Ethnohistorical and Archaeological Study of Mokumanamana and Nihoa Islands*. Honolulu, HI: University of Hawai'i at Mānoa.
- Kirch, P. (1977). Valley irrigation systems in prehistoric Hawaii: An archaeological consideration. *Asian Perspectives*, 22, 246-280.
- Ladefoged, T., & Graves, M. W. (2006). Hawaiian Traditional Community Territories. In I. Lilley (Ed.), *Archaeology of Oceania: Australia and the Pacific Islands* (pp. 259-270.). London: Blackwell Publishing.
- Loebenstein, A. B. (1904). Map of the Lands of Nuii Plantation, North Kohala, Hawaii. Registered Map in the Hawaii Archives.
- Lydgate, J. (1881). Map of North Kohala, Hawaii Island, Working Sheet 1. Honolulu.

-
- McCoy, M. D., & Graves, M. D. (2008). *An Archaeological Investigation of Halawa and Waiapuka Ahupuaa, North Kohala District, Hawaii Island*. Albuquerque: Hawaii Archaeological Research Project, University of New Mexico.
- McCoy, M. D., Browne Ribero, A. T., Graves, M. W., Chadwick, O. A., & Vitousek, P. M. (2013). Irrigated taro (*Colocasia esculenta*) farming in North Kohala, Hawai'i: sedimentology and soil nutrient analyses. *Journal of Archaeological Science*, 40, 1528-1538.
- McCoy, M., & Graves, M. W. (2007). *An Archaeological Survey of Halawa and Makapala Ahupuaa, North Kohala District, Hawaii Island: Hawaii Archaeological Research Project*. Albuquerque: Hawaii Archaeological Research Project University of New Mexico.
- McCoy, M., & Graves, M. W. (2008). *An Archaeological Investigation of Halawa and Waiapuka Ahupuaa, North Kohala District, Island of Hawaii*. Albuquerque: Hawaii Archaeological Research Project, University of New Mexico.
- McCoy, M., Murakami, G., & Graves, M. W. (2010). Prehistoric Introduction of Breadfruit (*Artocarpus altilis*) to the Hawaiian Islands. . *Economic Botany*, 20, 1-8.
- Newman, T. (1970). *Hawaiian Fishing and Farming on the Island of Hawaii in AD 1788*. Honolulu: Department of Lands and Natural Resources.
- O'Hare, C., & Goodfellow, S. T. (1994). *Chalon International Mahukona Lodge Project, Lands of Kapanui, Kou, Kamano, Mahukona 1st and 2nd, Hihui, and Kaoma, North Kohala District, Island of Hawaii*. Hilo: Paul H. Rosendahl, PhD, Inc.
- Oxley, M. (2006). *Pre-Contact Basalt Distribution of Pololu Valley: Results of a Recent EDXRF Study*. Honolulu: Department of Anthropology, University of Hawaii.
- Oxley, M., Graves, M. W., Mills, P., & Lundblad, S. (2008). Production, Distribution, and Utilization of Basalt Artifacts: A Localized Geochemical Analysis of Pololu Valley. *Paper presented in "Archaeology of Kohala", at the 18th Annual Meeting of the Society for Hawaiian Archaeology, University of Hawai'i at Hilo, HI*.
- Palmer, M. (n.d.).
- Palmer, M., Graves, M. W., Ladefoged, T. N., Chadwick, O. A., Duarte, T. K., Porder, S., et al. (2009). Sources of nutrients to windward agricultural system in pre-contact Hawaii. *Ecological Applications*, 19, 1444-1453.
- Plunkett, S. (2013). *Ho'opiliwaiola: Water and Relationship in Waiapuka*. Albuquerque: Hawaii Historical and Archaeological Research Project, University of New Mexico.
- Richards, L., Calugay, C., McCoy, M., & Graves, M. D. (2007). Mahele Land Claim Awards in North Kohala, Hawai'i Island: Results from Recent Research. *Paper presented at the 17th Annual Society for Hawaiian Archaeology Meeting*. Kona.

