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RESTORATION OF THE VIRGINIA OYSTER FISHERY.

THE ALTERNATIVE SPECIES STRATEGY

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INTRODUCTION

While it may not be universally accepted, it is now generally recognized that the public oyster fishery in Virginia is in collapse. In recent years disease has been an important contributing factor, but in the absence of realistic management strategies it is not the sole cause. Overfishing has "set the table" for the decline of recent decades. Less than one percent of historically important Baylor Grounds have harvestable stocks. The majority of these are contained within the important seed producing areas of the James River, where pressures to continue harvests threaten the potential for any managed or natural recovery of the native oyster, *Crassostrea virginica*. In economic and ecological terms, this is a disaster of great magnitude. The plight of the species and the industry it sustains has received broad attention in the press, but surprisingly the implications of this collapse are not appreciated. The value of the commons is diminished and an important ecological element of the Chesapeake Bay is destroyed with concomitant losses of habitat and water quality.

As prospects for a sustainable public fishery for *C. virginica* become vanishingly small, calls for an alternative species solution are more frequent. The major motivation is to restore economic gain in a declining industry. Some species, notably *C. gigas*, exhibit strong potential for resistance to the diseases MSX and Dermo. Others are untested. The use of alternative species to produce disease resistant hybrids with *virginica*, or to genetically engineer a "super *virginica*" utilizing the genetic potential of an exotic species, poses essentially the same environmental, economic and social/political questions as an outright introduction of that species. Both scenarios deserve careful consideration in the light of our experience with exotic introductions throughout the world. Because of this they are treated here as the same practical problem although obvious differences do exist. It is also necessary to ask if such introductions are technically feasible and economically practical as realistic solutions to the current crisis, and whether such introductions can serve both fishery and ecosystem resource objectives.

In the following discussion, we attempt to review and project the ecological, economic and legal issues surrounding the alternative species strategy as it relates to the public fishery, and propose some possible approaches and timetables for dealing with these issues *if* it is agreed that an exotic introduction is desirable and practical.

ECOLOGICAL ISSUES

Experience with accidental and intentional introductions of exotic species is generally unsatisfactory and most biologists and ecologists recommend that it should be avoided regardless of the presumed benefits. More often than not, such introductions have resulted in ecologic disruption and, in some instances, extinction of competing species. It is for this reason that strict international protocols for handling and introducing exotic species exist (i.e. the International Council for Exploration of the Seas (ICES) protocols), and why many nations and states give their concerns the force of law (i.e. The Lacy Act Amendments, U.S. Public Law 97-79; The Code of Virginia, Section 28.1-183.2; Chesapeake Bay Exotic Species Protocols). At the very minimum, these protocols and regulations must be followed if prior mistakes are to be reasonably avoided. A failure to follow them embodies unacceptable risks. In addition, there is reason to assume that each proposal for an introduction should include a comprehensive environmental impact statement. However, obtaining sufficient data for such an impact statement implies that some limited introduction must take place in order to project inter-species competitiveness, as laboratory studies on their own are insufficient. This is a dilemma that must be recognized by the authorities and bodies charged with the review and approval of an introduction.

Where oysters are concerned, there is considerable experience with the introduction of non-native species in several countries. Some of this experience suggests the loss of native species in competition (e.g. the loss of the New Zealand rock oyster due to the introduction of *C. gigas*), but in general geographic and physiologic barriers seem to permit a degree of coexistence with native species. There does not appear to be documented cases where non-native oyster species have disturbed an ecosystem or impacted genera and species other than native oysters. A far greater concern lies in the frequency of accidental introductions of diseases and parasites associated with oysters. These can have devastating impacts beyond the oyster itself. Careful adherence to the ICES protocols is the best prescription for avoiding this outcome. However, it is a fact that once an introduction is released, there is little chance to control subsequent events or contain the exotic species (or its fellow travellers) within geopolitical boundaries.

In the Chesapeake Bay, proposed non-native species such as *C. gigas*, exhibit preferences for higher salinities. Because disease currently restricts *C. virginica* to the lower salinity areas of the Bay, an effective separation

may occur. Current evidence suggests that this would be the case rather than alternative scenarios of head to head competition resulting in the loss of *C. virginica*. The laboratory and hatchery culture of *C. gigas* in quarantine is well established, and there are numerous disease-free certified strains in existence. Other species such as *C. rivularis* are less well known, especially with respect to diseases and parasites. *C. rivularis* is also lower salinity tolerant, and poses a more direct potential for competition with *C. virginica*, although it may be a more suitable candidate for a total replacement. Proposals for its introduction will require a greater investment in research and time.

