Committee on Resources

Witness Testimony

Testimony of
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Wildlife and Oceans.
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My name is Roger Mann. I am a Professor of Marine Science at the School of Marine Science, Virginia Institute of Marine Science, College of William and Mary. I have been a researcher in the field of marine science for over twenty years. Throughout that period I have maintained an active interest in the biology of introduced (non native) aquatic species. I have edited two volumes on this subject, maintained an interaction with other researchers in this field including those appointed to the International Council for the Exploration of the Seas Committee on Introductions, and have recently completed working with the US Department of Agriculture Working Group on Biotechnology developing guidelines for research involving genetically modified organisms.

My research efforts focus predominantly on the biology of marine shellfish, and in particular the oyster species of temperate and subtropical waters. Today I have been requested to briefly describe the current proposal to examine non native oyster species as a vehicle to rehabilitate the Chesapeake Bay ecosystem. I will do this by posing a series of questions, and offering responses to each in turn.

Why are we considering the introduction of a non native species to restore or rejuvenate the oyster resource of Chesapeake Bay?

Although the initial, and perfectly defensible, response to this question would be because it supports a commercially valuable industry I believe that the direct commercial exploitation aspect is of quite secondary importance - the ecological value of the oyster in the Bay is of much greater importance. The Chesapeake Bay is a young geological formation, on the order of only 10,000 years old. As it filled with rising sea level the oyster reefs formed and became dominant geological as well as biological structures. They remained this way until early colonial times, and we know from records of that day that the Bay was dominated by intertidal oyster reefs that supported extensive communities of finfish and crabs. The reefs provided both a food source and a physical structure within which complex and stable communities developed and survived. The oyster provided an all important link in harvesting the single cell plants, the phytoplankton, from the water column and providing a food source for animals higher in the food chain. Environmental degradation, related to poor land use practices in the Bay watershed, and directed harvest were well underway over 100 years ago and contributed to a decline in the native oyster resource that continues to this day. A barometer of the decline is the size of the commercial harvest of the native oyster in the Bay: the current level of harvest is less than 1% of that of 100 years ago! While harvest and environmental degradation must take some of the blame for the demise of the resource, losses over the past four decades have been exacerbated by the influence of two diseases, commonly known as Dermo and MSX, which are now endemic to the higher salinity portions of the Bay. Both result in significant mortalities of native oysters, so much so that the species now survives only in disparate, low salinity sanctuaries as subtidal crusts of living material overlaying a base of reef material. The typical reef structure is no longer present, and vast regions of Bay bottom formerly populated by oysters remain essentially barren. The distribution of the oyster diseases is related to freshwater input to the Bay, that is to climate - which we cannot control. Despite over 30 years of research examining the two oyster diseases we have yet to fully understand the biology of either. Further, despite both concerted efforts of researchers and the natural high fecundity of native oysters there has not been the development of a disease resistant strain to facilitate repopulating of the formerly productive areas. Stated simply, without disease resistance this repopulating and hence rehabilitation of the native oyster resource will not occur. If native species fail to demonstrate resistance then the next alternative is to examine disease resistance in non native species which might fill the vacated ecological niche of the native species in the Bay ecosystem.

What is the status of the proposal?

