THE NATIONAL ACADEMIES
REPORT IN BRIEF

Non-Native Oysters
in the Chesapeake Bay

Photo: Golden Memories Studio, Inc.

What's the Problem? Something's missing from the Chesapeake Bay: oysters. Hit by decades of heavy fishing, deadly diseases, and environmental pressures, native oysters in the Bay, *Crassotrea virginica,* today number less than 1% of levels a century ago. As recently as 1980, the Chesapeake Bay accounted for roughly 50% of the U.S. oyster harvest, but over the past decade, the region has produced only 1-5% of the total domestic supply of oysters. Despite various efforts to restore the oyster population, this decline—and its adverse effects on the oyster industry—continues (see Figure 1).

The oyster industry, scientists, resource managers, and policymakers are considering introducing a non-native oyster from Asia to substitute for the beleaguered native oyster. *Crassotrea ariakensis*, commonly known as the Suminoe oyster, grows well in estuarine habitats like the Chesapeake's, and recent research indicates that it is resistant to the two diseases that plague the native *C. virginica.*

Support for introducing the Suminoe oyster is driven largely by two pervasive assumptions. The first is that the oyster will populate the Bay rapidly enough to provide imminent relief to the oyster industry; the second is the belief that, because oysters feed on the microscopic algae that can grow rapidly and cause "dead zones," an increase in the oyster population would dramatically improve water quality in the Bay. Opponents of introducing the Suminoe oyster fear that it could become a nuisance species, displacing the native oyster and causing ecological and economic damage in the Bay and adjacent waters, or that the oysters could carry undesirable "hitchhiker species" including oyster predators and pathogens.

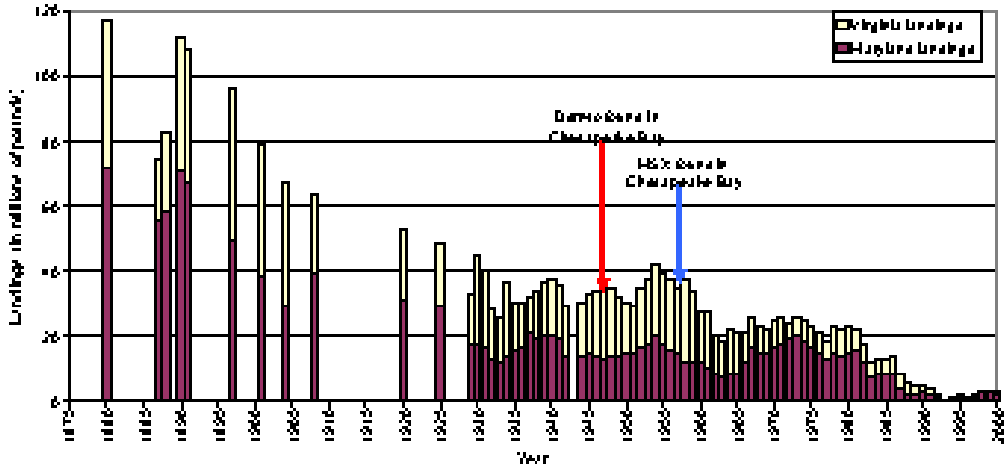

Figure 1. A history of commercial oyster landings in the Chesapeake Bay shows sharp declines over the last century. Sources: Chesapeake Bay Program, National Marine Fisheries Service

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Are Non-native Oysters the Answer? It is unrealistic to expect that any single management action can quickly reverse the long-term degradation in the Chesapeake Bay. In other words, a "quick fix" for the Bay is highly unlikely. The Bay ecosystem and fishery have been in decline for at least a century—the result of multiple stresses on the Bay's watershed and airshed that include excess nutrients (nitrogen and phosphorus that encourage algal blooms) and overfishing.

Introducing a non-native oyster is not enough to overcome these stresses. Restoring some of the Bay's valued ecological functions will require a multifaceted approach and sustained commitment from communities throughout the watershed. Further, restoring the native oyster is still a real possibility; some native oysters in the Delaware Bay are showing resistance to one of the diseases that is currently killing native oysters in the Chesapeake Bay.

What Can Be Done? The idea of introducing non-native oysters to the Bay was formally proposed in 1991 and, since then, some research activities on the Suminoe and other non-native oysters have been conducted (see Figure 2). However, state and federal agencies working through the Chesapeake Bay Program disagree on whether to use a non-native oyster. A lack of information on the Suminoe oyster makes it impossible to predict whether it will help, harm or have no impact on conditions, either for the watermen or for the ecology of the Bay. To help resolve this issue, the National Academies was asked as part of this study to evaluate the risks and benefits of three management options: 1) no use of non-native oysters, 2) open water aquaculture of genetically sterilized (triploid) oysters, or 3) introduction of reproductive (diploid) oysters.

