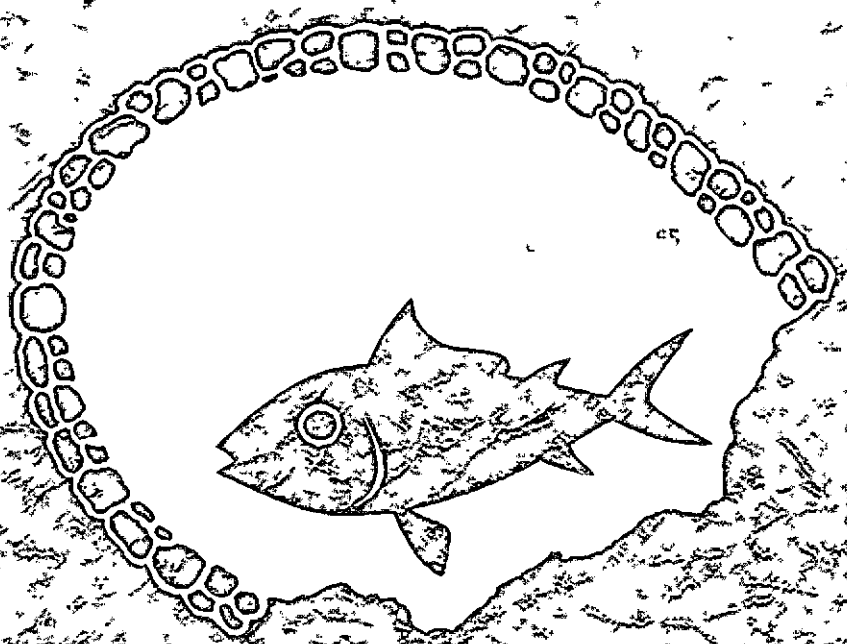


HAWAIIAN ARCHAEOLOGY



HAWAIIAN FISHPONDS

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CONTENTS

Introduction	1
Shore Ponds	2
Loko Kuapa	2
Loko 'Umeiki	12
Inland Ponds	19
Pu'uone	19
Loko I'a Kalo	23
Loko Wai	23
Conclusion	23
Glossary	24
Literature Cited	25

1 table, 14 figures in text

INTRODUCTION

opening
of
reference

Fishponds were things that beautified the land, and a land with many fishponds was called "fat."

S. M. KAMAKAU

THE CONSTRUCTION and operation of fishponds in the Hawaiian Islands, as they existed before the introduction of foreign materials to the Hawaiian culture, will be the primary concern here. The examples and statistics given are based on the Oahu and Molokai fishponds where the majority of ponds were located.

Fishponds are known to have been located on the islands of Hawaii, Maui, Lanai, Molokai, Oahu, and Kauai. Most of them are now in ruins or completely destroyed. The approximate number, not including the numerous small inland ponds, on each island was: Hawaii, 20; Maui, 16; Molokai, 58; Oahu, 97; and Kauai, 12. According to Cobb (1902, p. 429) "There used to be a number of fish ponds on Lanai, but they have all been allowed to fall into decay." The total number of ponds for all the islands, again not including the many small inland ponds, was about 210.

The general term for a fishpond is *loko*, "pond," or, more specifically, *loko i'a*, "fishpond." *Loko i'a* were used for the fattening and storing of fish for food, rather than for fish culture, and also as a source of tabooed fish.

A fish was tabooed by the Hawaiians during its spawning season. The taboo prohibited anyone, chief or commoner, from catching the fish in the sea, but it did not apply to fishponds because they were considered a part of the land. Consequently some fish, such as the mullet which was tabooed from November through March, were available throughout the year to the owners of ponds containing them.

There were two kinds of fishponds: shore ponds and inland ponds.



SHORE PONDS

The shore ponds were of two types: those entirely enclosed, *loko kuapa*; and those having lanes leading in and/or out of the pond, *loko 'umeiki*.

LOKO KUAPA

A *loko kuapa* is a "fishpond made by building a wall on a reef" (Pukui and Elbert, 1957, p. 157), and *kuapa* is the term for its wall.

Loko kuapa are not found anywhere else in Polynesia. Because of physical conditions, such as the shoal waters off of Molokai, they are unique to the Hawaiian Islands.

(*Loko kuapa*) were owned by the kings and chiefs, and at their command, were built by the common people. The building of a pond was a communal project of the chiefs who, from their individual land sections (*ahupua'a*), furnished the large number of people required for this work.

The following testimony about the building of Puko'o Pond, which was a *loko kuapa* on Molokai, is included in the transcript of a Land Commission hearing:

. . . said fishpond was affirmed to have been built by all of the people of Molokai, is the fruit of their joint labor and toil in former days, when they were drafted and commanded by lunas and chiefs, from every point of Molokai and brought to that work, and they further affirm, that said pond not having been built by the private labor of any one chief with his *po'alima*, but as afore said, by all the people of Molokai. . . .

Lokomaikai sworn: He helped build the wall of fishpond of Pukoo under Ilae Luna Auhau, about the year 1829. All the people were called to this work from Kamaloo to Halawa. [The area from Kamalo'o, now known as Kamalo, to Halawa is one quarter of the southern portion of Molokai.]

Kawelo of Ualapue sworn: He helped build said fishpond wall at the command of Ilae. Women and children also went and worked in the sea gathering lime [*puna coral*] for said wall.

Kaluna sworn: Lived at Kamaloo in day of Ilae and with all people from Kamaloo to Halawa was commanded and went and built fishpond wall in sea of Pukoo.

Said testimony confirmed by multitudes listening who said they were fellow workers in wall (Land Commission Award 3730, n.d.).

< The fish most commonly raised in *loko kuapa* were the *'ama'ama*, or mullet, and the *awa*, or milkfish. Hiatt (1944, pp. 254, 255) reports both of these fish reaching a length of 15½ inches in ponds. They obtain most of their food from microbenthos, which seems to grow best in brackish water and at a depth not < exceeding 2 feet. The following is a description of this food:

This is a complex found abundantly as a crust or mat upon the bottom of the ponds and is similar to "lab-lab" found upon the floor of nursery ponds for milkfish in the Philippines. It forms an almost solid mat on the bottom of the ponds from the edges down to a depth of approximately two feet. As greater depths are reached it becomes sparse, probably because of diminished light penetration as a result of nearly constant wind disturbances which fill the water with suspended detritus.

A microscopic examination of this complex shows it to be composed largely of unicellular, colonial, and filamentous blue-green algae, mostly small species of Oscillatoriaceae; there is a great variety of diatoms, bacteria, unicellular green algae, and a small proportion of very fine threads of Chlorophyceae, predominantly *Cladophora* spp. and *Vaucheria* sp. It also contains many protozoans, nematodes, and small crustaceans. The incoming tide and wind disturbance will often break up large patches of benthos filled with oxygen which buoys them up to the surface (Hiatt, 1944, pp. 264-265).

The adult *awa* feeds also on the larger algae, in addition to the above benthos. (For a complete account of the feeding habits of *'ama'ama* and *awa* in shore ponds see Hiatt, 1944, pp. 250-280.)

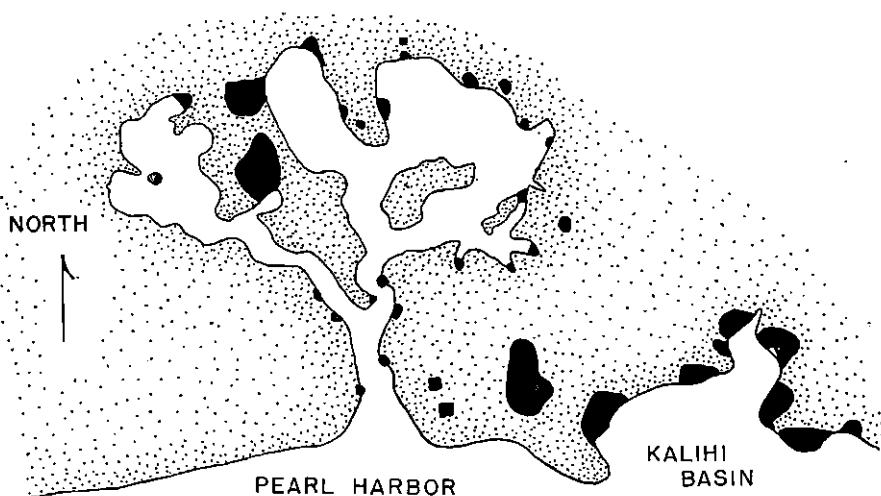


FIGURE 1.—Map of Pearl Harbor and Kalihi Basin, Oahu. Dark areas show the location of 40 fishponds. (Adapted from McAllister, 1933, p. 29.)

