Special Report No. 74
of the

Atlantic States Marine Fisheries Commission

Proceedings of the Workshop on the Introduction of Asian Oysters *(Crassostrea ariakensis)* to the Chesapeake Bay

September 2002

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Conducted on May 20, 2002

A publication of the Atlantic States Marine Fisheries Commission pursuant to
National Oceanic and Atmospheric Administration
Award No. NA17FG2205.

Acknowledgments

The Commission would like to thank Dr. Lisa L. Kline, Director of Research and Statistics, for designing the workshop and developing the summary report. We would also like to thank Peter Bonner from ICF Consulting for assisting in the design of the workshop and for his facilitation of the discussion sessions. Dr. Stan Allen (VIMS), Mr. William Goldsborough (Chesapeake Bay Foundation), and Mr. Tom Kellum (Virginia Seafood Council) provided summary presentations representing the scientific, fisheries management, and industry viewpoints, respectively. Tina Berger, ASMFC Public Affairs Specialist, assisted in publication of this report.

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Introduction

The eastern oyster, *Crassostrea virginica*, is native to the coastal waters from Canada to the Gulf of Mexico, and has supported a major fishery in the Chesapeake Bay for the past three centuries. In 1957, MSX disease spread southward from Delaware Bay to the lower Chesapeake Bay. By the 1970s, MSX had wiped out large tracts of oysters on Virginia's high salinity grounds. In the 1980s, a second disease (Dermo) also began killing Chesapeake Bay oysters. Dermo is not limited to higher salinity waters, as is MSX, but also appears in waters of 10 to 12 ppt.

The economic losses to harvesters, processors, and other support businesses caused by these diseases has been severe. The loss of oysters in the Bay may also have contributed to the decline in water quality and useful habitat for other species.

The Issue

With the major decline in Chesapeake Bay oysters due to both MSX and Dermo, researchers at the Virginia Institute of Marine Science (VIMS) began exploring the potential of introducing a non-indigenous species, the Asian oyster (*Crassostrea ariakensis*). Between June 1998 and September 1999 VIMS conducted field comparisons between infertile (i.e., triploid) *C. ariakensis* and *C. virginica*. These studies focused on survival, growth, and disease susceptibility. The results indicated that *C. ariakensis* was faster growing, reaching market size in about a year (as compared to two to four years for *C. virginica*). *C. ariakensis* also tolerated MSX and Dermo much better than *C. virginica*, with mortality of *C. ariakensis* ranging from 14 to 16 percent, as compared to 81 to 100 percent for *C. virginica*. VIMS has also developed triploid technology in order to sterilize *C. ariakensis*. This is necessary to insure that any *C. ariakensis* held in natural systems do not reproduce. Other VIMS research on *C. ariakensis* includes competition for space after settlement, disease certification of *C. ariakensis* stocks, and population genetics research.

The Virginia Seafood Council has also conducted on-bottom trials in 2000 and 2001 using 6,000 and 60,000 triploid oysters, respectively. Taste tests indicated that *C. ariakensis* is almost indistinguishable in taste from the native oyster. The Virginia Seafood Council has recently submitted a proposal to the Virginia Marine Resources Commission to continue trials in 2002 using 1 million oysters. Industry has expressed concern that a great deal of time and money has been invested in the restoration of *C. virginica* in the Chesapeake Bay, with little to no return. It has been suggested that the infrastructure to support the oyster industry for *C. virginica* will collapse in five to six years. Industry is interested in pursuing *C. ariakensis* as a means to restore the Chesapeake Bay oyster industry.

