

Fish Farming in Hawaii: A Lost Tradition Revived

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AS BEFITS a race of great ocean navigators and seafarers, the sea and its creatures have always held positions of honor within the religion and culture of the Polynesians of the Hawaiian Islands. At the time of the arrival of Captain James Cook the ancient fishponds of Hawaii, which numbered some 300, were all owned by the *alii* (the royalty) and guarded by the *akua mo'o* (water spirits). Entry was only available to high chiefs and their families, and to certain lower chiefs and priests. The fishponds provided the royal families with a ready supply of fresh fish, shellfish and edible seaweeds, and they were a distinct status symbol in a society where massive physique was revered and food obviously very important.

The poor commoners, of course, were not without their own resources of seafoods, but they were restricted to operating tidal fishtraps and harvesting fish and shellfish from the reefs with the traditional handlines and basket nets. They were, however, expected to provide the muscle to build the fishponds for the chiefs. All the families within the region, including the women and children and often the entire population of the smaller islands, were conscripted into pond construction. Sometimes their reward would be a share in the pond's yield or perhaps exclusive rights to one type of fish or shellfish. Often it would be nothing.

With the influence of the missionaries and others who followed in the

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Fig. 1. Alii Pond, Molokai—the traditional *loko kuapa* of the *alii* or royalty (Courtesy US Corps of Engineers).

wake of Captain Cook, the traditional rights of commoners were gradually lost through the introduction of the western concept of private property. New laws fabricated in the interest of the newcomers extended to the ownership of the sea fisheries as well as the fishponds, and there was great consternation among the people. Unfortunately, through the continuous outbreaks of smallpox and other scourges, the native population was rapidly depleted and unable to repel the onslaught of changes to the traditional lifestyle. With less dependence on fishponds and the lack of effective management and operation, the ancient Hawaiian fishponds slowly died.

The form of every ancient fishpond was traditional and each design was known by a specific name. The *loko kuapa* was a walled coastal pond built on top of the shallow reef. The south-

ern shore of the island of Molokai has an extensive and flat reef and, although exposed to the heavy seas, many fishponds were built along that particular coast. The pond was formed by fabricating three sides with substantial walls made of lava rock and pieces of coral. As each was entirely man-made, the ponds were uniform in shape and about 15 acres in size.

Another type of *loko kuapa* was constructed in more sheltered locations in bays, and made use of natural geographic features. Although it was also walled with rock and coral, the artificial construction was only along one or occasionally two sides between rocky outcrops or headlands which made up the other sides. Such ponds were obviously much more irregular in

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shape, and their size varied from 1 to over 100 acres.

The *loko pu'uone* was another form of coastal pond, one which had been created naturally and enclosed by land although still connected to the sea. Because of the volcanic origin of the Hawaiian islands and dynamics of its coral reefs, the changing shoreline formed a number of natural and suitable enclosures. The Hawaiians believed these ponds to have been built by the *menehune*, the magical little people. With further modification and construction these fishponds became very important to the Hawaiians as they were totally manageable. The entrances were improved and walls built so that control could be maintained over the fish stocks. The *loko pu'uone* were mostly brackishwater fishponds as there was seawater intrusion through the entrance or up through the coral bottom of the pond. The smaller inland freshwater pond was called *loko wai*. This was a naturally formed inland enclosure which was improved by the Hawaiians in the same way. As with the coastal *loko kuapa* and *loko pu'uone*, the inland *loko wai* was also

considered to be for the use of a royal chief.

The commoners had free access to a certain type of coastal pond called *loko 'umeiki*, although it too might be owned by a certain chief. This free-form fishpond was constructed along the shallow reefs of the shoreline. The fishpond was made by using a natural formation of the reef and improving on it by creating entrances where fish could be trapped or netted, and by blocking other exists. Within a *loko 'umeiki* the women and children were allowed to fish, which was a symbolic event in the Polynesian society.

The main crop of the shoreline fishponds was a mixture of mullet and milkfish. Certain ponds were noted for producing sweeter-tasting fish, particularly the ponds free from mud and through which there was a good flow of saltwater. The coastal fishponds also contained many of the indigenous Pacific fishes which entered through the gate of the fishpond or washed over the top of the walls with the surf. The coastal *loko kuapa* and *loko pu'uone* therefore contained a variety of species including the jacks, ahole, barracuda and anchovy, together with the larger edible reef fishes such as the parrotfish and surgeons. The ponds

also contained octopus, eels, and prawns. Truly a feast fit for a king.

The total production of the ancient Hawaiian fishponds was not exceptional in terms of weight. In 1776, when Captain Cook arrived, there were an estimated 5,000 acres of fishponds in production that provided almost 2 million pounds of fish to the islanders each year. At the turn of the nineteenth century this had dropped dramatically to about half a million pounds from the remaining 100 ponds that covered about 3,000 acres. Today the ancient fishponds of Hawaii that survive are a shadow of their former greatness and usefulness as a source of subsistence protein for the island people. The lack of care and attention, because of disinterested ownership, the continuous erosion by the sea or the occasional tsunami or tidal wave, and the burgeoning coastal development of the islands, have all contributed to the disappearance of a proud artisanal fishing culture. About 300 acres of workable fishponds remain with an estimated annual yield of 20,000 lb of fish, still predominantly mullet and milkfish. This is about 3% of the 1900 total, and only 1% of the peak production before the intrusion of the developed world.