In developing the proposal we (my collaborating colleagues at the Virginia Institute of Marine Science and I) followed the internationally accepted and respected guidelines for consideration of and effecting introductions as developed independently by ICES (International Council for the Exploration of the Seas), EIFAC (European Inland Fisheries Advisory Commission) and AFS (the American Fisheries Society). These guidelines emphasize the following: (a) a clear rationale for introduction, (b) selection of candidate species, including a consideration of associated pests, parasites and diseases, (c) testing, utilizing quarantine systems, before a decision to proceed with introduction, and (d) introduction using quarantine procedures and monitoring after release to provide data for subsequent considerations for introductions. The rationale, item (a) in the ICES list, is described in the previous section and is complete. For item (b) we developed, from the extensive scientific literature, a list of candidate species for consideration and reduced this to two species within the same taxonomic genus as the native species. The native species is Crassostrea virginica. We identified the Pacific oyster, Crassostrea gigas, and the Suminoe oyster, Crassostrea rivularis, as leading candidate non native species. The current status of the investigation is in item (c) of the ICES listing. Source populations of Pacific and Suminoe oysters have been identified which exist either within current quarantine facilities elsewhere (that is populations which have already been subjected to analysis for and procedures to minimize or eliminate associated pests, parasites and diseases) or can be transferred to quarantine within the current year for required disease study. The intent is to provide non native oysters that will not pose a risk of introducing a foreign disease when utilized in field exposures in the Chesapeake Bay designed to examine susceptibility of non native oysters to endemic diseases. Further, we are collaborating with researchers at Rutgers University in New Jersey in a program where Rutgers provides our effort with both Pacific and Suminoe oysters that have been genetically manipulated to vastly reduce or essentially eliminate their capability to reproduce. This process, termed ploidy manipulation, consists of changing the number of chromosome sets in each cell of the oyster such that viable egg production is greatly reduced but larvae do not survive. The rationale follows that reproductively impaired non native species cannot spawn and develop a self sustaining population in a new environment, in this case the Chesapeake Bay. Thus non native oysters can be used in field exposures designed to examine susceptibility to Bay endemic diseases with virtually no risk of either introducing an associated pest or parasite and without a fearof the establishment of an actively reproducing population of that non native oyster. The protocol for these studies has been approved by the designated regulatory body in the Commonwealth of Virginia, the Virginia Marine Resources Commission, and the current status is that we have started field exposure of one genetically manipulated population of Pacific oysters that originate from Rutgers University. This population is maintained in a caged facility at the end of limited access dock extending into the York River at the Gloucester Point campus of the Virginia Institute of Marine Science. A population of native oysters is maintained in the same location and conditions for comparative purposes. The Gloucester Point site has a long history of significant disease impact on oyster populations and is ideal for experimental disease challenges. The current experiment is the first of several which are planned for continuation in 1997 and 1998. During this period we intend to examine strains of Pacific oysters from three geographical origins, and Suminoe oysters from one geographical origin for disease susceptibility and growth in the Chesapeake Bay environment.

What scientific scrutiny has been employed in the preparation of this research?

It is important to reiterate that the previously mentioned ICES guidelines have been strictly adhered to throughout the current investigation, both in the preparation of documents describing and seeking permission to effect the proposed work, and in every aspect of the work as it proceeds. Initial scrutiny of the prospect of work with non native oyster species in Virginia dates back to 1989 when a previous proposal for field testing of Pacific oysters for susceptibility to endemic diseases was proffered to the Virginia Marine Resources Commission by the Virginia Institute of Marine Science. Compliance with ICES guidelines was considered to be a prerequisite by the Commission. Further, the proposal was circulated by the Commission to all equivalent state agencies from Maine to Florida with a request to comment directly to the Commission. Broad comment was received, and permission to proceed was granted with a further requirement by the Commission that regular examination of oysters should be performed to insure maintenance of a chromosome complement (ploidy) commensurate with impaired reproductive capability. In the event of any change in ploidy the experiment would be immediately terminated. The field test did proceed but a small proportion of the oysters exhibited changes in ploidy from the initial value. The experiment was terminated as required, but the information from the intervening period was very encouraging with respect to susceptibility of Pacific oysters to endemic diseases. Since that time the plight of the native species in the Bay has continued a downward trend while the state of the art in ploidy manipulation as an experimental tool to facilitate field testing has made considerable progress. In response to a request from the General Assembly of the Commonwealth of Virginia the Virginia Institute of Marine Science prepared a Strategic Plan for Molluscan Shellfish Research; including a Rational Plan for Testing Application of Non Native Oyster Species. This was delivered to the Governor an General Assembly of Virginia and published as House Document Number 16 for the 1996 session of the General Assembly. The Strategic Plan was subjected to extensive review by the scientific and industry community during its development. The current investigation is based on the appropriate section of House Document Number 16. Permission to proceed with the current work was requested from the Virginia Marine Resources Commission by the Virginia Institute of Marine Science in late 1995. The request was supported by the Secretary of Natural Resources of Virginia, and permission was granted by the Commission.