The ponds were built along the sheltered seashores (Fig. 11) or in bays, such as Pearl Harbor and Kalihi Basin (Fig. 1),* and Kane'ohē Bay on Oahu. Often they were located where fresh-water or brackish springs were to be found in the shallow waters, or at the mouth of a stream. As was stated above, the fish's food thrived best in brackish water. The streams also benefited the ponds by washing in inorganic material, thus fertilizing and consequently increasing the food supply.

Loko kuapa were made by using one of two methods. One was to construct a wall across the mouth of a small bay or between two close points of land (Fig. 2); the other was to run a wall out from two places on the shore line to

* The drawings in this book were made by William K. Kikuchi.

form a semicircular enclosure (Fig. 3). Most of the Molokai fishponds were built by the latter method. The coast line on the south shore of this island, where all the fishponds are located (see Fig. 11), is fairly straight; and the shoal waters, having a maximum depth of 3 feet, extend several hundred to over a thousand feet.

Where numerous ponds had been constructed close together, as was done on the southeastern coast of Molokai, and at Pearl Harbor and Kalihi Basin on Oahu, a new pond was sometimes built by using a portion of the wall of an existing pond as part of its wall. For example, Kalokoiki Pond at Wawaia,

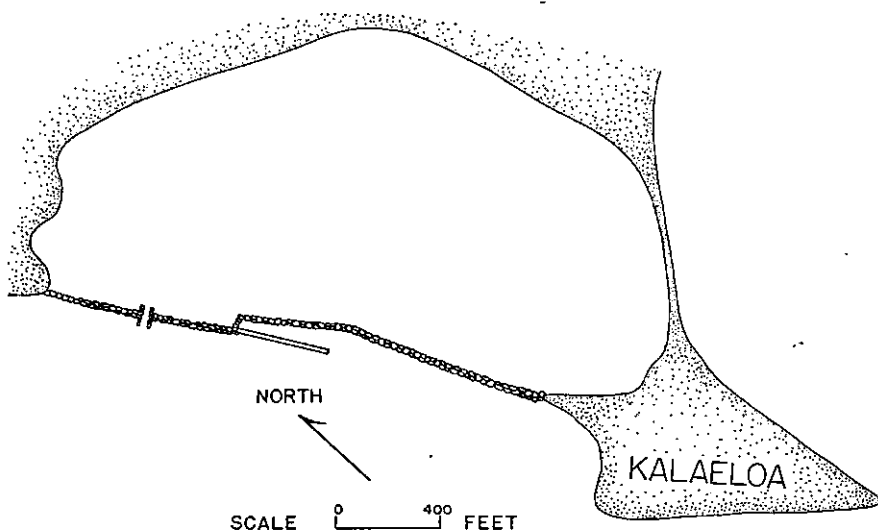


FIGURE 2.—Plan of a *loko kuapa* made by constructing a wall between two points of land. Keawanui Pond, Keawanui, Molokai; area, 54.50 acres. This pond was built before the 16th century and is still being used. (Plan adapted from Evans, 1937.)

Molokai, has 340 feet of Paialoa Pond's wall for its eastern wall. These two ponds, although damaged, may still be seen.

In a few cases, a connecting wall was built between two neighboring ponds to form a third pond. Kapu'u Pond in Kane'ohē Bay, Oahu, was constructed in this manner. A wall was made from the northeastern part of Mikiola Pond over to the northwestern part of Mahinui Pond, thus forming Kapu'u Pond. These three ponds are now filled.

↳ To build a *loko kuapa* probably required a year or more. Kamakau (1869a) reports that the repairing of the south wall of Kalepolepo Pond on Maui, which was approximately 500 feet long, "took several months of work," and, as he remarks, this was "not more than a quarter of the work done by the ancient people who built them [the ponds]." Many ponds had walls over 2,000 feet long.

The size of *loko kuapa* varied from 1 acre to 523 acres, the largest being Kuapa or Keahupua-o-Maunaloa Pond at Maunaloa, Oahu (now a part of the "Hawaii Kai" housing development).

The length of walls varied from a few hundred to several thousand feet. The longest wall reported for an Oahu pond is 5,000 feet. This pond, He'eia Pond, is still being used. The length is not always an indication of the size of a pond. The wall of Ali'i Pond (Fig. 3) is 2,700 feet. Keawanui Pond (Fig. 2), with over twice the area of Ali'i Pond, has a wall 2,000 feet long.

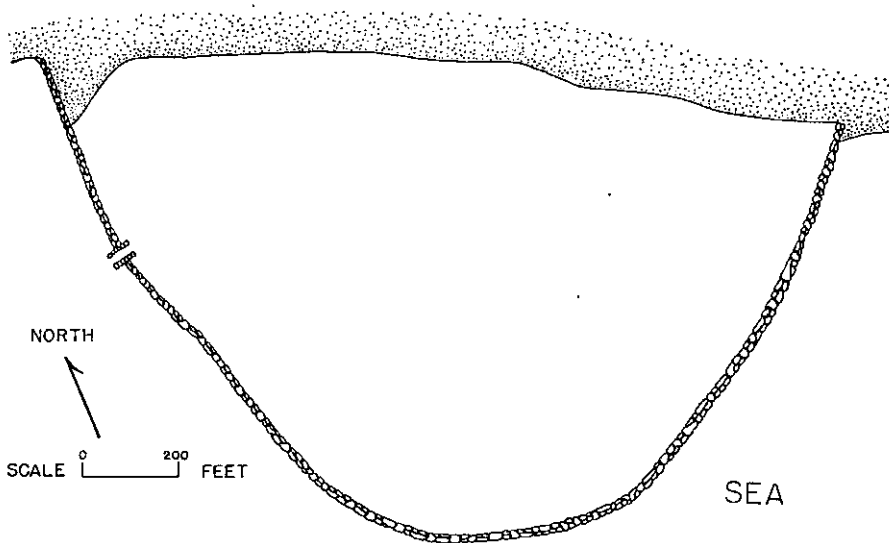


FIGURE 3.—Plan of a *loko kuapa* made by constructing a wall from two places on the shore line to form a semicircular enclosure. Ali'i Pond, Makakupaia, Molokai; area, 25.80 acres. (Plan adapted from Evans, 1937.)

The walls vary from 3 to 19 feet in width. The average is about 5 feet. However, the width of an individual wall sometimes varies. The wall of a pond near Kolo on Molokai was 8 feet wide in some sections and 11 feet in other sections; the wall of 'Ualapu'e Pond on Molokai is 8 to 19 feet wide.

Walls were from 2 to $5\frac{1}{2}$ feet high, the average height being 3 to 5 feet. The height of a wall depended on the depth of the water, which in most ponds reached a maximum of 2 or 3 feet. The wall of a *loko kuapa* was not submerged at high tide.

Walls were usually constructed of coral (Fig. 4) or basalt (Fig. 5), or with both coral and basalt (Fig. 6). As McAllister (1933) points out, the most accessible material was used. Some of the stones used in the walls are estimated to weigh half a ton.

