WATER QUALITY AND THE CULTURE OF SHELLFISH IN PROHIBITED WATERS

*By Michael A. Rice**

In the United States, water quality standards for shellfishing and shellfish aquaculture waters have been governed since 1925 by the National Shellfish Sanitation Program (NSSP) first administered by the United States Public Health Service.

In more recent decades the NSSP has been governed by the Interstate Shellfish Sanitation Commission (ISSC), a consortium of shellfish-producing states with coordination and oversight by the US Food & Drug Administration (FDA) [See:www.fda.gov/downloads/Food/GuidanceRegulation/FederalStateFoodPrograms/UCM415522.pdf] Enforcement of the provisions of the NSSP have largely been the responsibilities of each of the shellfish-producing states following the model ordinance that is part of the NSSP, with periodic review by the FDA. Compliance with NSSP requirements is assured by potential loss of interstate shellfish sales privileges as authorized by the Interstate Commerce Act. Any foreign nation state or their subsidiary governmental units (e.g. states or provinces) wanting to export and sell fresh, raw shucked, or raw frozen shellfish products into US markets is obliged to become a full voting member of the ISSC, and agree to be bound by the provisions of the NSSP, including submission to periodic program inspection by US FDA officials for compliance.

For nearly 70 years under the provisions of the water quality standards of the NSSP, harvest of shellfish in waters classified as *prohibited* for harvest (i.e. from areas most grossly contaminated by fecal contaminants, in the close vicinity of sewage outfalls, near sewage treatment plants, in boat harbors or at marinas) would be strictly off limits for harvest for human consumption. Enforcement of these NSSP prohibitions on shellfish harvests from prohibited waters have proven to be very effective in protecting public health in the US where shellfish are frequently consumed as fresh shucked product.

Over time a number of issues have arisen about the shellfish behind pollution closure lines, sparking considerable discussion and debate about the desirability of tapping into their economic potential. Often times, due to lack of harvest shellfish in these closed, prohibited waters would reach a mature "old growth" population structure with unusually

Figure 1. Photograph of Robert B. Rheault of Rhode Island's Moonstone Oyster Company taken in 1992 with a prototype floating dock FLUPSY at Billington Cove Marina, Wakefield, Rhode Island. Photo by Michael A. Rice.

Courtesy NMFS.

high population densities of slow growing individuals. In several US states, relaying or transplanting shellfish out of these closed waters has been a proposed strategy for a number of reasons. In some cases, officers tasked with the enforcement of NSSP provisions have advocated for the near complete removal of shellfish from these areas to prevent the temptation of illegal harvest, while some shellfishery biologists have contended that these pollution closure areas constitute de facto spawning sanctuaries for shellfish and should be managed as such, often by culling the shellfish to allow for younger more vigorous individuals to grow. But if shellfish are to be removed from these closure areas and eventually enter markets for human consumption, can there be an assurance that they would be safe to eat given the wide range of potential contaminants? Chapter V of the current (2013) revision of the NSSP addresses issues of shellfish relay out of lesser contaminated waters classified as conditionally approved, conditionally restricted or restricted. However, shellfish harvested from most the most restrictive prohibited water classification may not enter market channels for human consumption under any circumstances.

Regions at the head of estuaries where human population centers are located are also the very same areas where nutrient inputs are the greatest and there is the potential for abundant phytoplankton food resources for the shellfish seed. The technology for using upweller systems was under development several decades ago as a means for

Courtesy NOAA.

efficiently delivering phytoplankton-laden seawater in the nursery culture of shellfish seed in hatcheries [See for example: Manzi, J. et al., 1985. *Journal of Shellfish Research* 4(2):119-124]. These early, land based upweller systems were quickly modified into floating upweller systems or FLUPSYs that could be placed directly into estuaries where nutrient and phytoplankton rich waters can support good shellfish growth [See: Flimlin, G. 2000. *Nursery and Growout Methods for Aquacultured Shellfish.* NRAC Publication 00-002]. One modification of the FLUPSY was to design it so that shellfish upweller bins are covered by large doors that when closed allow the entire unit to be alternatively used as a floating dock. Such units could be placed in small boat marinas where a shore-based source of electrical power is readily available and there is usually good security of the site (Figure 1). So around 1989, issues arose about the extremely restrictive nature of the NSSP shellfish harvest out of prohibited waters with regard to the aquaculture of molluscan shellfish seed.

It had been known at the time that in water temperatures in excess of 15°C or so depending upon the species, most of the shellfish would be able to purge themselves of bacterial contaminants within a 48 hour period after being relayed into clean certified waters. However, viral pathogens might take a month or two longer. It had also been known from studies by several researchers in the 1960s and 1970s that the most persistent toxic heavy metals such as lead, cadmium and mercury would take several months to depurate from molluscan shellfish soft tissues given proper temperature and salinity conditions. So by the early 1990s, the issue of culturing shellfish in prohibited waters began to be debated by the ISSC. Although all of the NSSP shellfish sanitation standards were based on coliform bacterial indices, and no metal-based standards were ever agreed upon, there was still concern that the largest threat to public health would be persistent metals or other chemical toxicants that might be picked up in the prohibited waters.

As part of the data submitted to ISSC for evaluation of their shellfish aquaculture seed policy, Robert Rheault, then a graduate student at the University of Rhode Island, conducted some studies of growing seed oysters *Crassostrea virginica*, and quahogs *Mercenaria mercenaria*, in some

local marinas. He tested the seed for various heavy metals, including zinc, copper, iron, lead and chromium once they had reached field planting sizes. His data showed that the 30mm oyster seed and 15mm-long quahogs in general did not have any elevated levels of heavy metals in their tissues, except for some of the seed quahogs from one marina site that showed some slightly elevated iron and chromium in their soft tissues above environmental background (I recall musing that there might be a 1957 Chevy rusting away somewhere upstream). However, Robert's data showed that these shellfish that were being cultured off the bottom in areas without any active dumping of metal effluents nearby did not result in shellfish seed picking up metals to any great extent from the anti-corrosion zincs from boats or copper anti-fouling paints known to be around marinas and boatyards.

Another line of reasoning developed in the culture of shellfish seed in prohibited waters is that if the shellfish seed could be harvested and moved to certified growing waters for final growout to market size, the amount of new soft tissues added during the latter growout period would greatly dilute any metals that might be picked up during their time in the prohibited waters. This process of metal dilution by addition of new soft tissue would be in addition to any of the metal depuration losses demonstrated in the earlier studies.

After considerable discussion by the ISSC, the 1995 version of the NSSP Manual of Operations included an entire new chapter (Chapter VI, Aquaculture) that was added primarily to set apart shellfish hatcheries and aquaculture seed production from the regulated harvest of wild stocks from potentially contaminated waters. According to the most recent (2013) version of the NSSP Manual, the following activities are exempted from water quality classification requirements: 1) shellfish hatcheries; 2) shellfish seed that do not exceed ten percent of their final market weight; and 3) shellfish seed that require six months or more growing time from market size. Individual shellfish producing states may be more stringent in their requirements than the NSSP Model Ordinance, but never less stringent.

With the greater popularity of aquacultured shellfish in the United States and the growth of market demand, seed availability is cited as one of the most pressing issues for the industry. The early recognition by ISSC of shellfish seed under certain conditions as being exempt from NSSP water quality classification requirements has already removed one of the largest regulatory barriers to expansion of seed production in waters that could well benefit from the ecosystem services that these little filter feeders might be providing. Waters formerly written off as useless and unproductive may well be the newest economic frontier as major nursery seed production areas for the growing American shellfish industry.

Courtesy NMFS.

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