The results of the studies conducted by VIMS and the Virginia Seafood Council suggest that hatchery-reared *C. ariakensis* holds promise for rebuilding the commercial oyster industry in Virginia and Maryland through aquaculture production. At the same time, strong concerns have been expressed with the use of a non-native species for this purpose, as well as the lack of scientific knowledge concerning the life history of *C. ariakensis*. Position papers have been published by several environmental and fisheries management organizations including VIMS, the Chesapeake Bay Foundation, the Chesapeake Bay Program Federal Agencies Committee, the University of Maryland Center for Environmental Studies, U.S. Fish and Wildlife Service, and the Delaware Division of Fish and Wildlife. Some common themes of these position papers include (1) the available information on *C. ariakensis* is insufficient for policy decision-making, (2) more research is needed to fill gaps in knowledge of *C. ariakensis*, (3) biological, ecological, and economic risk assessments should be conducted in order to evaluate potential impacts, and (4) a National Academy of Science study should be conducted to address these concerns. The majority of these position papers suggested that the intentional introduction of *C. ariakensis* is "imprudent" at this time since the ecological consequences are too uncertain. It has also been suggested that the ecological risks of introducing *C. ariakensis* must be assessed over a broader geographical region than just the Chesapeake Bay because an introduced species could potentially spread throughout the Atlantic and Gulf coasts.

Recently, the National Academy of Sciences has proposed a study to examine the ecological and socio-economic risks and benefits of open water aquaculture or direct introduction of the non-native oyster, *C. ariakensis*, in the Chesapeake Bay. Funding for this study was provided by the Commonwealth of Virginia ($50K), the State of Maryland ($50K), the National Oceanographic and Atmospheric Administration ($50K), the U.S. Fish and Wildlife Service ($50K), the Environmental Protection Agency ($90K), Maryland and Virginia Sea Grant ($15K), and the National Fish and Wildlife Foundation ($5K). This study will commence in June 2002 and be completed in May 2003. A committee of 10 members is currently being formed to conduct this study. The committee will address how *C. ariakensis* might affect the ecology of the Bay, including effects on native species, water quality, habitat, and the spread of human and oyster diseases. Possible effects on recovery of the native oyster will be considered. The potential range and influences of the introduced oyster will be explored, both within the Bay and in neighboring coastal areas. The study will investigate the adequacy of existing regulatory and institutional frameworks to monitor and oversee these activities. The committee will assess whether the breadth and quality of existing research on oysters and other introduced species is sufficient to support risk assessments of three management options (1) no use of non-native oysters, (2) open water aquaculture of triploid oysters, and (3) introduction of reproductive diploid oysters. Where current knowledge is inadequate, the committee will recommend additional research priorities.

Workshop Goal and Objectives

On May 20, 2002, the Atlantic States Marine Fisheries Commission (ASMFC or Commission) sponsored a two-hour workshop to review information concerning the potential introduction of the Asian oyster in Virginia and Maryland waters of the Chesapeake Bay. The workshop also identified potential ecological risks over a broader geographical region since an introduced species could potentially spread throughout the Atlantic and Gulf coasts. Areas of agreement and disagreement were developed for presentation to the Commission's Interstate Fisheries Management Program (ISFMP) Policy Board. It should be noted that consensus recommendations were not developed during this workshop. This workshop was focused on obtaining information from ASMFC Commissioners and other agency personnel.

Specific workshop objectives included:

- Review VIMS research results of field comparisons between the Asian oyster and the eastern oyster,
- Review current position papers on this issue and results of introductions in other regions of the U.S.,
- Evaluate potential habitat impacts of introducing the Asian oyster in the Chesapeake Bay,
- Identify viewpoints from other state and federal agencies on potential impacts beyond the Chesapeake Bay,
- Develop a comprehensive list of potential benefits and hazards of introduction of the Asian oyster, and
- Identify and document areas of agreement and disagreement for presentation to the ISFMP Policy Board.

Workshop Discussion

The workshop's facilitated discussion session focused on the identification of risks and benefits to the introduction of *C. ariakensis* into Chesapeake Bay waters, as well as research and development activities required to gather more information. This session was initiated using information provided by the Commission's Habitat Committee, as well as lists developed at the October 18-19, 2001 symposium on Aquaculture of Triploid *Crassostrea ariakensis* in Chesapeake Bay, which was sponsored by a consortium of institutions. Workshop participants refined and added to this initial list.