It is now recognized that the historic oyster resource had an intrinsic ecological value, that contributed to both habitat and water quality. Apart from industry needs, it may be appropriate to consider an alternative species introduction solely on the basis of its potential ecological value. If, as many economists contend, expenditures to restore the fishery are not justified in economic terms, it may still be appropriate on purely ecological grounds, where a managed fishery is a by-product.

Economic Issues

The economic issues of the alternative species strategy are essentially those of any plan to restore the public fishery for *C. virginica*. The essential difference is that on the one hand we are considering restoration of a declining natural resource held by the commons, and on the other we are proposing to substitute that resource with an exotic species alternative in order to sustain a failing industry. This difference changes the character of the fishery from one held in trust for the public good where some are permitted to reap the harvest in return for a benefit to the commons, to a larger and more direct public subsidy of a specific segment of our society. We need to fully comprehend the meaning of this change, and recognize that it argues strongly for abandonment of the public fishery in favor of private enterprise in the form of traditional private leasehold and aquaculture.

Regardless of the change in the character of the fishery, there are several questions that relate to the economic issues at hand.

Who should pay for the program, and is it cost effective? For many years the Virginia Marine Resources Commission (VMRC) has operated a successful repletion program that effectively subsidizes the public fishery for *C. virginica*. Should this continue? Should the public fund additional efforts to introduce an alternative species into the public fishery? Should the repletion fund be redirected to support alternative species?

How will an alternative species resource be managed in a public fishery and maintained over time? "If the introduction is for the purposes of restoring a public fishery, the net benefit to producers will depend on how the resource is managed. If an open access management regime is maintained, then net benefits to producers will be less than if a bottom leasing program or limited entry program on public grounds are instituted..." (Lipton, Lavan, and Strand. 1992. *Economics of Molluscan Introductions and Transfers: The Chesapeake Bay Dilemma*, Journal of Shellfish Research, 11:511-519). A fundamental decision must be reached as to whether or not to continue a "put and take" fishery once an alternative species is introduced. There is a real distinction that must be made between the cost of introduction and the cost of maintenance. The latter represents a long term, perpetuating commitment of substantial public funds. This commitment argues strongly for abandoning the public fishery in favor of privately held grounds and aquaculture where the best prospect for success depends on private sector investment. "In reality, if any of the proposed research is to provide a rejuvenation of the oyster resource for private or public industry, there must be a significant culture (aquaculture) component..." (*A Plan Addressing the Restoration of the American Oyster Industry*, Virginia Sea Grant, VSG 90-02:20).

If more oysters are produced, is there a sufficient market for sale? There are conflicting opinions on the strength of the oyster market. A recently completed study suggests that there has been a measurable decline in the demand for oysters in the northeastern region of the U.S. (*A Profile of the Oyster Industry of the Northeastern United States*, Lipton and Kirkley, eds., Final Report to the National Marine Fisheries Service, Northeast Region). Market strength and potential for increased production of oysters in the Chesapeake Bay must be thoroughly evaluated before any major investment is made in an alternative species introduction.

What are the requirements for new support infrastructure and for the preservation of existing infrastructure? Two problems exist that deserve attention. The first is concerned with the loss of industry capacity (i.e. the fishing fleet, shucking houses, watermen, shuckers, etc.) as the harvestable resource has declined. What will be the cost to restore this capacity if oysters are again plentiful as a result of an exotic introduction? The second relates to the need to provide hatchery support in order to accomplish a large scale introduction. What is the scale of the investment required? Should the costs be borne by the public or private sector?

Legal and Societal Issues

The use of alternative oyster species does not have universal support within the Virginia oyster industry. There are numerous reasons for this. Perhaps the most compelling is the recognition that C. *virginica* is locally perceived as a superior product in the oyster market. Because of this there is widespread support for continued efforts to solve the industry's problem with the survival of harvestable numbers of *C. virginica*. These efforts would include development of disease resistant strains, management strategies that allow harvest around the disease, and the use of genetic and cellular techniques to impart resistance to disease. There is also a segment of the industry that argues for continued harvest with the expectation that time and "Mother Nature" will resolve the dilemma. Some argue that introduction of a non-native species is attractive because it holds out the prospect for cheap seed and lower materials costs in the industry. However, this may not be realized due to the economics of introduction in compliance with established protocols (see above), and the high cost of hatchery produced seed to sustain a put and take fishery. In the absence of an industry consensus, it will be important to reach some general understandings before proceeding with any plan to introduce an alternative to the native oyster.