Most walls are faced on both sides with a rubble of either coral or basalt, or a combination of the two. In a few cases sand or dirt has been added to the fill. On the walls of two ponds (Puko'o and Pakanaka Ponds, Molokai) coralline algae was observed growing on the coral which had been used as fill. In its secreting, the coralline algae had "cemented" together portions of the coral and rock fill, thus strengthening the wall. It is probable that the Hawaiians were

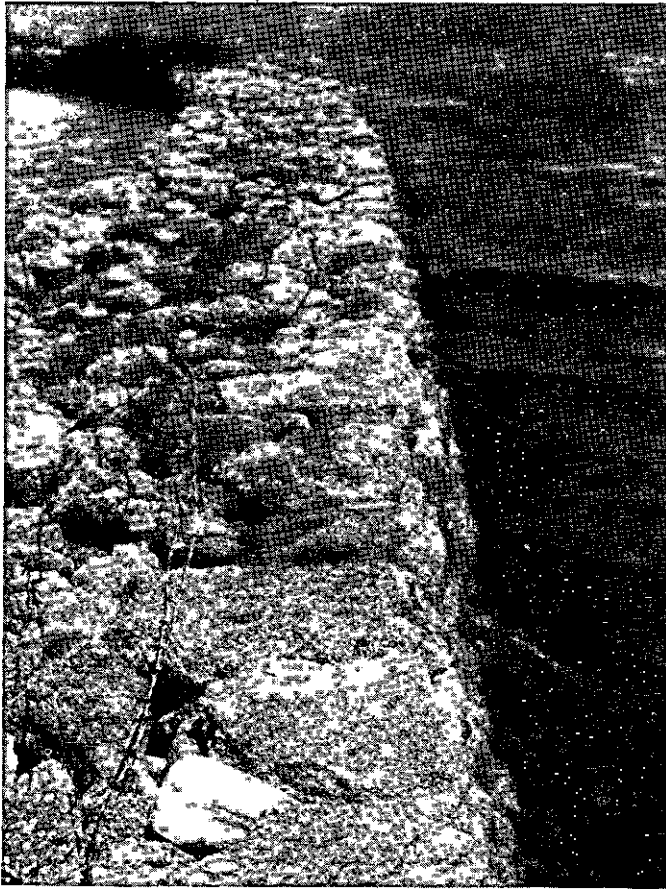


FIGURE 4.—Wall of *loko kuapa* made of coral. Laulaunui Pond, 'Ewa, Oahu. (B. P. Bishop Museum Negative 3744.)

aware of the characteristics of coralline algae. (A coralline algae is a lime-secreting seaweed. It serves as a binding agent on reefs; however, it is not necessary for it to be submerged in order to live.) The "women and children also went and worked in the sea gathering lime [*puna* coral, all *Porites* spp.]

for said wall" (see p. 2), and incidentally, or on purpose, gathered coralline algae, too.

The top of the wall is fairly level, providing easy access to the *makaha* and facilitating the supervision of the condition of the pond. A *makaha* is an opening in the wall with a grill across it. Specifically, *makaha* is the grill itself (see Fig. 7).

The majority of walls are loosely constructed to permit water to seep in and out according to the tide, thus preventing stagnation in the pond. McAllis-



FIGURE 5.—Wall of *loko kuapa* made of basalt. Weloko Pond, Waimano, Oahu. (B. P. Bishop Museum Negative 3751.)

ter (1933) describes two ponds on Oahu with compact walls. One, Wailupe Pond (Site 56, p. 71), which is now "Wailupe Circle," had four *makaha* in its 2,500-foot wall; the other, He'eia Pond (Site 327, p. 173), has five *makaha* in its 5,000-foot wall. In these ponds, the flow of water through the *makaha* provided the only means of circulation.

It was taboo for a menstruating woman to walk on the wall of a fishpond "lest the *kuapa* be defiled" (Kamakau, 1869b).

Makaha were constructed to permit both water and very young fish to enter the pond. "These [*makaha*] are of straight sticks tied on to two or three cross beams, the sticks in the upright standing as closely as possible, so that no fish half an inch in thickness can pass them, while the water and young fry can pass freely in and out" (Beckley, 1883, p. 21).

Not only did the *makaha* keep the fish inside the pond, it also kept undesirable fish, such as predators, out, providing they were large enough to be unable to pass through the openings.

∟ No part of the ancient *makaha* was movable. Those of today may be opened or closed like a gate; others may be raised or lowered (Fig. 8). They are

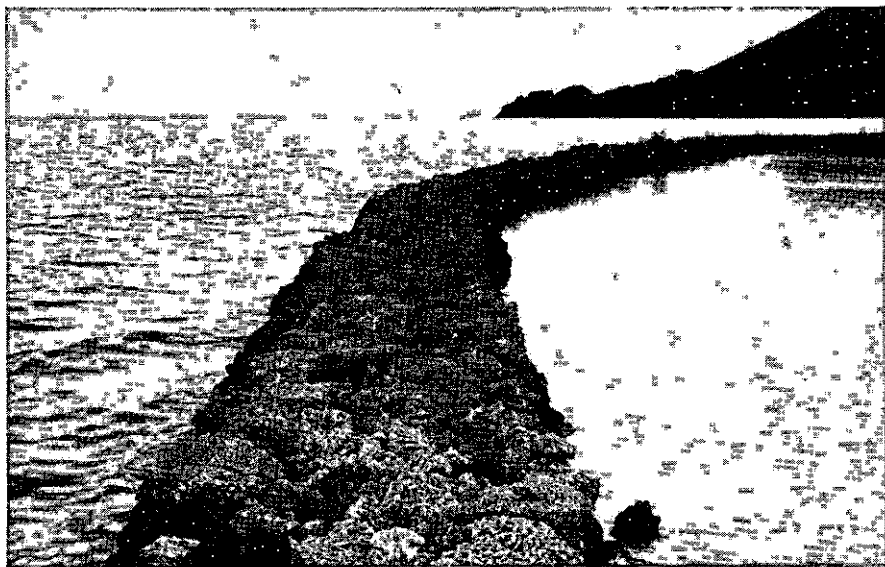


FIGURE 6.—Wall of *loko kuapa* made of coral and basalt. Pakole Pond, Kahalu'u, Oahu. (B. P. Bishop Museum Negative 15359.)

opened when the tide is rising in order to allow fish to enter. At this time both desirable and undesirable fish can come into the pond. When the tide turns, the gates are closed thus entrapping the fish.

Makaha were placed either on the seaward side of the opening, the pond side, or in between. In some ponds there is a sluice or lane called '*auwai* or '*auwai o ka makaha*, "ditch of the *makaha*," which was made of two rows of piled stones running from the *makaha* opening to about 10 feet in or out of the pond. Sometimes the '*auwai* extends both inside and outside the pond (Fig. 9).

A *makaha* was built in the following manner:

When the stone walls of the *kuapa* banks were completed, then the task remained to find the proper wood for the *makaha*. This was selected by the kahuna of the '*aumakua* who

increased the fish in the shore ponds. The wood was either *'ohi'a 'ai* or *lama*, or some other suitable wood. When the wood for the *makaha* was ready, and the proper day had arrived for its construction, the kahuna was fetched to set up the first piece of timber. For this important duty he offered a hog and a dog suitable to this work of inspiring the increase of fish, and appropriate prayers to this work. Then he reached for a timber and set it up for the *makaha*, and offered the closing prayer. Then the men built the *makaha*, binding it together with 'ie cords. After that they arranged foundation stones with the *makaha* grating, and poured in pebbles. It was in this way that all *makaha* were made (Kamakau, 1869a, 1869b).

Most *loko kuapa* have from one to four *makaha* openings, although some have as many as seven, and others have none. The number of *makaha* did not necessarily depend on the size of the pond or the length of the wall. Mahilika Pond on Molokai had an area of 13.30 acres. In its 1,750-foot wall there were

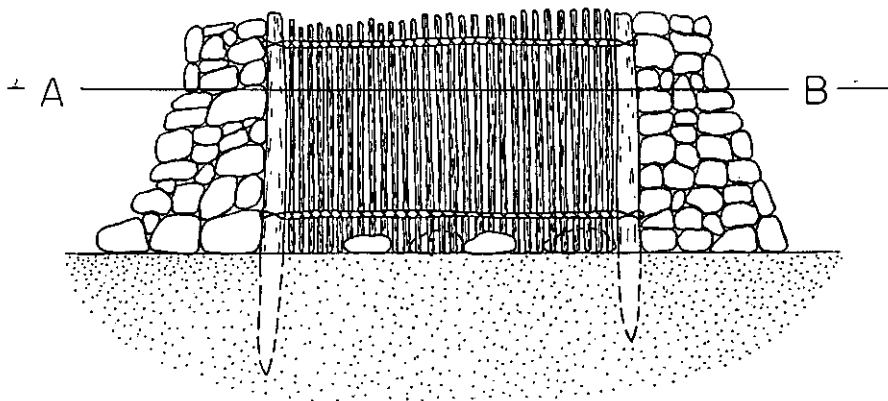


FIGURE 7.—Vertical view of a *makaha*. Line A-B indicates water level. (Adapted from McAllister, 1933, p. 30.)

three *makaha*. Ali'i Pond (Fig. 3) has an area of 25.80 acres, with but one *makaha* in its 2,700-foot wall.

There was no set rule for the location of a *makaha* opening. In some ponds they are located in the outermost bend of the wall, in others on the sides, and sometimes they are near the shore.