Areas of Agreement

There was little divergence of opinion on the major issues regarding the introduction of *C. ariakensis* into Chesapeake Bay waters. The major question appeared to be "what is the balance between the risk of doing nothing and the risks associated with introduction of *C. ariakensis*"? Workshop participants recognized that the native oyster (*C. virginica*) is facing many challenges in the Mid-Atlantic region. As noted in the introduction, the spread of MSX and Dermo has caused large economic losses to harvesters, processors, and other support businesses. The loss of oysters in the Chesapeake Bay may also have contributed to the decline in water quality and useful habitat for other species. Results of the studies conducted by the VIMS and the Virginia Seafood Council indicate that *C. ariakensis* grows and survives well, and is promising for the industry. *C. ariakensis* grew significantly faster than *C. virginica* through the range of salinities studied. Mortality of *C. ariakensis* was low at all three sites (ranging from 14 to 16 percent), while mortality of *C. virginica* was high (ranging from 81 to 100 percent). Disease prevalence and intensity for Dermo was low for *C. ariakensis*. Taste tests conducted by the Virginia Seafood Council indicated little difference between *C. ariakensis* and *C. virginica*.

Much more information is needed to fully identify the potential benefits and risks of introducing *C. ariakensis* into the Chesapeake Bay or other coastal systems. There is a great deal of unknown information concerning this species even in its natural environment. It was noted that the impacts of any introduction of a non-native species are unpredictable and virtually irreversible. Potential pathogens, parasites, and other organisms associated with the introduced species may also be a problem. However, quarantine and other processes will resolve some of these issues. Workshop participants felt that the risk of doing nothing needs to be considered, as should the risks of non-regulated introductions ("hooliganism") of any non-native oyster species. The potential for hooliganism will be influenced by the timetable for taking action - the longer the delay, the more chance of hooliganism. Finally, it was recognized that there is a need for coordination among all states, since introduction by any one state may affects all states on the Atlantic coast.

Areas of Disagreement/Questions

The discussion on areas of disagreement was guided mainly by one workshop participant and may reflect industry perspectives, as opposed to the viewpoints of all workshop participants. Industry is concerned that there is a great deal of money going into restoration efforts for *C. virginica* and questioned how far managers should proceed before giving up on the native oyster. In other words, is the native oyster a lost cause for the Chesapeake Bay? There was also some discussion of how much risk should be assumed and whether the timeline proposed by industry (e.g., Virginia Seafood Council proposal to conduct field trials with one million oysters in 2002) will result in too much risk.

Several of the position papers have recommended continuation of restoration efforts for *C. virginica* while evaluating the benefits and risks of introducing *C. ariakensis* into the Chesapeake Bay. The Chesapeake Bay Program Federal Agencies Committee has expressed concern that a re-direction of Chesapeake Bay oyster restoration funds and effort toward research, analysis, regulation, monitoring and enforcement necessary to support *C. ariakensis* aquaculture would detract from the funding and implementation of restoration efforts for *C. virginica*.

Several of these position papers also recommend improvements in biosecurity technologies to curtail the potential for introducing reproductively capable *C. ariakensis* and completion of the National Academy of Science study to evaluate the risks and benefits associated with introductions and to identify research needs. Careful evaluation of ecological, genetic, and disease impacts and/or benefits of *C. ariakensis* is necessary to provide information on the long-term aquaculture potential and ecological impacts of this species.

