THE OCEAN FOUNDATION

SUSTAINABLE ANCIENT AQUACULTURE

Phrases like “lessons from the past” or “learning from ancient history” are apt to make our eyes glaze over, and we flash to memories of boring history classes or droning TV documentaries. But in the case of aquaculture, a little historical knowledge can be both entertaining and enlightening.

Fish farming is not new; it has been practiced for centuries in many cultures. Ancient Chinese societies fed silkworm feces and nymphs to carp raised in ponds on silkworm farms, Egyptians farmed tilapia as part of their elaborate irrigation technology, and Hawaiians were able to farm a multitude of species such as milkfish, mullet, prawns, and crab (Costa-Pierce, 1987). Archaeologists have also found evidence for aquaculture in Mayan society and in the traditions of some North American native communities (www.enaca.org).

The award for oldest records about fish farming goes to China, where we know it was happening as early as 3500 BCE, and by 1400 BCE we can find records of criminal prosecutions of fish thieves. In 475 BCE, a self-taught fish entrepreneur (and government bureaucrat) named Fan-Li wrote the first known textbook on fish farming, including coverage of pond construction, broodstock selection and pond maintenance. Given their long experience with aquaculture, it’s no surprise that China continues to be, by far, the largest producer of aquacultural products.

In Europe, elite Romans cultivated fish on their large plantations, so that they could continue to enjoy a rich and varied diet when they were not in Rome. Fish like mullet and trout were kept in ponds called “stews.” The stew pond concept continued into the Middle Ages in Europe, particularly as part of the rich agricultural traditions at monasteries, and in later years, in castle moats. Monastic aquaculture was devised, at least in part, to supplement declining stocks of wild fish, a historical theme that resonates dramatically today, as we confront the effects of declining wild fishstocks around the world (http://www.laphamsquarterly.org/roundtable/ roundtable/the-mastery-of-fish.php).

Societies have often used aquaculture to adapt to growing populations, changing climate and cultural diffusion, and in ways that were both sophisticated and sustainable, especially when we compare them to some of the destructive and technologically obsolete approaches being used today.

Below, we take a closer look at some of the remarkable, sustainable practices of ancient societies. These examples can and should inform our attempts to encourage aquaculture which is both environmentally sustainable and which doesn’t increase the use of antibiotics or the destruction of wild sea populations.

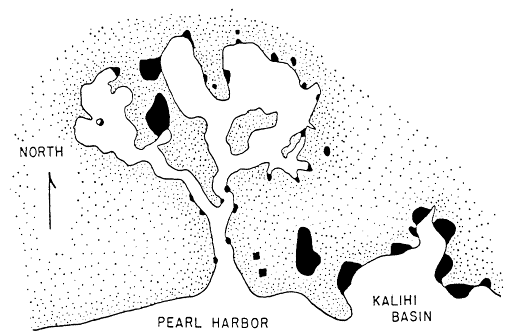
Hawaiian Pond Construction Models

Taro fishpond

The taro fishpond was used in the uplands of Hawaii to cultivate and grow a wide range of euryhaline and freshwater fish, such as mullet, silver perch, Hawaiian gobies, prawns and green algae. These ponds were created by small diversion streams used for irrigation runoff, and over time the Hawaiians used these streams in developing aquaculture. Taro fishponds were located close to the sea and were stocked with surplus fish. Fish also entered these ponds through newly created estuaries (Costa-Pierce, 1987). Fish seemed to thrive extremely well in the transition from high salinity seawater to freshwater. Productivity can also be attributed to fewer pests and greater food availability through the mounds of hand planted taro plants and insects that fish grazed on.

Loko wai

Loko wai ponds are freshwater ponds typically found inland and excavated by hand, usually from natural depressions such as lakes or pools. Water was supplied to the pools by diverting streams or rivers, or from accessing natural ground water supplies (i.e., aquifers, springs, etc). This type of pond was stocked with migrants from the sea that moved from saltwater to freshwater. Harvesting occurred when spawning fish moved seaward during the spring.



Brackish-water ponds

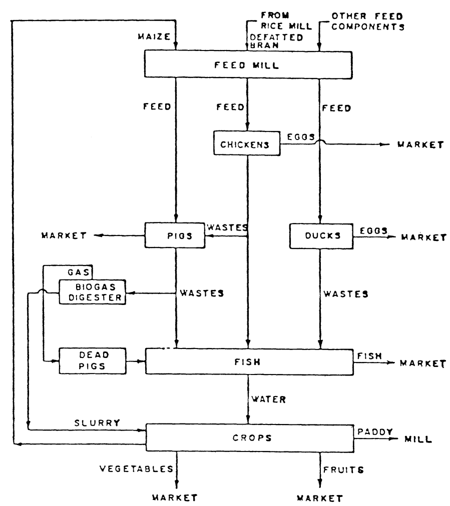
Brackish-water aquaculture systems used in Hawaii were usually created by hand-excavating a depression from a natural body of water that had been stranded by sea-level change, or by forming an embankment parallel to the coast using mud, sand or even coral. Both of these techniques created ponds isolated from the sea by wall or land, but still connected by a small canal so seawater could enter the pond during rising tide. Freshwater inputs into this system would come from percolating ground water and submarine ground water discharge. The combination of both fresh and salt water created a productive habitat with a diverse species pool.