It was customary to build a small thatched guard house, *hale kia'i*, near the *makaha*. Here the keeper of the *makaha* stayed.

On the nights of high tides every keeper slept by the *makaha* of which he had charge, and it was their custom to build small watch houses from which to guard the fish from being stolen, or from being killed by pigs and dogs. When the tides receded the fish would return to the middle of the pond, out of reach of thieves (Kamakau, 1869b).

The stocking of a *loko kuapa* with fish was accomplished in two ways. One was by the young fry entering through the *makaha*. After feeding in the pond, they would be unable to return to the sea because they had become too large

to pass through the narrow openings of the *makaha*. The other method used was to catch the fry, measuring $\frac{1}{2}$ to 1 inch long, in nets while they were in shallow waters or bays, and transport them alive to the pond.

The general opinion is that mullet do not spawn in fishponds. However, Phelps was told to the contrary:

It has been said that mullet do not spawn in the ponds, but I have been assured that under the old management they did. The Hawaiian knowledge of the natural history of fishes, in the old days, should not be underestimated (Phelps, 1937, p. 14).

When the keeper of the pond wished to remove some fish, he would go to the *makaha* while the tide was coming in. Here the fish had gathered, being



FIGURE 8.—*Makaha* of Weloko Pond, Waimano, Oahu, in 1911. (B. P. Bishop Museum Negative 3754.)

attracted by the incoming water. With a scoop net, the keeper caught the number of fish desired.

[On the nights of high tide] the keeper would dip his foot into the water at the *makaha*, and if the sea pressed in like a stream and felt warm, then he knew that the sluice would be full of fish. The fish would scent the fresh sea and long for it. I have seen them become like wild things. At a sluice where the fish had been treated like pet pigs, they would crowd to the *makaha*, where the keepers felt of them with their hands and took whatever of them they wanted, perhaps *awa*, *'anae*, *'o'io*, or whatever they desired (Kamakau, 1869b).

Another time for catching the fish was when they were fed, "for this was regular and always at the same spot. A common food was taro" (Phelps, 1937, p. 15).

When a large number of fish was desired, "the long net, generally known as the *'upena ku'u*, is used, the same as in shallow sea fishing" (Beckley, 1883, p. 21). Two men held the net while others splashed the water to drive the fish into it. According to Kahaulelio (1902), this form of catching fish in a pond was done just before daylight.

Fish raised in ponds, in addition to the *'ama'ama* and the *awa*, were the *awa'ana*, *kaku*, *aholehole*, *'o'opu*, *'opae*, and *puhi*. "The caretakers of the pond could eat openly of the *aholehole*, *awa'ana*, *kaku*, *'o'opu*, and the *'opae*, but those kinds reserved for the chiefs they would eat secretly" (Kamakau, 1869b).

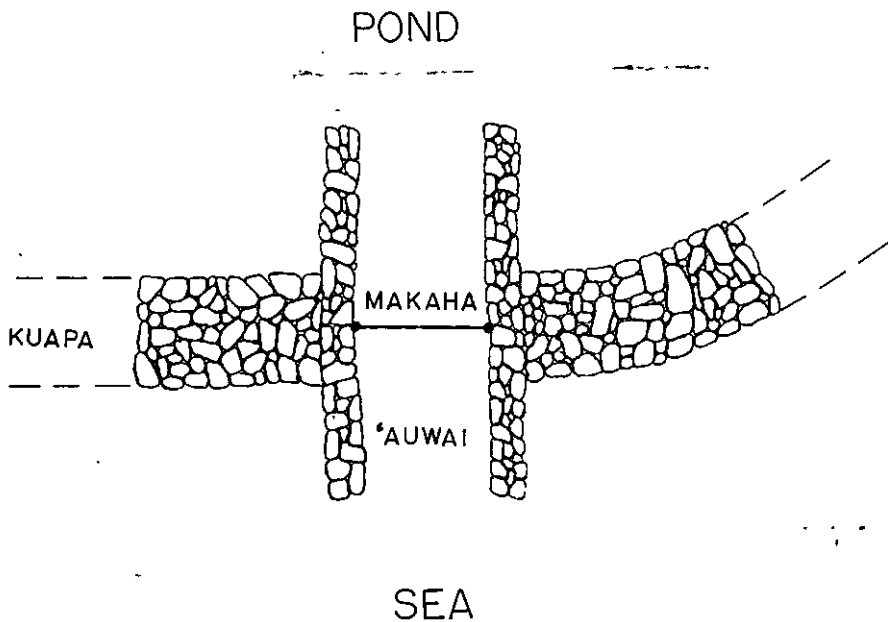


FIGURE 9.—Horizontal view of *'auwai o ka makaha*.

During heavy rains, sediment was washed into the ponds, especially into those which were located at the mouth of a stream. In order to prevent the filling of a pond with silt, an entrance, probably with a *makaha*, was sometimes built near the shore on either side of the pond. On the flow of the tide, the water entered through one entrance and washed the silt to the other side of the pond where it would be carried out through that entrance at the ebbing of the tide. This method of cleaning was employed in some of the Molokai ponds.

Phelps (1937, p. 15) speaks of a weighted bamboo rake, *kope 'ohe*, as being used to clean a pond. "This *kope 'ohe* was towed behind a canoe and the collected matter taken to the sluice. At ebb tide, while the fish were kept in by

nets or the gate [*makaha*], the mud was swept into the *'auwai* and so carried out."

According to Carlson (n.d., p. 17), "The people once or twice each year had to go out into the pond and with coconut halves scoop the mud out. At the same time the pond was firmed on the bottom creating a better bed for the fish plants and the fish food."

The earliest recorded date for the building of a *loko kuapa* is in the middle of the 15th century. At this time Kauholanuimahu built the pond at Keone'ō'io on Maui (Fornander, 1880, p. 71). Ponds were probably built before this time, for by the 13th century, or perhaps earlier, the chiefs had enough power to command the number of people required to build a large *loko kuapa*. (It is known from archaeological evidence that the Hawaiian Islands were well populated by A.D. 1000. See Emory, Bonk, and Sinoto, 1959, p. ix.)

Ponds were built over the years until the early part of the 19th century. Some were destroyed by the sea or by volcanic action; others were abandoned due to the decrease of the population. In some cases the very existence of a pond has been forgotten. Such was the case of two ponds on Molokai whose foundations appear on aerial photographs. One pond was adjacent to the land of West 'Ohi'a, and the other adjacent to the seaward wall of Ni'aupala Pond at Kalua'aha. No claim was made to either pond during the Land Commission hearings in the 1800's. Presumably the ponds had been destroyed so long ago that they had been forgotten.

The following list of *loko kuapa* which were still being used commercially in 1960 was compiled by the State Department of Agriculture and Conservation:

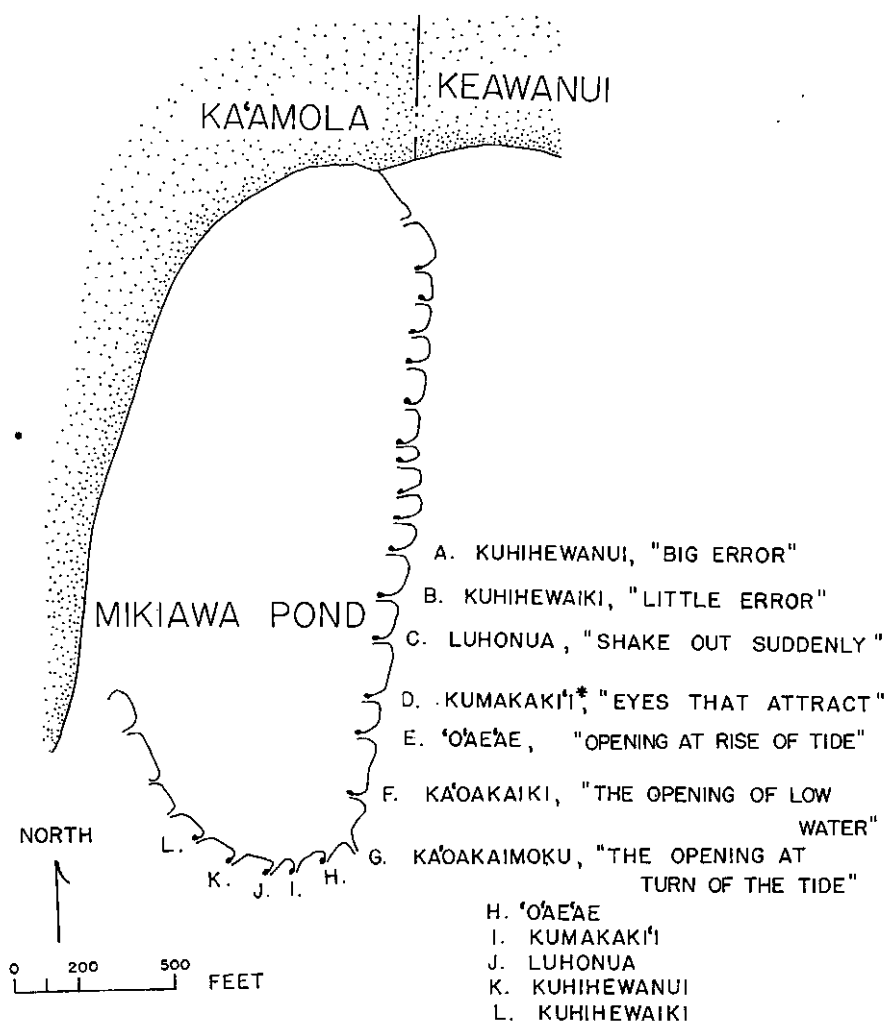
OAHU	MOLOKAI
Heeia Pond, Heeia	Kaopeahina Pond, Kaluaaha
Pond, Honouliuli	Keawanui Pond, Keawanui
Kahouna Pond, Kahaluu	Kupeke Pond, Kupeke
Kuapa Pond, Maunaloa	Ualapue Pond, Ualapue
Molii Pond, Kualoa	
Waikalua Pond, Kaneohe	