Commission Review and Action

The Commission's Management and Science Committee reviewed the summary workshop results directly following the workshop and concluded that this is an interstate issue that has the potential to affect all Atlantic coast states. The results were further reviewed by the Commission's ISFMP Policy Board. The Policy Board recommended that the Commission nominate Mr. Preston Pate, Director of the North Carolina Division of Marine Fisheries, to the National Academy of Science's Committee on the Introduction of the Non-Native Oyster *C. ariakensis* to the Chesapeake Bay. Mr. Pate would represent the interests of the state of North Carolina, as well as the common interests of the Commission and its member states. Many of these interests are included in the Commission's *Procedural Plan to Control Interjurisdictional Transfers and Introductions of Shellfish* adopted in October 1989. Other interests of the Commission and the Atlantic coast states include (1) considerations and issues as itemized in this workshop report; (2) consideration of state management responsibilities, both singularly and collectively; (3) the interest of the states to have an active oyster industry; (4) essential fish habitat issues, including shellfish substrate for Commission-managed species; and (5) issues involving interstate transfers to neighboring states.

List of Potential Benefits and Risks

Potential Benefits

It was noted by workshop participants that any potential benefits need to be quantifiable. It was also noted that many of these benefits could be realized with restoration of *C. virginica* or introduction of *C. ariakensis*.

- A restored oyster industry would provide for an expansion of employment and income.
- Oyster industry expansion would result in an increase in state revenues.
- Oyster industry expansion would provide social and cultural benefits by maintaining watermen's way of life.
- An increase in filter-feeding bivalves would improve the ecological function of the Chesapeake Bay. It was noted that the Chesapeake Bay Foundation estimate of turnover rate for Chesapeake Bay waters is currently close to a year. The overall goal for restoration determined by the Chesapeake Bay Program is to filter the Bay in 50 days.
- Increases in oyster populations would enhance benthic and submerged aquatic vegetation (SAV) habitats.
- A restored oyster industry may take the pressure off of other species that are being fished. For example, blue crabs are currently being fished year round but a shift to oystering may occur if oyster populations were restored.

Potential Risks

In identifying potential risks, workshop participants included many items that were unknown (i.e., more information is required). Workshop participants noted that many of these unknown risks may also be benefits once more information is available. It was also suggested that some of these risks may be caused by either introducing *C. ariakensis* or restoring *C. virginica*, as noted below.

- Introduction of *C. ariakensis* may result in introduction of potential pathogens, parasites and other organisms.
- Increases in oyster populations may result in a reduction in productivity of certain fisheries through changes to the ecosystem (e.g., shifting from pelagic to benthic production). It was noted that this would occur with restoration of *C. virginica* or introduction of *C. ariakensis*.
- If *C. ariakensis* is not commercially viable the anticipated benefits may not be realized.
- Introduction of *C. ariakensis* may impede native restoration efforts through cross-breeding of *C. virginica* and *C. ariakensis,* thereby causing a gamete sink.

- Introductions may result in changes in community structure through interrelationships between *C. ariakensis* and other reef community organisms.
- There may be a potential for infection of *C. ariakensis* by native pathogens.
- Introductions of *C. ariakensis* will divert resources and attention away from *C. virginica*.
- There are unknown hazards and the potential for cascading effects caused by the introduction of any non-native species. For instance, once the non-native species reproduces in the wild it cannot be halted.
- There is a potential for *C. ariakensis* to become a fouling species, such as the zebra mussel in the Great Lakes.
- A shift to an aquaculture industry may have social and economic impacts for individual watermen and communities.
- There is a potential for impacts to other East Coast states if one state introduces *C. ariakensis*.
- Increases in oyster populations of either species may result in lack of food for other species.
- *C. ariakensis* may act as a disease vector for the introduction of viruses, or they may act as a carrier for Dermo or other pathogens.
- The reef-building capacity of *C. ariakensis* is unknown compared to *C. virginica*.
- The filter feeding dynamics of *C. ariakensis* are unknown compared to *C. virginica*.
- The ecological functional equivalency of *C. ariakensis* is unknown compared to *C. virginica*.
- The adaptability of Dermo and MSX to a new species is unknown.

