
tential environmental downsides. Of course, the issue evoked strong interest by both the natural resource conservation communities who simultaneously recognized the benefits of having improved ecosystem services in the Bay while remaining skeptical and cautious about introducing an exotic species from across the globe that potentially might bring unintended ecological consequences. The introduction, and spread of the exotic zebra mussel *Dreissena polymorpha* into the freshwater lake and river systems of North America in the 1990s was fresh on peoples’ minds at the time. This tiny mussel from the Caspian Sea region proved to be an aggressive fouling organism, forcing the expensive redesign of water supply systems and industrial facilities drawing water from freshwater sources that had been invaded by the mussels, and there was reluctance to risk another similar episode with another exotic bivalve.

As a result of the growing controversy and moves by the states of Maryland and Virginia to favorably consider the introductions, the US Congress directed the US Army Corps of Engineers and several cooperating federal agencies to study the issue and prepare a programmatic environmental impact statement (PEIS) about the introduction. This effort resulted in cooperation with the US National Oceanic and Atmospheric Administration (NOAA) Chesapeake Bay Office and the National Research Council in convening a top panel of experts and reviewers to produce a 2004 Report on Non-Native Oysters in Chesapeake Bay [available at: http://www.nap.edu/catalog/10796/non-native-oysters-in-the-chesapeake-bay]. This report analyzed the three management options of: introducing and allowing aquaculture of the reproductive non-natives, aquaculture of triploid non-natives, and total prohibition of introductions. The report also recommended at least five years of research on *C. ariakensis* biology, including susceptibility to pathogens, their ecology and interaction with native North American oysters. In the end in 2009, the final decision by the states of Maryland and Virginia and the U.S. Army Corps of Engineers was to disallow the introduction of *Crassostrea ariakensis* into the Chesapeake Bay. However, research undertaken as part of this effort to evaluate the exotic species has serendipitously shown that triploid versions of the native *C. virginica* do have very good growth characteristics in comparison to their reproductively active counterparts, so these fast growing native triploids have become very popular among Chesapeake Bay oyster farmers and they now comprise a substantial fraction of the oysters being farmed in the Bay.

On the other side of the world in the Philippines, a recent acciden-
Pacific shipping, possibly by way of ships traversing the Panama Canal bound for port areas in Manila Bay.

Since the 1970s, Philippine mussel farmers have been cultivating the Southeast Asian green mussel, *Perna viridis* and it has become very popular in local markets. The green mussels are known to thrive in high salinity waters between 25 and 35 ppt and grow quickly during the dry seasonal months, being harvested for sale prior to the onset of monsoonal rains that considerably lower estuarine and coastal water salinities. Mussel farmers, particularly in Western Pangasinan, quickly realized that the Charru mussels that appeared to be setting primarily in the low salinity months following the heavy monsoon rains proved to be a viable culture species that is marketable in the off-months when the *P. viridis* are not as widely available. The Philippine Bureau of Fisheries and Aquatic Resources (BFAR) and the mussel industry began researching means to adapt the traditional culture techniques to the Charru mussels and begin optimizing the staggered seasonal culture of these two species.

The beginnings of some controversy over the Charru mussels arose after the rainy season of 2015 (August to October in Pangasinan and Manila) in which the mesohaline (mid-salinity) *M. charunana* began to overset spat collectors for mangrove oysters (primarily *Crassostrea tredalet*) in the Dagupan City estuary system. These oysters thrive in the same salinity regimes as the Charru mussels, but the oysters can tolerate the high (>33 ppt) salinities of the dry season (March to May) and are harvested year-around, obtaining slightly higher market prices than either of the two mussel species. Charru mussels oversetting of productive farms has been cited as a problem for some oyster farmers, thus creating some conflict between different groups of shellfish farmers. Initial enthusiasm for having a new mussel species to fill the less-served post-rainy season market niche has been dampened somewhat and BFAR has begun some work to investigate salinity tolerances of the Charru mussels, and the timing of their spawning to better advise mussel and oyster farmers on timing and placement of spat collectors to optimize either oyster or Charru mussel sets.

Unlike the Chesapeake Bay experience of investigating before-hand aspects of the biology of the proposed exotic species, the Philippine shellfishery and aquaculture communities are mostly managing the introduction of the exotic species after the fact. Although they quickly found the mussels to be readily accepted in local markets, some downsides to the accidental introduction did crop up. Dr. Christopher McKindsey and co-workers provide an excellent review of bivalves and exotic species if the reader wishes to further explore the potential impacts of introduced bivalves in greater depth (Journal of Shellfish Research 26:281-294). It is often best to deliberate before-hand the introduction of a new species as was done by the Chesapeake Bay authorities, but in these times of expanding global ocean transportation and global markets, after the fact management of the introduction of a species may be more common than not.