There were no *loko kuapa* reported as being used commercially on the islands of Hawaii, Maui, or Kauai.

LOKO 'UMEIKI

A *loko 'umeiki* is a shore pond "surrounded by a low wall that is submerged at high tide and has openings, walled on each side like lanes, leading in or out of the pond" (Beckley, 1883, p. 20). (See Fig. 10.) Both Beckley (1883) and Stokes (1911) give *loko 'umeiki* as the name for this type of pond.

It was a form of fish trap, but was regarded as a pond by the Hawaiians. Beckley (1883, p. 20) uses the term "pond" in describing *'umeiki*; Keawe'iwi



* KUMAKAKI'Ī WAS A GOD OF FISHPONDS

FIGURE 10.—Plan of a *loko 'umeiki*. The inward lanes were used when the tide was coming in, the outward lanes when the tide ebbed. Mikiawa Pond, Ka'amola, Molokai; area, 35 acres. When known, the name of the lane is given. (Adapted from plan made by John F. G. Stokes.)

(n.d.) refers to Mikiawa Pond, which was a *loko 'umeiki*, as "Ka loko o Mikiawa"; and Cobb (1902, pp. 429-430) includes them in his list of Molokai fishponds, making no distinction between *loko i'a* and *loko 'umeiki*.

There were at least ten *loko 'umeiki* on Molokai. No record of this type of pond has been found for the islands of Kauai, Oahu, and Maui. (See: Ben-

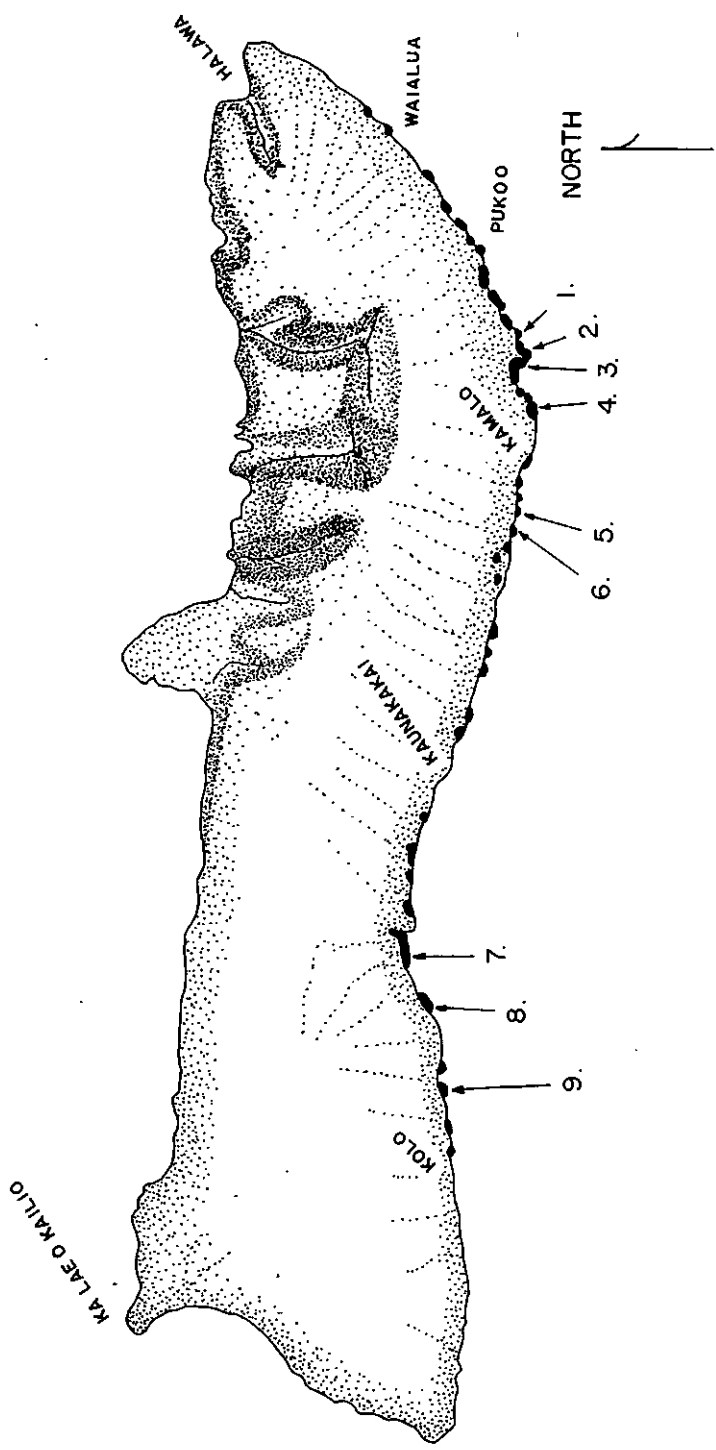


FIGURE 11.—Map of Molokai. Dark areas on south coast are fishponds. Arrows indicate *loko 'umeiki*. Numbers refer to ponds listed in Table 1. (Adapted from Cobb, 1902, Plate 27.)

nett, 1931; McAllister, 1933; Stokes, 1909a; and Walker, 1931.) Whether there were any on Hawaii or Lanai is not known.

In 1909, John F. G. Stokes surveyed and drew plans of five *loko 'umeiki* on Molokai: Kaunahiko'oku; Mikiawa; Papa'ili'ili; Pala'au; and Naninani-ku'eku'e. He made notes on two others: Ho'olehua and Pakanaka. The foundations of three more can be seen on aerial photographs (Aerial Photographs, 1949). Six of the ponds were located on the southeastern portion of Molokai, the other four on the southwestern part of the island, as shown in Figure 11.

A *loko 'umeiki* was generally used by the people for catching one fish at a time, and it provided a means for a number of individuals to conveniently catch their day's supply. The fish caught in one of these ponds, Mikiawa Pond, Mo-

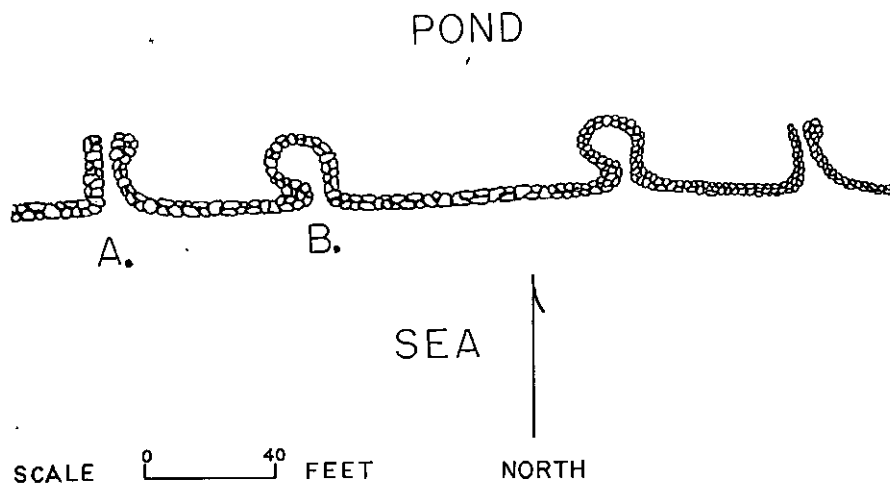


FIGURE 12.—Section of the wall of Papa'ili'ili Pond, Ka'amola, Molokai. A, Inward lane showing platform on eastern side of the end of the lane; western wall of lane was 21.6 feet long. B, Closed inward lane, 2.6 feet wide at wall, 16 feet long, 14 feet wide (inside dimension). Note platform on western side. (Adapted from plan by Stokes.)

lokai, were the *'ama'ama*, *awa*, *weke*, *uluu*, *moi*, *kala*, *'o'io*, and *palani* (Stokes, 1909b, p. 11).