Research and Development

- A risk assessment should be conducted to provide information on unknown risks.
- Ecological risk should be evaluated.
- Economic benefits and risks should be assessed.
- Research should be conducted on native *C. virginica* parasites and diseases to evaluate their influence on *C. ariakensis*.
- Regulatory authorities along the Atlantic coast should be evaluated to determine who has authority to regulate non-native species introductions and what specific actions are required by each state.
- The legal implications of one state allowing the introduction of *C. ariakensis* should be considered in the context of cost to society and regulatory changes required.
- A cooperative outreach/extension service program should be developed.

Other Issues and Concerns

- Efforts to produce commercially viable numbers of tetraploid individuals should be continued.
- Triploid research in confined environments (hazard pathways and probabilities) should be continued.
- Introducing reproductively capable diploid *C. ariakensis* should be considered (opportunity and risk assessment would need to be evaluated).
- Development of selectively bred *C. virginica* stocks should be continued (recognizing that these would be genetically altered compared with wild native oysters).
- Non-regulated ("hooligan") introductions (e.g., the intentional introduction of a non-native species) may cause additional problems through introduction of a non-native species without any constraints or regulations. It was suggested that this issue be addressed in any outreach programs developed to address *C. ariakensis* introductions. Also, publicized progress from the National Academy of Science study may help to offset hooliganism.
- If introductions are allowed and problems occur, who pays the cost to fix these problems?
- *C. virginica* are currently being shipped from bay to bay, therefore, some of the risks may already be occurring between populations of *C. virginica* on the Atlantic coast.
- The broad issue that needs to be considered is the balancing of the risks associated with introductions versus the risks associated with doing nothing.

Appendix A - Position Papers

Position papers have been developed and published by the Virginia Institute of Marine Science, the Chesapeake Bay Foundation, the Chesapeake Bay Program Federal Agencies Committee, the University of Maryland Center for Environmental Science, U.S. Fish and Wildlife Service, and Delaware Division of Fish and Wildlife. The major viewpoints and/or recommendations of these position papers are documented below.

Virginia Institute of Marine Science, College of William and Mary

It is the general position of VIMS at this time that the intentional introduction of reproductively capable (diploid) *C. ariakensis* into the waters of the Commonwealth would be imprudent. The ecological consequences of introducing this oyster to the Chesapeake Bay are too uncertain to support such an introduction. From discussions to date, it is clear that the broader marine science community shares this view. Further, we believe that the introduction of diploid *C. ariakensis* into the Atlantic coastal waters of the U.S. is a resource management decision of far reaching consequence. Such a decision should involve stakeholders beyond Virginia for the obvious reasons that colonization is enabled by larval transport and that the risks and merits of this species may vary spatially.

VIMS research has shown that aquaculture of sterile (triploid) *C. ariakensis* offers promise for economic development in Virginia and the region. However, the development of an aquaculture industry based on *C. ariakensis* will require adequate biosecurity in commercial-scale operations and implementation of adequate regulatory structure. We also recognize that with current technologies and production methods, large-scale use of triploid *C. ariakensis* would entail some possibility of introducing reproductively capable non-native oysters over the long term (decades) through reversion, production errors, or both. Therefore, scale-up to commercial production needs to be accompanied by implementation of and improvements in biosecurity.

Carefully designed and monitored commercial trials serve the dual purpose of providing data on the long-term aquaculture potential and the ecological impacts of this species. The paucity of such data underscores the need for parallel research on ecological, genetic, and disease impacts and/or benefits of *C. ariakensis* because of the possibility of introducing reproductively capable populations over the long term, at least with current triploid technology and production methods. Acquiring such knowledge for use in policy decisions is a primary role of VIMS and is in accordance with the International Council for the Exploration of the Seas (ICES) Code of Practice on Introductions.

Chesapeake Bay Foundation

Until there is substantial scientifically validated information about the ecological risks and benefits associated with the use of sterile *Crassostrea ariakensis* oysters for aquaculture, a public policy decision to sanction large-scale aquaculture or outright introduction cannot be made responsibly. Therefore, the Chesapeake Bay Foundation calls for the following actions to develop a rational basis for decision-making before large-scale commercial production or introduction of *C. ariakensis* in Chesapeake Bay is considered:

- An independent review by the National Academy of Sciences (NAS) or a similar independent, technical body, with an evaluation of relative risks and benefits associated with the use of non-native oysters in the Bay and an identification of research needed before a responsible decision can be made on *C. ariakensis* introduction.