What are the implications of this research for the future of the Bay?

The research is designed to proceed in a sequential manner. In the event that none of the tested oyster species or strains exhibit resistance to the endemic disease the studies are terminated and we are destined to work in what limited way we can with the native species in managing the limited stocks that remain in low salinity regions. Should one or more of the tested species exhibit resistance to the endemic diseases the following series of questions will be addressed. Does the candidate exhibit reasonable growth and over what range within the Bay? If so, can the candidate successfully reproduce and form a self sustaining population? Will the candidate compete with the native species or be spatially separated from it by gradients in physical environment? Will the candidate survive pressures of predation from native predators like crabs? Will the candidate adopt a reef forming habit in the Bay environment? Progression through this series of questions will determine optimal use of a disease resistant candidate. For example, a disease resistant form with good growth characteristics but poor reproductive ability in the Bay might be an option for hatchery based aquaculture activity. Active reproduction over a wide spatial range offers the option of a naturally sustainable resource, but critical issues of developing a breeding stock of sufficient size and optimal placement to effect maximum recruitment of juvenile stages have to be addressed. As an aside, it should be noted that recent research by investigators at Rutgers University and the University of Delaware indicates that natural hybridization of either Pacific or Suminoe oysters with native oysters will not occur. It is important to underscore the time frame and magnitude of addressing the rehabilitation problem. Even with good growth and reproductive capabilities, and optimal placement of introduced stocks a rehabilitation process will be framed in decadal rather than annual time frames. With such a progressive program it would, however, be realisic to expect increasing stability of the reef associated communities, including species of commercial value, and improving water quality as dense oyster populations again filter the plankton from the nutrient rich waters of the Bay.

What improvements can be made to the existing scientific protocols regarding intentional introductions so that these experiments may be viewed as sound responsible science?

The ICES guidelines for effecting introductions of non native species have an excellent track record where compliance has been effected. Where there is non compliance the results have been very varied. These guidelines have been developed over a period of at least twenty years and they work, but they must be respected as minimal standards for work of this nature. The guidelines are the subject of regular review by the international scientific community, and will continue to evolve to incorporate new technological tools as these become available. By contrast, there is great and urgent need to educate the scientific community, the regulatory agencies, political bodies and the general public about positive and responsible use of non native species. Many species that are non native to the North American continent are widely and responsibly used - they are, for example, the basis of much of north American agriculture. Beneficial uses are often transparent to the general populous because they are accepted or cause no obvious detrimental effect. Non native species are unfortunately often typecast as universally detrimental to native ecosystems or having severe economic impacts. We can all appreciate the impacts of Dutch Elm disease, gypsy moths and zebra mussels. What we fail to appreciate in such discussions is that deleterious introductions could be generally avoided if careful preventative quarantine procedures were employed. Further, we must place studies of non native species and reasons for considering introductions in context. Introductions are often considered in response to loss or decline of native species. In these cases it is relevant to ask why the native species declined? In truth the unpalatable answer may be because we have so manipulated the environment that it is no longer a native environment. So, we should not expect the native species to survive. We generally do not consider the species environment interaction in time and space frames that are more appropriate than just the immediate. Our logic concerning prospects for maintenance of the native species in such environments is, thus, often flawed, but to admit this would be an embarrassing admission of the inability of recent short term reparative strategies to reverse trends which are the results of tens or even hundreds of years of cumulative environmental degradation. As we make progress in educating all participants in the public policy process we must also exploit some of the developing tools in science to assist prediction of potential impact. Culture and experimental manipulation of candidate species in quarantine systems in sound experimental designs allows data gathering in a manner that was until recently unavailable to most scientific investigators. When coupled with rapidly developing numerical modeling tools we have the option to evaluate scenarios in short timeframes and a manner that is iterative with experimental study. The result is a far better database to contribute to the scientific, regulatory, political and public arenas. Such a partnership of better informed participants in the public policy process should provide a much improved climate for responsible discussion of the beneficial uses of non native species.

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