The ponds were operated in the following manner: At night when the tide was coming in, a man or a woman (Beckley, 1883, says more frequently a woman) waded out to the end of an inward lane. Here he, or she, sat on a raised stone platform which was situated at the end of one side of a lane (see Figs. 10 and 12). The fisherman held a net which was just wide and deep enough to cover the opening of the lane. The mouth of the net was faced toward the sea.

[The man or woman] sits very quiet until a jerk in the net is felt, when it is immediately pulled up before the fish have time to return, and the fish dropped into a gourd or basket, when the net is immediately returned to the water and waiting and watching are resumed. Two persons generally go to this kind of fishing and sit on opposite sides of the entrance, so that as one net is raised another is still there, and under certain conditions of the water and weather, two persons will be kept busy scooping up fish as fast as the nets can be lowered. No fish must be allowed to get free as that would put a stop to the fishing at that entrance during that turn of the tide.

These entrances are favorite stations for the ground sharks of the neighborhood to prey on the fish as they go in or out, and so when the tide is about medium height, the fishing people return to shore, as their platforms would be entirely submerged at high tide (Beckley, 1883, p. 20).

When the tide turned and the platforms were once again exposed, other people waded out to the outward lanes, faced the nets toward the pond, and fished in the same manner as described above.

The above description is adapted from Beckley (1883), who at one time had part ownership in a *loko 'umeiki* located on the eastern section of Molokai. Stokes (1911) was given the same information about the operating of these ponds as Beckley describes, "except in regard to two people fishing at one opening simultaneously." It seems more likely that only one person used an opening at a time. The platforms were located on only one wall of an individual lane; and the walls of the lanes being fairly narrow, they would not provide a good seat for a fisherman.

"Sometimes one person had a prior right to fish at a certain inward and a certain outward opening both of which bore the same name. [See Fig. 10, A and K, B and L, etc.] . . . Other persons might use the same openings in the proprietor's absence" (Stokes, 1911).

Some *loko 'umeiki* were owned "by proprietors of two adjoining lands, the people of one owning the right to fish during the rise of the tide known as the *kai-ki*, and the others during the ebb, *kai-emi*" (Beckley, 1883, p. 20). Such was the case of Mikiawa Pond at Ka'amola, Molokai (Fig. 10). When the tide was coming in, the people of Keawanui could use the lanes. When the sea ebbed, "the fish belong to Ka'amola" (Keaweivi, n.d.).

Long nets were also used in these ponds, but they could only be used by the people of the land who had the right to use the pond at that particular condition of the tide.

Due to the functioning of this type of pond, the features and dimensions vary considerably, for an individual pond had to be adapted to its own location. The features and dimensions of each pond are given in Table 1.

Pond Nos. 4, 5, and 6 were deteriorated in 1901 (Cobb, 1902, p. 430). However, the portions of their foundations which appear on the aerial photographs are similar to the dimensions of Kaunahiko'oku Pond (No. 1). Only half of the foundation of No. 4 remains, therefore the number of its lanes reported is probably incomplete. Presumably there were more outward lanes.

TABLE 1

STATISTICS FOR LOKO 'UMEIKI ON MOLOKAI*

POND	AREA (ACRES)	No. LANES		DIMENSIONS (IN FEET)										
		Total		Inward Lanes				Outward Lanes				CLOSED		
		Inward	Outward	Width at Wall	Length	Width at End	Width at Wall	Length	Width at End	In- ward	Out- ward			
Eastern														
1. Kaunahiko'oku, West 'Ohi'a	13.0	2	9	11	10-15	30	3.6	9-15	20-40	2-5.6	....	....	....	....
2. Mikiawa, Ka'amola	44.0±	16	10	26	27-36	47-70	5-7	19-25	32-50	4-5.5	....	....	....	....
3. Papa'i'i'ili, Ka'amola	6.5	3	3	8	9	16-24	.....	.....	24-31	.....	2	.....	.....	.....
4., Wawaia	40.0	4	4	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5. Kanukuawa, Kapuoko'olau	30.0	3	7	14	.....	.....	.....	.....	.....	.....	3	.....	.....	1
6. Panahaha, Makolelau	36.0	5	9	17	.....	.....	.....	.....	.....	.....	2	.....	.....	1
Western														
7. Pala'au, Pala'au	200.0 (approx.)			27				4-7.5	12-18	3-5				
8. Pakanaka, 'Iloli	68.8			20				10	13	5				
9. Nanianiku'ekue, Kaluako'i	22.0			8				5-13	8-20	4-6				

* The statistics used are from Stokes (1909b, 1909c); and from Aerial Photographs (1949).

The six eastern ponds had lanes leading both into and out of the pond. All inward lanes were located on the eastern portion of the pond, and all outward lanes in the center or western portion. The arrangement of the lanes was probably made to take advantage of the currents. The currents along the shore line of Molokai, between Kalua'aha and Kaunakakai, usually run from east to west, in the same direction as the prevailing wind. Therefore, it is logical that the inward lanes, which were used when the tide was coming in, should be located on the eastern side, and the outward lanes, which were used at ebb tide, should be located to the west. Stokes (1909a, p. 29) found a similar situation in the Pearl Harbor fish traps:

It is interesting to note what advantage of natural conditions was taken by the early fishermen in constructing their traps on the banks jutting out into the channel. . . . The natives say that the incoming tide flows more strongly against the east side of the channel, while the west side bears the heavier proportion of the ebb. To reap the full benefit of the condition, the entrances of the ponds [traps] were built opposed to the stronger current.

On the eastern wall of an inward lane, at its end, was the platform which the fisherman sat upon (see Figs. 10 and 12). The platform for an outward lane was located at the end of the western wall. All the platforms recorded were in the same relative location. The fact that the Hawaiians are mainly a right-handed people probably accounts for the positions of the platforms.

Three of the ponds had closed lanes which opened either toward the sea, as shown in Figure 12, B, or toward the pond. Here, too, platforms were located in a similar manner as on the open lanes. The walls of these ponds were from 4 to 7 feet in width. The platforms averaged 6 feet in width, and were from 1½ to 2½ feet high.

The western ponds differ somewhat from those on the east. Instead of having lanes leading both into and out of the pond, as was the case in the eastern ponds, all the lanes of a western pond led in one direction, either into or out of the pond. Despite this difference, Stokes (1911) was of the opinion that the western and eastern ponds functioned in the same manner. No platforms are reported for western ponds.

Of the four western ponds, only one, Ho'olehua Pond, had lanes leading inward. When Stokes saw this pond in 1909, it was almost entirely covered with mud. However, he did find the walls of six inward lanes (Stokes, 1909c). The lanes of the other three ponds all led outward.

Pala'au Pond, which was the largest *loko i'a* on Molokai, had walls 3½ feet high with a maximum width of 5 feet. They were constructed of coral and basalt. The height of the walls of Pakanaka Pond is 2½ feet. They vary in width from 3 to 6½ feet, and are loosely constructed of basalt and some coral.

Stokes (1911) was told that Pala'au Pond was a *loko po'oiki* which he considered was a local term for *loko 'umeiki*.

The earliest date for a *loko 'umeiki* is before the 16th century. Keawanui Pond, Molokai, was being used at the beginning of the 16th century (Keawe'iwi, n.d.), and according to Stokes (1911), Mikiawa Pond was built by the same chief that built Keawanui Pond. Papa'ili'ili Pond was built later for its walls connected on the east to the wall of Keawanui Pond and on the west to the wall of Kaina'ohe Pond. Pala'au Pond, according to one account (Anon., 1922) was built during the time of Kamehameha I. It was constructed after Ho'olehua Pond, for the western wall connected to Ho'olehua Pond.