- A dedicated and funded Baywide program to conduct the research identified as necessary in the NAS review, including in-water research that meets strict safety criteria and does not represent a significant risk of de facto introduction.

- Continued field-testing, with state oversight and strict safety criteria, of the aquaculture and marketing potential of sterile *C. ariakensis* and *C. virginica*. To evaluate the potential for a controlled culture industry for both species and to maximize the information generated for decision-making, this work should be conducted throughout the relevant salinity ranges of both species.

- A comprehensive review of state policies related to oyster aquaculture in Maryland and Virginia, with recommendations for providing a framework for fostering an environmentally responsible aquaculture industry.

- An evaluation of the public actions necessary to stimulate the development of sufficient private oyster hatchery capability to support a large-scale aquaculture industry.

- A dedicated bi-state initiative to educate the public about the danger to the Bay posed by illegal private introductions of *C. ariakensis*. It has been suggested that in the absence of action by the government to introduce *C. ariakensis* the likelihood of this type of "hooliganism" would increase. To deter any such attempt, attention should be drawn to the devastating impact of the oyster parasite *Haplosporidium nelsoni* (MSX), which entered the Bay through illegal introductions of the non-native oyster *Crassostrea gigas*.

- Upon completion of the studies called for in the NAS review, the re-convening by the Chesapeake Research Consortium of the group of Chesapeake Bay oyster scientists who produced the consensus document for oyster restoration in 1999 for the purpose of evaluating and updating that document to reflect all new information. Specific consensus should be sought on the issue of introducing *C. ariakensis* to the Bay.

- Continued funding commitment by federal, state and private partners to restoration and stocking of oyster reefs in order to meet the C2K goal of a 10-fold increase in native oysters by 2010.

Chesapeake Bay Program Federal Agencies Committee

In general, it is the opinion of the Federal Agencies Committee that there are a number of significant, poorly understood risks and potential adverse consequences associated with the prospect of introducing *C. ariakensis* into the open waters of the Chesapeake Bay. Consistent with the 1993 Chesapeake Bay Policy for the Introduction of Non-Indigenous Aquatic Species, it is the opinion of the Federal Agencies Committee that the other Chesapeake Bay Program partners should oppose *C. ariakensis* introduction unless environmental and economic evaluations are conducted and reviewed in order to ensure that the risks associated with the introduction are acceptably low.

Based on current knowledge of benefits, risks, and potential adverse consequences, the Federal Agencies Committee makes the following findings and recommendations:

- The protocols in the 1993 Chesapeake Bay Policy for the Introduction of Non-Indigenous Aquatic Species should be adhered to should any Chesapeake Bay Program partner receive an application to initiate *C. ariakensis* aquaculture in the Bay. Also consistent with this policy, any proposal to increase the scope of *C. ariakensis* research or aquaculture in the Bay beyond the current experiments should trigger an interagency ad hoc review, which should be thoroughly considered by the permitting agency before it decides the disposition of the permit.

- The Federal Agencies Committee is concerned that a re-direction of Chesapeake Bay oyster restoration funds and effort toward the research, analysis, regulation, monitoring, enforcement, and logis-

tic support necessary to support *C. ariakensis* aquaculture would significantly detract from the funding and implementation effort necessary to fulfill the Chesapeake 2000 commitment.

- Any judgement as to whether to approve an application to initiate *C. ariakensis* aquaculture in Chesapeake Bay should be based on sound science, and there are several significant gaps. *C. ariakensis* aquaculture should not be initiated until significant unanswered questions concerning disease ecology and other potential ecological consequences are addressed through scientific research. Following that research, a thorough independent ecological and economic analysis and risk assessment should be conducted. After the risk assessment, a Chesapeake Bay Program ad hoc panel (including federal agency representatives) should review the findings.