Because an introduction cannot be controlled within strict geopolitical boundaries, regional interstate agreement will be essential. States rights, and the general public view of the autonomy of individual states will make this difficult. Generally state government is, on such issues, reluctant to function within a single regional political unit. The success of the Chesapeake Bay program offers some hope, but there are many states outside those agreements with significant economic and political interests (i.e. Connecticut, Delaware, New Jersey, North Carolina). Experience at the Virginia Institute of Marine Science (VIMS) with the proposal to introduce sterile triploid *C. gigas* in 1990, on an experimental basis, gives some flavor for the difficulty and time involved in reaching multi-state regional agreements on this subject. Ultimately, federal and state governments, environmental interests and industry will have to reach a consensus that favors an exotic introduction. Given the effort required to reach agreement on experiments with sterile triploids, it is obvious that it will take a significant effort to reach agreement where reproducing populations are concerned. At this level, it will be a purely political decision.

The U.S. Code, in the form of the Lacy Act Amendments of 1981 (Public Law 97-79), regulates the movement of non-endemic species across state lines. The Code of Virginia, Section 28.1 - 183.2 ("Importing fish or shellfish for introduction into the waters of the State.") makes it illegal for any entity to place non-native fish or shellfish into Virginia waters without prior approval of the Commissioner of the VMRC, with concurrence from the VIMS Director. If permission is obtained, it is assumed that provisions of the Lacy Act would be satisfied and no Federal action would occur. Once permission is obtained from the VMRC, the issues raised above come into play. The VMRC approval would not preclude legal action by interested parties to intercede and block the introduction of alternative species. It is thus important to at least attempt to establish consensus before seeking permission from the VMRC.

Strategies and Time Lines

1. Species selection and evaluation:

At present there are at least three likely candidate species that could be considered for introduction into the Virginia waters of the Chesapeake Bay, *C. gigas, C. rivularis* and the more tropical races of *C. virginica* in the Central and South American Caribbean. Each presents different concerns and considerations. Work with *C. gigas* is most advanced. It demonstrates pronounced resistance to both MSX and Dermo when compared with *C. virginica*. However its growth rate in the lower salinity, higher seasonal temperature regime of the Chesapeake Bay is impaired, and it is susceptible to heavy infestation by the flatworm *Polydora*. The latter may be of more concern to product quality and market acceptance. Several strains exist that may prove to be more suitable alternatives, but in general *C. gigas* could hold promise in the higher salinity region of the lower Bay. Scientific evaluation of alternative strains and field evaluations of reproducing populations to develop an environmental impact assessment would require at a minimum 2 years.

In the case of *C. rivularis* and the tropical strains of *C. virginica*, we have no definitive information on disease resistance characteristics, physiological tolerances or ecology. Their disease status under ICES protocols would also need to be established in quarantine. This would involve culture through at least the F_1 generation. The time to develop this information to the level now existing for *C. gigas*, and meet ICES protocols would require 2-3 years in addition to the time noted for *C. gigas* above.

2. Species introduction:

Three possible options exist for carrying out an alternative species introduction to establish a replacement oyster fishery in Virginia. Their exercise implies fundamental decisions by the Commonwealth regarding the desirability of creating a unique, publicly subsidized fishery outside the traditional natural resource held in the commons.

A. Establish a put and take oyster fishery without following ICES protocols. This might be called the NIKE approach - "Just do it!" Proceed with large scale bottom planting without research or evaluation by importing large quantities of seed and adult oysters regardless of source or disease status. This approach has been used historically in other regions of the world with mixed success, and it satisfies the demand for immediate action. Success and growth rates are likely to be variable and unpredictable. Planters would need to evaluate as they proceed and the approach would likely require plantings over several years. At a minimum 4-6 years might be required before harvest could be attempted. This is a high risk approach that has numerous ecological, legal and political consequences that make it unacceptable to all but a very few advocates. It is an unquestionable violation of the Lacy Act Amendments.

B. Establish a put and take fishery following ICES protocols, Bay Program protocols and state and federal law. This option is strictly hatchery dependent with no attempt to establish independently reproducing oyster grounds. It closely follows the West coast model with the significant exception that the West coast model is privately owned and operated and it is not a state supported public access fishery. Time lines are in addition to those stated for species evaluation.