Option 1: Prohibit introduction of non-native oysters. While this option precludes the risks associated with introducing a non-native species, the report concludes that it is not the best option for two reasons. First, the watermen and fishery-dependent com-munities will continue to suffer severe economic hardship if oyster populations continue to decline. Second, the common belief that the Suminoe oyster will "save the industry" has heightened the risk of rogue (unsanctioned, uncontrolled) introductions if the Suminoe oyster is banned outright. The risk of introducing other harmful hitchhiker species or diseases to the Bay and Atlantic region through rogue introductions poses the greatest threat to the ecosystem and could jeopardize future harvests of both the native and Suminoe oysters.

Option 2: Open-water aquaculture of sterilized (triploid) non-native oysters. The report recom-mends allowing carefully managed aquaculture of a genetically sterilized (triploid) oyster. Although it is unlikely to solve the present fishery crisis, con-trolled aquaculture should not result in an irreversible introduction of the Suminoe oyster and offers more opportunity for adapting to changing circumstances.

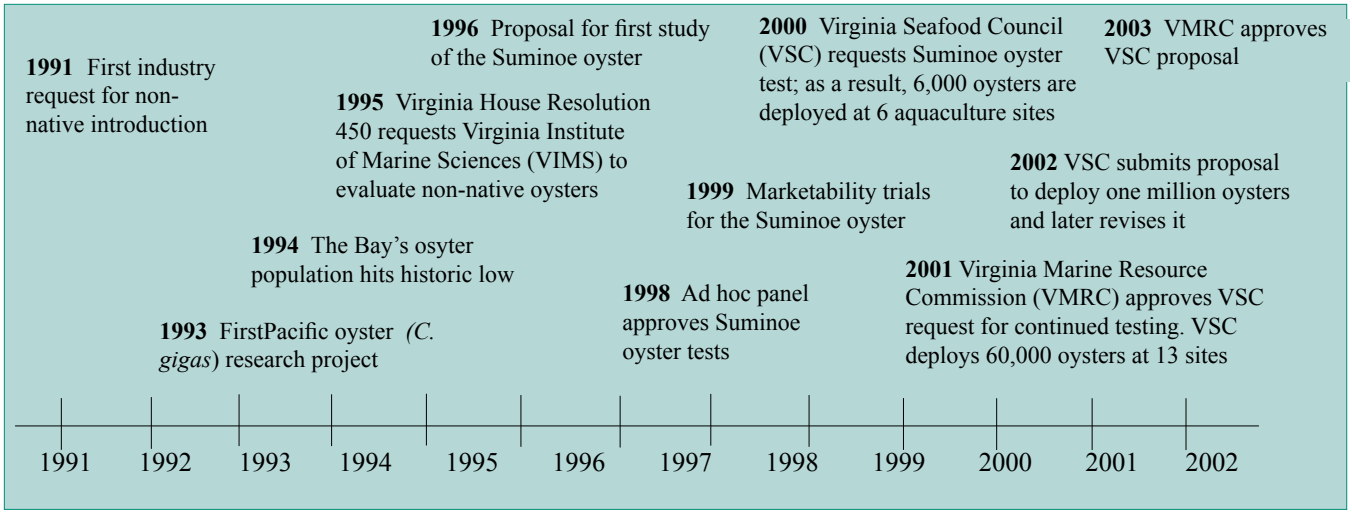

Figure 2: A timeline of research activities related to the introduction of non-native oysters to the Bay.

Most importantly, this option gives scientists time to research critical biological and ecological information about the Suminoe oyster and its impact on the Bay. It may also provide some economic opportunity in the beleaguered fishery.

In order to prevent unintentional release of reproductive Suminoe oysters, as well as to reduce the risk of unwanted hitchhiker species, a protocol should be developed and implemented to guide open-water aquaculture practices (see Sidebar 1).

Option 3: Introduction of reproductive (diploid) oysters. This option has strong support in some sectors because it appears to be the most likely avenue for maintaining the traditional way of life for the watermen. Underlying this support is the assumption that a purposeful introduction will yield a large population of Suminoe oysters after a few years with little or no adverse effects. This assumption is weak; too little is known about the Suminoe oyster to determine whether it would rapidly increase in abundance and spread throughout the Bay or whether it would have beneficial or detrimental ecological effects. Because this option would essentially be irreversible, it is ill advised given current knowledge.