It is evident that Mikiawa Pond was originally built as a *loko 'umeiki*. The shape of its curving walls and the length of the lanes indicate that it was built with the intention of being used as a fish trap. Pala'au Pond, with its 6,300-foot wall and 27 lanes, seems likely to have been in its original form. The other *loko 'umeiki* could have been *loko kuapa* which were converted into *loko 'umeiki*.

The open lanes and the closed lanes of these ponds are similar to features found in Polynesian fish traps.

Portions of Panahaha Pond at Makolelau can still be seen at low tide. Pakanaka Pond at 'Ioli and Naninani'eku'e Pond at Kaluako'i are damaged, but most of their walls can be seen:

INLAND PONDS

The following is a description of the inland ponds at Waikiki in 1824:

The whole distance to the village of Whyteete is taken up with innumerable artificial fishponds extending a mile inland from the shore, in these the fish taken by nets in the sea are put, and though most of the ponds are fresh water, yet the fish seem to thrive and fatten. Most of these fish belong to the chiefs, and are caught as wanted. The ponds are several hundred in number and are the resort of wild ducks and other water fowl (Bloxam, 1925, pp. 35-36).

The inland ponds were of three types: those which connected with the sea, *pu'uone*; those in which wet land taro grew, *loko 'a kalo*; and fresh-water ponds, *loko wai*. The majority of these ponds were built and used by the land agents (*konohiki*) and the common people. A few were for the exclusive use of the chiefs.

PU'UONE

Pu'uone were located near the sea and were connected to it by a ditch (Fig. 13) or a stream (Fig. 14). They had either brackish water or a combination of brackish and fresh water. Some ponds were fed by springs, and some by streams flowing into them from the interior.

The ponds were of two kinds: those which were small, needed little artificial work in their construction, and were usually built by the farmers who cared for and used them in addition to cultivating their fields; and those which were large, from several acres to over 300 in area, required many workers in their construction, and were for the use of the chiefs.

The farmer made his pond by clearing out and improving a depression or natural basin near the seashore. He first cleared away the rushes and weeds, then dug out the mud to the desired depth. The mud was piled up around the pond to form earth embankments. In sections where the earth embankment was not adequate, a rock wall was built which was either covered or backed with dirt.

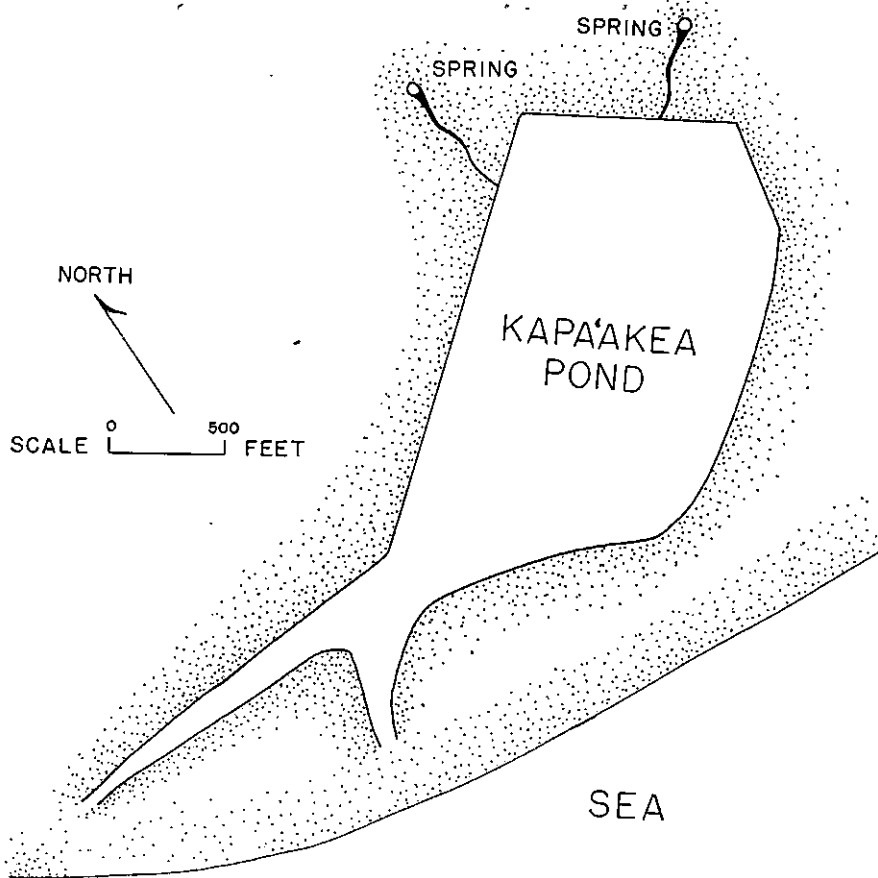


FIGURE 13.—Plan of a *pu'uone*. Kapa'akea Pond, Kapa'akea, Molokai. (Adapted from Evans, 1937.)

A ditch (*'auwai kai*, "salt-water ditch") was made from the pond to the sea, or if there was a stream connecting the pond to the sea, it was enlarged, thus allowing the entrance of salt water. "If sea water was made to enter the fresh water at times, the fish would grow more rapidly, and they would be delicious and full of fat" (Kamakau, 1869b).

By bringing two or three gourds full of *awa* and other young fry at a time, the ponds were stocked over a period until there was a sufficient supply of fry. After the first stocking of the pond, an offering was made of sweet potatoes to the *'aumakua*, "and if there were no such service, the grubs of freshwater creatures (*mo'o*) and dragon flies would take over, and there would be either no fish at all, or else maimed and sickly fish that would soon die" (Kamakau, 1869b).

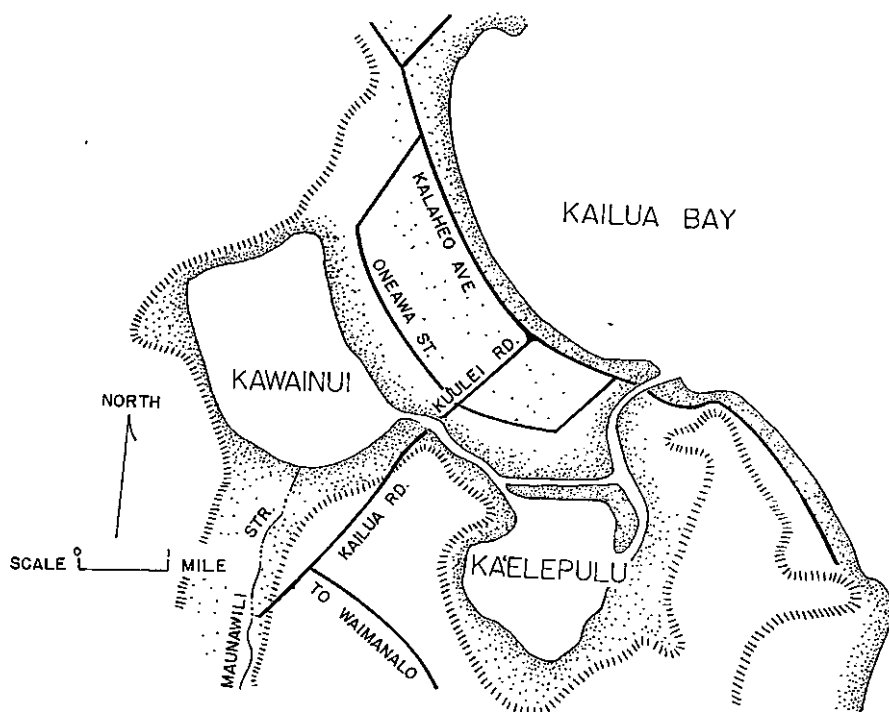


FIGURE 14.—Map showing location of Kawainui and Ka'elepulu Ponds at Kailua, Oahu.

After the pond had been built, silting and the action of the sea formed a dam (*kumano*) in the *'auwai kai*; and with the growing of the young fry, the water in the pond became stagnant. A *makaha* was then built.