A few well-managed ponds remain but the operators and farmers face the future with uncertainty. In addition to the continual demands for coastal lands for recreation and the high costs of construction and repair of the seawalls and pond gates, each year the owners are faced with fewer juveniles to put into the ponds. Overfishing offshore, the destruction of the juvenile shoaling grounds by shoreline construction, and pollution of the estuaries and bays have all contributed significantly to reducing the numbers of young fish available to collectors and remaining fishpond farmers.

Although fishpond farming might continue to survive at its present minimal level for several more years, some significant events are presently occurring in Hawaii which might produce a stable and economic farm-



Fig. 2. Niaupala Pond, Molokai—the *loko kuapa* framed in natural features of the coast (Courtesy US Corps of Engineers).

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Fig. 3. The *makaha* or walled gateway of the Alii Pond, Molokai (Courtesy Oceanic Institute).

ing activity once more. The Oceanic Institute, a private nonprofit organization on Oahu, has completed an artificial propagation program to provide fish farmers of the future with a regular supply of juveniles from hatcheries. After 5 yr of intensive research and development, young mullet is now ready for pilot-scale production in hatcheries. Although the mullet does not whet the appetites of most Hawaiians, it has local demand among Polynesians and Chinese. Mullet is also an important subsistence food fish in Southeast Asia, India, the Mediterranean, Central and South America, and other Pacific islands. In these countries the coastal fishpond operators, who supply fish as the only source of animal protein for the tremendous populations, have been faced with the same problems. The juveniles for the fishponds are in short supply, and a Hawaiian hatchery can help these countries too.

At present, only about 10,000 to 20,000 fingerlings are produced each year in the Institute's limited hatchery facilities. These are given to the local farmers or sent overseas as broodstock for farms in Southeast Asia. Others are

The coastal waters of Hawaii, famed for their sweet-tasting fish, are proving to be a focal point for a modern age of fish farming.

used in research. A large pilot-scale hatchery has been planned which will take the new technology through its next level of development. Production from the hatchery, designed for more than one million juveniles each year, could more than meet the needs of the remaining fishpond farmers in the state. About 200 acres of good ponds are still under extensive cultivation of mullet and certain other brackish-water fish. Improving existing fishponds and certain others might increase the demand for juveniles to over 800,000 each year. This should enable local production to increase to about half a million pounds a year. It would still be a far cry from the production of 200 yr ago, but would nonetheless make a significant contribution to increasing production in the state. The young mullet might also create an important export industry as they can be shipped long distances easily, and they might be useful as a baitfish for the tuna fishermen who work the Hawaiian archipelago.

There may be new life for the ancient *loko kuapa* and *loko pu'uone* with a steady supply of brackishwater fish from a hatchery, but the freshwater ponds or *loko wai* are already benefit-

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Fig. 4. Silting and lack of care of many coastal ponds have led to disuse, as seen at Puhaloa Pond, Molokai (Courtesy US Corps of Engineers).

ICLARM Staff Profile:

Roger S.V. Pullin



Roger S.V. Pullin

ROGER PULLIN is a man on the move. His infectious enthusiasm captivated his colleagues right from the start, and he wasted no time after his arrival in April 1979, quickly becoming involved in some major projects including tilapia broodstock improvement at Central Luzon State University (CLSU) Freshwater Aquaculture Center with Dr. Rafael Guerrero, Dean of the College of Inland Fisheries, and planning a conference on the biology and culture of tilapia. In addition he is assisting with the ICLARM/CLSU integrated farming research project where he ensures that the experiments integrating fish and pig husbandry are running smoothly and helps in supervising the research of visiting student Hans van Weerd on *Ophicephalus striatus*.

A British citizen by birth, Dr. Pullin was educated at Imperial College, London University, where he received a B.Sc. in Zoology in 1965, specializing in parasitology, and at York University where he was awarded his Ph.D. in 1970 for his thesis entitled, "A study of the environment of larval *Fasciola hepatica* L. with a view of developing a defined medium for *in vitro* culture."

Before joining ICLARM, Dr. Pullin was for 10 yr a lecturer in the Department of Marine Biology, Liverpool University. His primary research interest was the reproductive physiology of marine flatfish, and in particular, the investigation of artificial control of spawning and low temperature storage of gametes for use in fish culture. He pursued a variety of other interests including the chemotherapy of fish diseases, the biology of burrowing fish, and the neuroendocrine control of activity in decapod crustaceans.

His demonstrated abilities as a research scientist attracted national

attention, and soon invitations for consultancies and solicitations of advice were directed his way. He served on the register of Kelvin Hughes Aquacultural Services and performed advisory work for the Isle of Man Board of Agriculture and Fisheries on aspects of fish disease control, aquatic pollution, and expansion of the Island's rainbow trout industry, in which he also participated as a broodstock farmer. He also investigated the effects of an oil spill on marine fish cage farms at Lamma Island, Hong Kong in late 1977.

Besides serving on the editorial board for the journal *Aquaculture*, Dr. Pullin is a member of the Institute of Biology, the Fisheries Society of Great Britain and Ireland, the American Fisheries Society, and the Underwater Association. His publications in the primary scientific literature are numerous and span several disciplines. His achievements are not all academic either, for he is an accomplished SCUBA diver, bridge player, and guitarist, and enjoys angling and horseback riding.

Dr. Pullin, his wife Diane, and two daughters reside in Manila. ●

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