- In accordance with Section 10 of the Rivers and Harbors Act of 1899, Federal authorization from the U.S. Army Corps of Engineers would be required for in-water structures necessary to support *C. ariakensis* aquaculture. Consistent with provisions of the Fish and Wildlife Coordination Act, the Corps' public interest review of any Section 10 permit application would include full and equal consideration of potential ecological consequences of the action. In addition, the potential for environmental impacts likely would trigger a thorough evaluation of impacts and alternatives in accordance with the National Environmental Policy Act.

University of Maryland Center for Environmental Science

Scientific experts within the University of Maryland Center for Environmental Science have collectively developed the following perspectives:

- Efforts should continue to evaluate the feasibility of aquaculture of sterile, triploid *C. ariakensis*, but only with strict biosecurity and vigilant monitoring in place to minimize the risks of introduction.

- Risks of the establishment of reproducing populations from triploid aquaculture should be carefully determined. While these risks probably cannot be totally eliminated, they potentially can be reduced to a very low level. Key objectives of this assessment should include quantifying risks in a manner so that decision makers can knowledgeably determine whether the risks are acceptable and evaluating the technical, economic, and regulatory practicality of appropriate biosecurity.

- Seed stock can be propagated in hatcheries in ways that eliminate the risk of infection by protist pathogens such as Dermo and MSX. This should be done in compliance with the internationally accepted code of practice. At present, similar controls on the transmission of viral diseases are not possible. Although there are no indications that such viral diseases pose a threat to the Eastern oyster or other organisms, the potential for such cross-infection should be rigorously investigated.

- Both the intentional introduction of reproductively capable *C. ariakensis* into Atlantic coast estuaries and experimental aquaculture trials that pose significant risks of this are irresponsible and should be guarded against until the potential impacts of such introductions on these ecosystems are thoroughly analyzed.

- More concerted efforts are required to improve the level of confidence of predictions of the impacts (both beneficial and detrimental) of reproducing populations of *C. ariakensis*, not only in Virginia or the Chesapeake Bay as a whole, but in coastal environments along a likely range of habitation on the Atlantic coast. Developing such predictions should involve investigations of *C. ariakensis* in its

native habitats and in areas where it may have been introduced, such as Oregon and northern California, as well as carefully managed experiments in the laboratory and in Atlantic coast field settings.

- The State of Maryland has taken a risk-avoiding position concerning the potential for introduction of *C. ariakensis*. Nonetheless, it is important that Maryland scientists are actively engaged in assessments of biosecurity measures, risks and consequences associated with introduction in order to ensure that the State's concerns are fully addressed. Much of this can be done through collaboration in experiments and trials taking place in Virginia and North Carolina; however, some carefully controlled experiments on factors such as competition, predation, disease, and reproduction may be required to evaluate performance or ecological consequences in the extensive low-salinity, turbid environments prevalent in Maryland. Any such studies must be conducted under strict biosecurity protocols.

- There is a sense of urgency in addressing issues surrounding *C. ariakensis* aquaculture and introduction due to the economic and social benefits of improved oyster production, the challenge of restoring the ecological functions of oyster reefs, and the potential for counter-productive conflicts among economic and regulatory interests. Because the issues are of national significance, a broad group of experts convened by a body such as the National Research Council should identify the needed knowledge and develop a research agenda. Regional scientists should strive to address this agenda in a concerted and timely manner without compromising the rigor of science or rushing to judgement. With appropriate resources and effective organization such a strategic scientific evaluation could be accomplished over a 3 to 5 year period. Meanwhile, there is no reason to conclude that efforts to restore populations of the native *C. virginica* should be postponed or abandoned.

U.S. Fish and Wildlife Service

Executive Summary of the paper "Introduction of *Crassostrea ariakensis* (formerly *rivularis*) to Chesapeake Bay: The Solution to Restoring an Oyster Fishery and Water Quality in the Bay?" prepared by Julie A. Thompson (U.S. Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, Maryland) - November 8, 2001.