-
- Rivera, K. (2013). *Ola Ka Inoa*. Albuquerque: Hawaii Historical and Archaeological Research Program, University of New Mexico.
- Rosendahl, P. (1972). *Aboriginal Agriculture and Domestic Residence Patterns in Upland Lapakahi, Hawaii island*. Honolulu: University of Hawaii.
- Rosendahl, P. (1983). *Archaeological Studies, Puakea Bay Ranch, North Kohala, Island of Hawaii*. Hilo: Paul H. Rosendahl, PhD, Inc.
- Rosendahl, P. (1994). Aborginal Hawaiian structural remains and settlement patterns in the upland agricultural zone at Lapakahi, Hawaii Island. *Hawaiian Archaeology*, 14070.
- Schweitzer, S. (2003). *Kohala Aina*. Honolulu: Mutual Publishing.
- Tominari-Tuggle, M. (1988). *Cultural Historic Resources Overview for Kohala*. Honolulu: International Archaeological Research Insitute, Inc.
- Tuggle, H. (1976). *Survey of Pololu and Honokane Valleys, Windward Kohala, Hawaii Island*. Honolulu, HI.
- Tuggle, H., & Tominari-Tuggle, M. J. (1980). Prehistoric Agriculture in Kohala, Hawaii. *Journal of Field Archaeology*, 297-312.
- Uyeoka, K., Ah Sam, A. D., Mahi, L., Macabio, U., Santos, A., & Kapuni-Reynolds, H. (2013). *Kohala I Ka Unupaa, Kohala of the Solid Stone: An Ethnohistorical Study of Puanuii, Upolu, Kokoiki, Puuepa, Waiapuka, and Honokane Ahupuaa, Moku o Kohala, Moku of Keawe*. Honolulu: Kamehameha Schools.
- Uyeoka, K., Lehuakeapuna, K., Ah Sam, A. D., Liula, M., Macabio, J., Macabio, U., et al. (2013). xxxxx. Hakalau, HI: Kumupa'a Cultural Resource Consultants.
- W.J., B. (1968). *The Archaeology of North and South Kohala from the Ahupuaa of Kawaihae to Upolu: A Coastal Archaeological Survey*. Honolulu: Department of Land and Natural Resources.
- Walker, K. (2013). *Wai'āpuka Tunnel: Ethnohistorical and Archaeological Details*. Albuquerque: Hawaii Historical and Archaeological Research Program, University of New Mexico.
- Williams, J. (1919). A little known engineering work in Hawaii. *Thurm's Hawaiian Almanac and Annual for 1919*, pp. 121-126.
- Wolforth, T. (2003). *An Archaeological Inventory Survey for the Proposed New Moon Retreat Center in Iole, North Kohala, Hawaii: Investigations into the Changing Patterns of Water Control in the Uplands of Iole*. Hilo: Scientific Consultant Services.
- Wolforth, T. R. (2008). *Final Archaeological Inventory Survey for the Proposed New Moon Contemplative Education Center in Iole, North Kohala, Hawaii: Invesigations into the Changing Patterns of Water Control in the Uplands of Iole, Portions of TMK: (3) 5-3-005: 5, 24, 39, 43, 4*. Honolulu: T.S. Dye and Colleagues, Archaeologists, Inc.

Wolforth, T. R. (2009). *Archaeological Inventory Survey for the Proposed New Moon Contemplative Education Center in Iole, North Kohala, Hawaii, Portions of TMK: (3) 5-3-005: 5, 16, 17, 24, 39, 43, and 45-51*. Honolulu: T.S. Dye and Colleagues, Archaeologists, Inc.

Wulzen, W., & Goodfellow, S. T. (1995). *Chalon International Mahukona Mauka Parcel, Lands of Kamano, Mahukona 1st and 2nd, Hihii, nad Kaoma, North Kohala District, Island of Hawaii*. Hilo: Paul H. Rosendahl, PhD, Inc.

Student Reports, Hawai'i Historical and Archaeological Research Project 2013

Ruth Aloua

1. Ho'ike Presentation
2. Society for Hawaiian Archaeology Poster
3. Completed Research Paper

Tara del Fierro

1. Ho'ike Presentation
2. Society for Hawaiian Archaeology Presentation

Samuel Kamuela Plunkett

1. Ho'ike Presentation
2. Society for Hawaiian Archaeology Presentation
3. Senior Research Paper

Kaui Rivera

1. Completed Research Paper (includes Society for Hawaiian Archaeology A Presentation)

Kehea Walker

1. Ho'ike Presentation
2. Society for Hawaiian Archaeology Poster

Paul Duran

1. Ho'ike Presentation
2. Society for Hawaiian Archaeology A Poster

Nicholas Ferriola

1. Ho'ike Presentation
2. Society for Hawaiian Archaeology Poster
3. Completed Research Paper

Joseph Birkmann (Masters' Student Graduate Supervisor)

1. Society for Hawaiian Archaeology Presentation
2. Completed Masters Paper