Additional hatchery capacity would be required. Within Virginia, this could be done at the VIMS Wachapreague Laboratory (new capital facilities) and at Gloucester Point (existing facilities), or through private venture facilities. Compliance with various laws and protocols would require new construction and modification of existing facilities. At Gloucester Point we would abandon programs supporting aquaculture development with *C. virginica*. Theoretically, west coast hatcheries producing *C. gigas* could also provide a source of seed in Virginia, but recent economic downturns and failures in the largest facilities suggest that reliable and adequate capacities might not exist. All of these methods of seed production require continuous annual investment, either public or private.

Once facilities were on line, a reasonable timetable would project 1 million seed oysters in year one, rising to 3 million in year three. Annual operating costs would be $150,000 - $200,000. Capacities well beyond these numbers would be essential, requiring a far greater capital investment.

This option makes no attempt to establish independently reproducing populations. However, over time inefficiencies in harvests and incidental in water reproduction may result in the establishment of natural breeding populations.

Worldwide hatchery-based oyster fisheries depend very heavily on predator protection methods in field plantings. The seed are simply too valuable to leave unprotected. In regions with significant decapod predators cages are almost always used. *Once cages are used, the benefits of bottom culture over off bottom culture disappear.* A hatchery-based put and take fishery in Virginia would most likely be off bottom, making it unsuitable for a public fishery. In addition, recent advances with the off bottom culture of *C. virginica* permit management around disease with successful market production. Why substitute a potentially less desirable species under this option when the more desired (marketable) *C. virginica* can be produced at the same relative cost? Furthermore, the labor intensive nature of this option and the need for continuous annual investment brings into focus the requirement for public vs. private funding of this option. Given these technical and economic realities, the question will arise as to whether the strategy is not more appropriate to the private sector as opposed to the public fishery. This is the reality of the U.S. Pacific Coast industry based on *C. gigas*. Washington and Oregon are often cited as examples of success with *C. gigas*, but its private sector character is often overlooked in the enthusiasm for the species.

C. Sustainable public fishery following existing law and established protocols. This is the most difficult option to carry out from a technical, management and operational

standpoint. The approach would attempt to establish self-sustaining oyster reefs, protect them from harvest until a sustainable yield fishery could exist, and manage closely to prevent over harvest. These goals require major investments of capital, time and research to establish suitable planting sites, reproductive rates and management strategies.

While data exist on some aspects of *C. gigas'* biology, we have inadequate information to assess fecundities in the field or even project the environmental conditions necessary for reasonable levels of egg production and larval survival. A base requirement would be a population model with an age-specific fecundity schedule related to environmental conditions. Placement issues demand detailed knowledge of the hydrography of planting sites. As a result of research at VIMS, we have gained a substantial understanding of circulatory patterns in the James River Estuary. From that understanding we would expect any successful reproducing populations of *C. gigas* to be limited to the lowermost reaches. We do not have comparable knowledge of other river systems in Virginia. Failure to do this prior to an introduction will extend the time scale, and possibly doom efforts to establish persistent breeding populations that will support a fishery. Application of current tools and analysis would require a minimum of three years.

At a minimum, this option will require 3-5 years investment in establishing the research data needed to execute the plan, and at least 6-10 years to establish manageable sustainable yield oyster reefs.

SUMMARY

If pursued by the Commonwealth, the alternative species strategy will require careful evaluation of the ecological, economic, political and legal parameters. The ecological, legal and political issues will likely transcend state boundaries. If we are speaking of the public fishery on traditional oyster ground, this strategy will also entail a fundamental decision to abandon a publicly held natural resource in favor of a direct state subsidy to create a new industry option that will no longer be the domain of the commons. It is also necessary to consider whether the strategy is more suited to private oyster culture as opposed to the public fishery. Depending on the options pursued, an alternative species strategy may take anywhere from 6-15 years to accomplish before there would be any harvest potential in a traditional public fishery. Private planting on leased bottom, and aquaculture options may be more efficient on a limited scale for private sector production. Most of this time would involve the establishment of self sustaining populations that are manageable for harvest. The large scale dumping of seed and adults as a quick fix is unacceptable and would most likely be barred by existing law, through legal action in neighboring jurisdictions and at the federal level.

Apart from the fishery restoration issues reviewed here, the matter of alternative species introductions for their ecological value alone deserves careful review and evaluation. Because there are no economic time constraints associated with the fishery, an ecologically motivated introduction may be an option to restore the ecosystem functions lost with the decline of *C. virginica* in the Chesapeake Bay. We are not in a position to offer a considered opinion on this question at present.

The Virginia Institute of Marine Science cannot endorse, in the current understanding of associated risk, large scale, uncontrolled introductions of non-indigenous oyster stock into the waters of the Commonwealth or the Chesapeake Bay.