Evaluating Ecosystem Impact of Proposed Oyster Restoration Strategies

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Introduction

Maryland Department of Natural Resources (DNR) and the Virginia Marine Resources Commission have proposed the introduction of the Asian oyster (*Crassostrea ariakensis*) into the Chesapeake Bay system. DNR and other organizations have initiated a wide range of studies to evaluate the environmental impact of *C. ariakensis* introduction. These studies fall under the heading of Ecological Risk Assessment (ERA) and will be summarized in a Programmatic Environmental Impact Statement (EIS). We propose to add value to the ERA and EIS by evaluating several endpoints related to ecosystem impacts of the oyster restoration effort. Our work will address, among other factors, oyster impact on dissolved oxygen, algal biomass, light penetration, and submerged aquatic vegetation (SAV) abundance.

Methodology

The modeling being done to support the ERA has a very tight deadline with results due by the end of December 2004. Consequently optimal use must be made of existing resources and work must start immediately. We propose to build on an existing model developed for the EPA to evaluate the effect of a ten-fold increase in existing population of the Virginia oyster (*Crassostrea virginica*). The existing model is a component of the Chesapeake Bay Environmental Model Package (CBEMP), which has a long, successful, history as a management tool employed by the EPA, Maryland Department of Environment, and other agencies. The EPA effort is nearing completion and resources are available for immediate employment in the ERA effort.

University of Maryland/Versar is presently constructing a demographic oyster model for C. *virginica* and *C. ariakensis*. Results from this model will not be available until mid-November, however, leaving little time for employing these results in our environmental model. We propose to first conduct a series of ranging scenarios. These will examine the impact of various levels of oyster biomass. Scenarios will be conducted for existing biomass, historic biomass, and 25%, 50%, and 75% of historic levels. We have available historic biomass circa 1870. We can substitute historic biomass 1920-1970 if we are provided with the biomass and spatial distribution. We will also conduct one scenario to examine biomass and spatial distribution from proposed aquaculture efforts.

Our model is parameterized for "market size" *C. virginica*. We know of no information that specifically differentiates filtering rates of *C. ariakensis* from *C. virginica*. Allometric relationships are available, however, that relate filtering and respiration to organism size. We will consult with the sponsor regarding potential corrections for size of individual *C. ariakensis* versus *C. virginica*. Appropriate information must be available early in the project and a decision must be reached almost immediately. In the absence of information we will proceed with parameters suited for "market size" *C. virginica*.

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We will also run two scenarios examining the effect of size distribution on computed results. We propose examining larger and smaller oysters. We will examine specific size distributions if these are provided. If results from the demographic model are available by mid-November, we will conduct two scenarios using computed biomass, size, and spatial distribution from the demographic model.

Our model is operable for the years 1985-1994. This period encompasses as suite of wet, dry and average years. Individual years can be sequenced to examine flood and drought conditions if desired. We will maintain the 1985-1994 hydrology, however, unless advised otherwise.

We will examine the following parameters:

Total Nitrogen (surface)	Total Phosphorus (surface)
Dissolved Inorganic Nitrogen (surface)	Dissolved Inorganic Phosphorus (surface)
Chlorophyll (surface)	Algal Biomass, as carbon (surface)
Light Attenuation	Total Suspended Solids (surface)
Dissolved Oxygen (bottom)	Microzooplankton biomass
Mesozooplankton biomass	Other bivalve filter feeders
Deposit feeders	Submerged Aquatic Vegetation
Benthic algal biomass	Primary production

Spatial segmentation for reporting will be based on current Chesapeake Bay Program monitoring segments. Results will be seasonally averaged for each year, seasonally averaged over ten years, and annually averaged.

Products and Services

We will provide documentation of the model formulation and results. Results will be provided in graphical and tabular format and in digital form. Sponsor will have thirty days to comment, after which a final report will be produced. We will make two three-day trips to the sponsor's location for meetings and presentations. We will be available for conference calls and advisory services. Computer code will be provided to the sponsor, if requested.

Potential Follow-up Activities

We will be available to run additional scenarios based on the demographic model upon completion of this initial effort. We will also be available to provide instruction on use of our model. Under ideal circumstances, the demographic model should be incorporated into the CBEMP. This dynamic coupling between the demographic and mass-balance models will provide the most accurate estimate of oyster biomass and spatial distribution. This coupling cannot be accomplished in the time available. We recommend this activity as a second phase of the modeling effort.

Sponsor's Responsibilities

The sponsor will specify abundance and distribution of oysters, 1920-1970, if these are to be considered as the historic abundance for scenarios. These must be specified upon initiation of our effort. Any sequencing of hydrology other than 1985-1994 must also be specified upon initiation of our effort. Sponsor will provide size distribution for the two relevant scenarios

within six weeks of project initiation. Sponsor will provide biomass and spatial distribution of oysters for the aquaculture scenario within six weeks of project initiation.

Schedule

Work will commence upon acceptance of funds by the Engineer Research and Development Center. We propose an October1 starting date. Scenarios can be executed at a rate of approximately one per week so delay past September 1 may reduce the number of scenarios that can be executed. We expect to deliver a draft report and model results by December 31, 2004. We will provide interim results as they become available, if requested.

Total Costs

Research Hydrologist, 10 weeks	$56,880
Mathematician, 10 weeks	$35,560
Secretarial, 2 weeks	$3,184
Administrative Assistant	$2,000
Computer	$2,000
Supplies and Miscellaneous	$1,000
Travel	$2,010
Burden	$3,505
Total	$106,139

Total Deliverables

● Documentation of the model formulation and results. Results will be provided in graphical and tabular format and in digital form.
● Two three-day trips for meetings and presentations at locations specified by Project Officer and accessibility for conference calls and advisory services.
● Support to provide fully operational computer code on National Environmental Supercomputer Center platforms.
● Develop a series of ranging scenarios examining the impact of existing biomass, historic biomass, and 25%, 50%, and 75% of historic levels.
● Develop one scenario to examine biomass and spatial distribution from proposed aquaculture efforts.
● Develop two scenarios examining the effect of size distribution on computed results using larger historical oyster sizes, filtration rates, respiration rates, etc., and current smaller oyster size and associated parameterization.

Partial Funding Costs
Only partial funding of 50k is available for this project. Accordingly, the total cast and deliverables are scaled back consistent with funding available.

Research Hydrologist, 5 weeks	$28,440
Mathematician, 5 weeks	$17,780
Secretarial, 3 days	$955
Administrative Assistant	$500
Computer	$500
Supplies and Miscellaneous	$100
Travel	$0
Burden	$1,725
Total	$50,000

Partial Funding Deliverables
● Documentation of the model formulation and results. Results will be provided in graphical and tabular format and in digital form.
● Support to provide fully operational computer code on National Environmental Supercomputer Center platforms.
● Develop a series of ranging scenarios examining the impact of existing biomass, historic biomass, and 10% and 50%, of historic levels.