Seawater ponds

Seawater ponds created in Hawaii are cited as a valuable achievement and contribution to mariculture. These ponds were created by the construction of a seawall, often times made up of coral or lava rock. Coralline algae gathered from the sea were used to strengthen the walls, as they act as a natural cement. The seawater ponds contained all of the biota of the original reef environment and supported 22 species. Innovative canals constructed with wood and fern grates allowed water from the sea, as well as very small fish, to pass through the wall of the canal into the pond. The grates would prevent mature fish from returning to the sea while at the same time allowing smaller fish into the system. Fish were harvested at the grates by hand or with nets during the spring, when they would attempt to return to the sea for spawning. The grates allowed ponds to be continually re-stocked with fish from the sea and cleaned of sewage and waste using natural water currents, with very little human involvement. This form of "ebb tide cycling" allowed accumulated sediment from the middle of the pond to be pulled toward and out of the downstream grate. Closing and opening the proper grates was an effective cleansing system. Heavy silting that sometimes occurred after heavy rains was mixed by the towing of bamboo rakes by canoes. Benthic raking created turbidity, thereby facilitating movement and mixing the accumulated sediment (Costa-Pierce, 1987; Kamakau, 1976).

Egyptian Saline Soil Reclamation Model

The Egyptian model, which is based on historical traditions which originated around 2000 BCE, is still highly productive, reclaiming over 50,000ha of saline soils and supporting over 10,000 families (Cross, 1981). During the spring, large ponds are constructed in saline soils (≥200ppt) and are then flooded with fresh water (5-8ppt) for two weeks. The water is then drained and flooding is repeated. After the second flooding is discarded the ponds are then filled with 30cm of water and stocked with mullet fingerlings caught in the sea. Fish farmers regulate the salinity by adding water throughout the season and there is no need for fertilizer. About 300-500kg/ha/year of fish are harvested from December through April. Diffusion takes place where the low salinity standing water forces the higher salinity groundwater downward. Each year after the spring harvest the soil is checked by inserting a eucalyptus twig into the pond's soil. If the twig dies the land is used again for aquaculture for another season; if the twig survives farmers know the soil has been reclaimed and is ready to support crops. This aquaculture method reclaims soil in a three to four year period, compared to 10-year periods required by other practices used in the region.



China and Thailand Integrated Multi-trophic Aquaculture

Some of the ancient aquaculture in China and Thailand took advantage of what is now referred to as integrated multi-trophic aquaculture (IMTA) (Costa-Pierce, 1987). By bringing animals and plants from different trophic levels – different levels on the food chain – into the same place, aquaculture can function more like a natural ecosystem. IMTA systems allow the uneaten feed and waste products of a desirable, marketable species, such as shrimp or finfish, to be recaptured and converted into fertilizer, feed and energy for farmed plants and other farm animals. IMTA systems are not only economically efficient; they also mitigate some of the most difficult aspects of aquaculture, such as waste, environmental harm and overcrowding. In ancient China and Thailand, a single farm might raise multiple species, such as ducks, chickens, pigs and fish while taking advantage of anaerobic (without oxygen) digestion and waste recycling to produce thriving terrestrial husbandry and farming that in turn supported thriving aquaculture farms.

Where are we now and how do we move forward?

Introduction of foreign cultures, migrations, the industrial revolution and the change from barter to monetary economies all contributed to a decline in aquaculture practices in these ancient societies. However, Costa-Pierce 1987 and Madden and Paulsen 1977 cite that seven fishponds were still in use in Hawaii in 1985, down from 28 in 1977 and 360 in 1778.

Aquaculture is again on the rise, however, for many reasons, including: 1) pressures from population growth; 2) changing consumer tastes in developed world; and 3) declines in fish landings due to "fishing down the food web" (Pauly, 2005; Morato et al., 2006). Five years ago, aquaculture provided 43 percent of all fish consumed by humans (FAO, 2007; Green Peace, 2008), yet current aquaculture practices are causing more harm than good.

For instance, shrimp farming has led to the overexploitation of wild juveniles and high mortality rates of bycatch, not to mention the massive destruction of mangroves in Thailand and the Phillipines. As is also the case in land-based livestock farming, the lack of information about the quantity and quality of chemicals (i.e. antibiotics) used in current aquaculture practices makes it difficult to monitor and assess the impact of antibiotic resistance. Fish escape from farming pens, particularly following hurricanes, has led to increased competition for food with threatened native species, interbreeding and loss of vulnerable native species' offspring (www.oceana.org). And farming of carnivorous species is leading to overexploitation of small oily fish, threatening the diet of wild carnivorous fish and marine mammals, as well as the poor in coastal communities (http://www.pbs.org/strangedays/episodes/dangerouscatch/experts/farmed.html).

Lessons from the past should be integrated into current aquaculture methods for sustainability of fishing and marine resources.

Lessons We Can Learn from Ancient Aquaculture Technology

- Use plant-based feeds instead of wild fish;
- Use integrated polyculture practices such as IMTA;
- Reduce nitrogen and chemical pollution through multi-trophic aquaculture;
- Reduce escapes of farmed fish to the wild;
- Protect local habitats;
- Tighten regulations and increase transparency
- Re-introduce time-honored shifting and rotating aquaculture/agriculture practices (Egyptian Model).