19 Culture of Clams

Manila clam, *Venerupis philippinarum*. Credit: Department of Fisheries and Oceans, Canada.

History

The Manila clam, *Venerupis philippinarum*, was unintentionally introduced to the west coast with imports of Japanese oyster seed in the 1930s, and has since become an important species to the aquaculture industry in California. Also known as the Japanese littleneck clam, this species has become naturalized throughout the Pacific coast and is harvested recreationally. The culture of clams in California began in 1981, but production levels were relatively low until the mid 1990s (Figure 19-1) according to the California Department of Fish and Game's (Department) aquaculture harvest survey database. While British Columbia, Canada and Washington State are the largest commercial producers of adult Manila clams, California is a leading supplier of clam seed worldwide.

Culture of Manila clams begins at hatcheries where broodstock animals are brought into reproductive condition. Broodstock can be selected for faster growth rates by choosing animals that have widely spaced growth rings, or a particular color variation might be selected for to identify the farm of origin. Clams are conditioned by maintaining them in tanks filled with heated water around 64°F (18°C). In addition to water temperature, the quality and availability of food plays a critical role in reproductive success. Cultured algae can be used to supplement naturally occurring food in the water. The conditioning process can take 6 to 9 weeks when conducted outside of the natural breeding season, and the amount of time needed for conditioning decreases as summer approaches. Once the clams have been conditioned, eggs or sperm can be introduced to the tank to induce spawning.

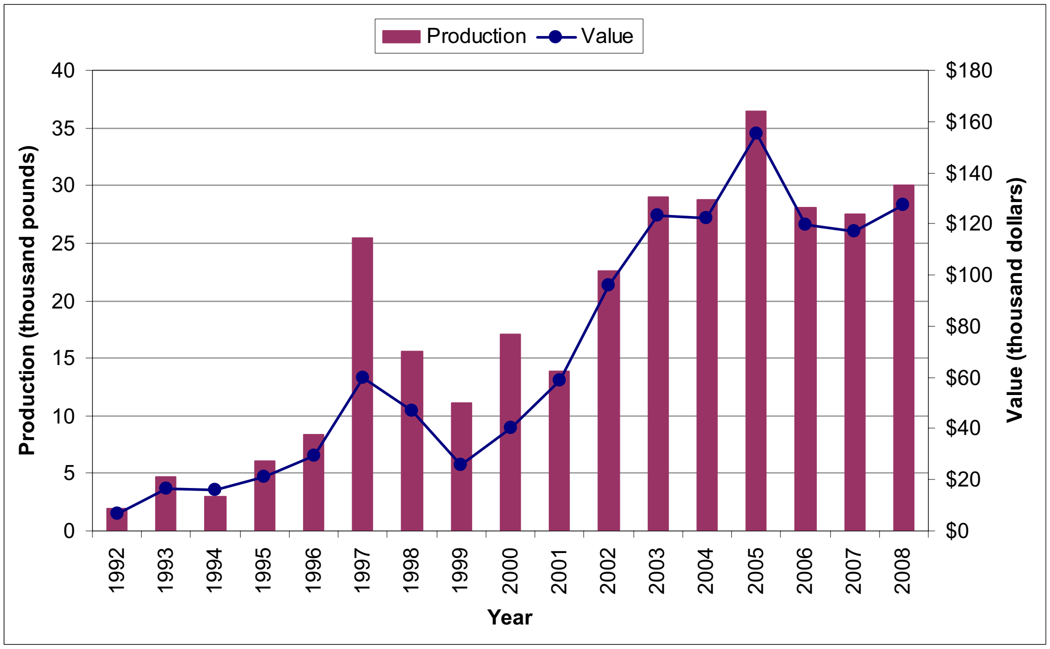

Figure 19-1. Adult Manila clam production and value, 1992-2008. Data source: California State Tax records (royalty reports) and Department Aquaculture Harvest Survey Database. This graph does not include clam seed values.

There are no hatcheries that rear Manila clam larvae in California; certified disease-free larvae are imported from Hawaii, Oregon and Washington. The larvae are cultured in floating upweller systems (FLUPSYs) or suspended trays covered in mesh netting until they are between 0.08-0.39 inches (0.2-1.0 centimeters); it is at this point in development that they become clam seed. FLUPSYs are raft-type structures that house a series of trays or containers that hold the clam larvae. Water is forced upwards through the trays with the tides or through mechanical methods. In 2008, over $1.1 million worth of clam seed was sold by California seed producers.