... he [the farmer] went upland to fetch *lama* wood and *uluhe* ferns for a *makaha*. He made several bundles, tied them with *'ie* vines, until he had a matting an *iwilei* or more in width. If he had two or three *pu'uone*, he made as many *makaha*. When the high tide days came, he kindled a fire, and when that was done, he went to break down the dam (*kumano*) at the outlet to the sea (*'auwai kai*). First he set up the *makaha* securely, packing mud around it to hold it in place. When the sea washed in over the *'akulikuli*, *ilioha* and the *hinahina* plants on the shore, and the *makaha* was found to be set firmly in place, he broke down the dam on the sea-washed side, and the sea water entered the *pu'uone* (Kamakau, 1869b).

The large *pu'uone* owned by the chiefs required more work in their construction. Lelepaua Pond at Moanalua, Oahu, had an area of 332 acres with walls of "coral and earth embankment, 10 feet or more wide" (McAllister, 1933, Site 82, p. 93).

Two chiefs' ponds, Kawainui (now Kawainui swamp) and Ka'elepulu (now "Enchanted Lake") in Kailua, Oahu, are shown in Figure 14. Ka'elepulu Pond, having an area of approximately 200 acres, "was limited by natural contours and some earth embankments" (McAllister, 1933, Site 377, p. 190). It was connected to the sea by a stream a mile long. "Fat mullet, *awa*, *ahole* and 'o'opu fish were found there [Ka'elepulu], and much *limu kala-wai*. This limu was eaten with fat fish and much liked with *awa* fish. The fish were tender and always fat" (Alona, 1939).

Formerly there were taro patches between the [Ka'elepulu] pond and the stream from the Kawainui swamp. The stream was diverted into patches and from the taro terraces ran into Kaelepulu. When the taro land was being dried, there was a ditch which could be used to bring water from the Kawainui stream to the pond (McAllister, 1933, Site 377, p. 190).

Kawainui Pond had an area of approximately 450 acres. It had "the finest fat mullet on this side of the island. . . . The *awa* fish were so tame that they were easily caught" (Alona, 1939). The pond was fed by the Maunawili stream. According to Louis Mahoe (informant, 1953), there was a *makaha* located in back of the present Davis Building in the "auwai" which leads to the sea.

Large *pu'uone* required cleaning when few fish were caught, owing to the accumulation of algae preventing the nets that were used for catching the fish from reaching the bottom of the pond. The fish were then able to escape from under the nets.

The following account of the cleaning of Kawainui Pond is adapted from Kekoowai (1922):

This being communal work, the *konohiki* (land agent) commanded the men, women, and children of Maunawili, Kailua, and Waimanalo to come to Kawainui. The people went into the pond, and with their hands, broke the limu (algae) loose, piling it up and twisting it under as it was gathered. After a quantity of limu had been piled and twisted under, the workers formed it into a ring. "Then the limu that was broken off was pressed (*pili*) down like a dish, and all the fish that were caught in this limu dish were for the limu breakers." The workers put these fish into *lauhala* bags which were tied behind them, for the fish in the "limu dish" were no longer the property of the *konohiki*. Breaking of the limu was continued until the pond was clean and "the food of the fish clean," which for Kawainui Pond, required three days.

Not all *pu'uone* owned by the chiefs were as large as Lelepaua, Ka'elepulu, or Kawainui Pond. The ponds at Waikiki whose areas are recorded (Cobb, 1902, p. 429) were from 1.3 to 13 acres, and some shown in the same area on a map made by Monsarrat (1897) were smaller than an acre.

LOKO I'A KALO

Loko i'a kalo, "taro fishpond," are also referred to as *loko lo'i kalo*, "taro-patch pond." As the name implies, they were a combination of taro patch and fishpond.

The taro in such ponds was planted in mounds (*pu'epu'e*), each separated from the other, leaving spaces and channels where the fish could swim about. They fed upon the ripe leaf stems (*ha pala*) of the taro, and thus quickly acquired size (Kamakau, 1869b).

After the taro had been planted, the ponds were stocked by hand with *awa*, mullet, *'o'opu*, *aholehole*, and *'opae 'oeha'a*. Fish also entered through the *makaha* (Kamakau, 1869b).

Some fish grew to a large size in these ponds. McAllister was told by one of the old Hawaiians at La'ie, Oahu, that "one day in her childhood, while her parents were gathering taro, as she swam and played in the water she was knocked senseless by a fish" (McAllister, 1933, Site 282, p. 158).

LOKO WAI

Loko wai, "fresh-water pond," were natural ponds. "Some *loko wai* were made when the earth was made . . ." (Kamakau, 1869b).

Fresh water ponds are very seldom over half an acre in extent and are for *'o'opu* and *'opae* preserves, and sometimes for *awa*, a kind of tropical salmon that breeds in brackish water and will live and grow fat in perfectly fresh water. The young fry of this fish is procured in shallow waters on the beach where a stream or spring of fresh water mingles with the sea, and is carried sometimes many miles inland in large gourds with water (Beckley, 1883, p. 21).

Kamakau (1869b) lists "*'opae*, crisp *limu kala-wai*, and reddish *'o'opu* roe" as being "furnished" by *loko wai*.

CONCLUSION

Fishponds provided a convenient source of one of the Hawaiian's basic foods. Catching the fish required little effort, and was not dependent on weather as is sea fishing. The *loko kuapa* and large inland ponds furnished chiefs and their retinue with the numerous fish they required. For the commoner, the inland ponds were a source of fish which did not require a fisherman's skill and knowledge.

Fish of the *loko i'a kalo* gave life to men, women and children and to the family. . . . If a stranger, or a land overseer arrived in the night, the dwellers were prepared; they could quickly get the fish that had grown fully developed scales and hard heads, and the container of poi. Then the poi, the *awa*, the *'anae*, were placed in front of the stranger or the overseer, or friends, perhaps. Thus they lived in the old days, and that is why the "children" of places that had *loko kalo i'a* and *pu'uone* loved the lands where they dwelt (Kamakau, 1869b).

GLOSSARY*

- ahole, aholehole. *Kuhlia sandvicensis*.
- ahupua'a. Land division usually extending from the uplands to the sea.
- 'akulikuli. General name for succulent plants.
- 'ama'ama. Mullet (*Mugil cephalus*).
- 'anae. Mullet (*Mugil cephalus*).
- 'aumakua. Family or personal god.
- 'auwai. Ditch.
- awa. Milkfish (*Chanos chanos*).
- awa'aua. Ten pounder (*Elops hawaiiensis*).
- hinahina. Beach heliotrope (*Heliotropium anomalum*).
- 'ie. Aerial root of *Freycinetia arborea* Gaud.
- ilioha. Horseweeds (*Erigeron* spp.), tall, slender coarse weeds of the daisy family.
- iwilei. Measurement of approximately one yard.
- kaku. Barracuda (*Sphyræna barracuda*).
- kala. Unicorn fish (*Naso unicornis*).
- konohiki. Headman of an *ahupua'a* land division under the chief.
- kope 'ohe. Bamboo rake.
- kuapa. Wall of a *loko kuapa*.
- kumano. Natural dam.
- lama. *Diospyros* sp.
- lauhala. Pandanus leaf, especially as used in plaiting.
- limu kala-wai. One or more kinds of pond scum (*Spirogyra* spp.).
- loko. Pond.
- loko i'a. Fishpond.
- loko i'a kalo. Pond in which wet land taro grew.
- loko kuapa. Enclosed shore fishpond made by building a wall on the reef.
- loko 'umeiki. Shore fishpond having lanes leading in and/or out of the pond.
- loko wai. Fresh-water pond.
- makaha. Sluice gate of a fishpond.
- moi. *Polydactylus sexfilis*.
- 'ohi'a 'ai. Mountain apple (*Eugenia malaccensis* L.).
- 'o'io. Bonefish (*Albula vulpes*).
- o'opu. General name for fishes included in the families Eleotridae, Gobiidae, and Blenniidae.
- 'opae. Shrimp.
- 'opae 'oeha'a. Clawed shrimp, *Macrobrachium grandimanus*.
- palani. *Acanthurus dussumieri*.
- po'alima. Work done by the commoners once a week on the chief's plantations.
- puhi. Eel.
- pu'uone. Inland fishpond connected to the sea.
- uluu. Jacks of the genera *Caranx*, *Caragoides*, *Gnathodon*, and *Alectis* (family Carangidae).
- uluhe. False staghorn fern.
- 'upena ku'u. Gill net.
- weke. Family Mullidae.

* Major references used: Pukui and Elbert (1957) and Gosline and Brock (1960).

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