Sidebar 1: The First Step: Developing Non-native Oyster Aquaculture Standards

Before continuing with pilot-scale field trials or open water aquaculture of triploid non-native oysters, the report recommends developing a protocol to help prevent the unintentional release of reproductive Suminoe osyters. This protocol should establish:

1) Acceptable limits for a variety of biological parameters to prevent release of reproductive non-native oysters from the culture system.

2) Disease and quarantine certification of broodstock.

3) Confinement and accounting of non-natives at all life stages.

4) Bonding, certification,and monitoring of hatchries and grow-out facilities

5) Fidelity of triploid induction and the stability and sterility of triploids.

6) Parameters of growth, survival, reproductive maturation, and fecundity of cultivated triploids.

Ecological Considerations

Based on what is known of oyster biology and past introductions of non-native species (both deliberate and accidental), the Suminoe oyster is likely to compete favorably with the Bay's native oyster. However, it is difficult to predict whether or not a species will become invasive (spread rapidly and outcompete native species). The ecosystem and conditions under which a species is introduced can play a pivotal role in how it spreads. For example, the Pacific oyster C. gigas has been introduced in every continent but Antarctica and is now the principal oyster species harvested worldwide. In the U.S., Canada, and Europe, it is not invasive, but in Australia and northern New Zealand, C. gigas has spread rapidly, in some cases displacing the native rock oyster.

In order to gain a better understanding of the ultimate fate of the Suminoe oyster in the Bay, the report recommends researchers develop a deeper understanding of the oyster's biology under the varying environmental conditions characteristic of the Chesapeake Bay. Specifically, the report recommends research on the following: growth rate; reproductive cycle; larval behavior; settlement patterns; size-specific post-settlement mortality rates; susceptibility to native parasites, pathogens, and predators; and the ecological interactions of the Suminoe oyster and *C. virginica* at all life stages.

Economic and Social Considerations

Faced with a dramatic decline in oyster harvests, the industry's interest in the Suminoe oyster has intensified, even if this non-native is approved only for use in contained aquaculture. Because aquaculture costs more than wild harvest, it is unlikely to become a major source of oysters for shucking houses. Most intensively cultured oysters are targeted for the higher value half-shell market. Although both Virginia and Maryland value the oyster fishery, policy differences regarding private leasing of submerged oyster grounds will affect how readily the states adapt to hatchery production.

In the 1990s, more than 60% of Virginia's oyster harvest—but less than 4% of Maryland's—came from private-leased beds.

Baseline economic and social data are needed to assess the impacts of future management options, whether or not these include the introduction of a non-native species, so that the effects of the management action can be evaluated relative to longer-term trends. Although development of a comprehensive risk assessment model is daunting, managers should pursue the development of a decision analysis model that clearly defines management objectives and stakeholder concerns.

Regulatory Issues

Most people are surprised to learn that the introduction of most non-native species is not regulated at the federal level. Today, an inadequate patchwork of state, regional, federal, and international laws and directives address the accidental or deliberate introduction of non-native species into marine waters. This leaves significant gaps in the ability to monitor and oversee the direct introduction of the Suminoe oyster or the interjurisdictional aspects of open water aquaculture. To fill these gaps, the report recommends that the Chesapeake Bay Program be evaluated as a model for an interjurisdictional decision-making system with binding authority over introductions that could affect the coastal areas of several states.

Glossary of Terms

Chesapeake Bay Program. Coordinates regional agreements among state and federal agencies regarding the Chesapeake Bay.

Non-native species. Animals, plants, or other species intentionally or accidentally moved outside their historical geographic range. Also referred to as introduced, nonindigenous, alien, or exotic species.

Invasive species. A non-native species that spreads rapidly, in some cases outcompeting or displacing native species.

Open-water aquaculture. Various methods of growing marine or freshwater organisms in a managed setting. In this case, non-native oysters would be initially raised in a hatchery and then placed in mesh bags, which are placed in the Chesapeake Bay on racks. The oysters grow to market size within the bags, which are then removed from the water.

Triploid oysters. Unlike normal, reproductive oysters that have two sets of chromosomes (diploid), triploid oysters contain three sets of chromosomes, which renders them reproductively sterile.

For More Information: Contact the National Academies' Ocean Studies Board at 202-334-2714 or visit www.national-academies.org/osb. *Non-native Oysters in the Chesapeake Bay* is available from the National Academies Press; 500 Fifth Street, NW, Washington, DC, 20001; 800-624-6242 or 202-334-3313 (in the Washington area); http://www.nap.edu.

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