Clam seed is purchased by growers at either 0.16 inches (0.41 centimeters) or 0.24 inches (0.61 centimeters), and is placed in plastic mesh bags with 0.13 inch (0.33 millimeter) or 0.25 inch (0.64 millimeter) mesh, respectively. If smaller seed is used, the clams are transferred to the larger mesh bags when they grow to an appropriate size (greater than 0.25 inches; 0.64 centimeters). Pea gravel and pieces of crushed oyster shell are placed in the bags as substrate for the small clams to attach themselves. The bags are placed into shallow trenches to allow some of the sandy bottom to cover and protect the developing clams. Mud is placed on each of the four corners of the bags to weigh them down (Figure 19-2). The grow out process takes approximately 2 years from the time the clams are placed in the 0.25 inch mesh bags

Figure 19-2. Mesh grow out bags filled with Manila clam seed in Tomales Bay. Photo credit: Thomas O. Moore.

after which time they are manually harvested. The clams are sold in the shell by the pound and cost roughly $5.00 for a bag of 40 to 50 individuals. Demand for cultured clams far outpaces the supply as available space severely limits the amount that can be produced. Because clams take years to reach market size, shellfish growers often practice polyculture (the culture of multiple species in the same space) using other species such as the Pacific oyster.

Outside of California, instead of using mesh bags, small clams are spread at specific densities along prepared subtidal plots and then covered with plastic mesh to inhibit predation. The ends of the mesh are secured using wood stakes, rebar, or may simply be dug into the substrate itself. Experimental plots using this method are being tested in California.

Status of Biological Knowledge

On the Pacific coast, Manila clams range from British Columbia, Canada to southern California. The Manila clam has separate sexes and is a broadcast spawner. They reach maturity at around 0.8 inches (2.0 centimeters), and naturally spawn during the spring when sea temperature rises. Spawning can also be induced when clams are exposed to the gametes of another clam. Fertilized eggs develop into free-swimming larvae within 24 hours. These veliger larvae are able to swim and eat using a ciliated structure called the velum. The Manila clam enters the pediveliger stage after about two weeks at which point it can crawl with its foot as well as swim with the velum. The developing clam then searches for suitable substrate with which to attach itself via byssal threads. At this point, the clam loses the velum, but can still move using its muscular foot.

Age and growth rate can be determined using the annual rings on the shell. The legal size for recreational harvest of 1.5 inches (3.8 centimeters) is reached after 3 to 4 years. Growth rates vary by location, but can also differ greatly between individuals in the same area.

Manila clams prefer habitat higher in the intertidal zone and at shallower depths than native clams, which makes them more susceptible to mortality from extreme temperature variations. Because they are filter feeders, clam health can be affected by poor water quality. In addition, low salinity caused by heavy rains or flooding can lead to large scale mortality events.

Viral or bacterial infections caused by organisms such as *Vibrio sp.*, *Rickettsia sp.* and *Perkinsus sp.* can occur; however, Manila clams in California experience negligible mortality due to disease. Natural predators of the Manila clam include fish, birds, sea stars, rays, crabs and gastropods. For California shellfish growers, loss of product due to predators can lead to serious economic consequences. Predator nets are effective; however, they are unable to protect against larval forms of sea stars and crabs, which can easily pass through the mesh.

The introduced European green crab, *Carcinus maenas*, has been especially detrimental as crab larvae can settle inside the mesh grow out bags and are difficult to remove. Altering grow out methods can reduce the losses caused by green crab predation. Growers may attempt to time the transfer of clams to larger mesh size bags around crab larval set times to reduce the amount of settling inside the bags.

Management Considerations

Expansion of adult clam culture in California is limited by the amount of suitable habitat available to farmers. In addition, mechanized harvesting methods and the process of gravelling are not being used due to possible negative impacts to benthic communities. Disease monitoring should continue to be a priority for cultured species. Changing oceanographic conditions as well as harmful algal blooms could also present serious consequences for shellfish culture in the future.

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Further Reading

Department of Fisheries and Oceans (DFO), Canada. 2001. Manila Clams (Area 7). DFO Science Stock Status Report C6-17 (2001). 5 p. Available at: http://www.dfo-mpo.gc.ca/csas/Csas/status/2001/SSR2001_C6-03.pdf

Grosholz E and Ruiz G (editors). 2002. Management Plan for the European Green Crab. Prepared for the Aquatic Nuisance Species Task Force. 55p. Available at: http://www.fws.gov/stockton/nis/Docs/Green%20Crab.pdf.

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Adult Manila clam production and value, 1992-2008.					
Year	**Pounds**	**Value**	**Year**	**Pounds**	**Value**
1992	1,900	$6,650	**2001**	13,825	$58,756
1993	4,664	$16,323	**2002**	22,545	$95,816
1994	2,930	$16,240	**2003**	29,026	$123,361
1995	6,070	$21,245	**2004**	28,799	$122,396
1996	8,330	$29,155	**2005**	36,489	$155,078
1997	25,393	$59,674	**2006**	28,096	$119,408
1998	15,604	$46,813	**2007**	27,491	$116,837
1999	11,070	$26,014	**2008**	29,980	$127,416
2000	17,080	$40,138			

Data source: California State Tax records (royalty reports) and Department Aquaculture Harvest Survey Database. This table does not include clam seed values.