Numbers of eastern oyster (*Crassostrea virginica*) have drastically declined in the last century, mainly due to the invasion of two parasitic diseases, MSX (*Haplosporidian nelsoni*) and Dermo (*Perkinsus marinus*). In 1993, the General Assembly of the Commonwealth of Virginia directed the Virginia Institute of Marine Science (VIMS) to develop a plan to restore shellfish populations to historic levels, which included the testing of triploid (sterile) non-native shellfish species. VIMS has conducted field experiments with the Suminoe oyster (*Crassostrea ariakensis)* to determine its tolerance to environmental conditions in the Chesapeake Bay. The results of these experiments show that *C. ariakensis* has lower disease prevalence and superior survival and growth rates in comparison to the native oyster. This species is becoming a prime candidate for aquaculture in Virginia waters to supplement the native oyster. Currently, the Virginia Seafood Council has 60,000 triploid *C. ariakensis* in Virginia waters and will test marketability of the species in the region when the oysters reach market size. If the species proves to be marketable, there could be pressure from the shellfish industry in Virginia to utilize triploid *C. ariakensis* for aquaculture. There are concerns that aquaculture of triploid *C. ariakensis* would eventually lead to a self sustaining diploid population. This could occur due to: reversion of triploids to diploids over time; imperfect hatchery production of triploids; catastrophic loss or control over triploids with a consequent higher probability of reversion over time; and intentional introduction of diploids. A self-sustaining population could have uncertain benefits and adverse effects in the Chesapeake Bay. The benefits could include revitalization of the oyster industry and increased biofiltration, which could result in reduced nutrients and increased water clarity. Potential

adverse effects, however, include introduction and harboring of diseases, competition with the native oyster and other benthic organisms, trophic level and food web effects, and diversion of resources away from native oyster restoration. There is little information available about the biology of this species in its native environment, which could help us to evaluate the benefits and risks. At this time, there is not enough information for jurisdictions with a stake in this matter to responsibly make a decision regarding introduction of this species to the Chesapeake Bay.

Delaware Division of Fish and Wildlife

Staff of the Delaware Division of Fish and Wildlife has been reviewing proposals for in situ research with exotic oysters, almost annually, since 1989. Our concerns have centered on safeguards against escape of the exotic and public policy issues relating to any eventual decision to introduce an exotic oyster species. This should be a coastwide, rather than a local decision, because any local introduction will eventually impact many east coast states.

Over the years, researchers have proposed field research with reproductively normal diploid oysters, as well as chemically-induced "virtual triploids", individually certified chemically-induced triploids and "mated" triploid oysters. Triploids were proposed to mitigate the huge reproductive potential of oysters. Both chemically-induced triploids and "mated" triploids have been characterized as sterile and stable over time. This has not proven to be the case in field research. In 1996, 26.5% of individually certified triploid *Crassostrea gigas* reverted within seven months. Six percent became reproductively normal "virtual diploids". "Mated" triploids, once thought to be stable have been shown to revert to the diploid state over time.

The 2002 Virginia Seafood Council proposal is a departure from past research proposals. It is a geometrically expanding aquaculture demonstration. It proposes a major increase in the number of oysters (one million). It proposes a major increase in the number of sites (39 sites). We believe that because there is no form of triploid oyster which is stable over time, the use of triploids in an aquaculture project of this magnitude provides no meaningful barrier to escape of *C. ariakensis*. This proposal must be viewed as an intentional first time commercial introduction of *C. ariakensis* to the east coast of the United States.

Very little is known about the ecology of this oyster, how and where it would compete with the native oyster, whether or not it is a reef builder, how it would interact with other species and how it would affect estuarine habitat. These questions must be answered prior to any responsible proposal to introduce diploid *C. ariakensis* for aquaculture purposes. In addition, all U.S. East Coast jurisdictions must be engaged in the decision making process.

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