Appendix D
For Economic Analysis of Alternatives:
Projecting Oyster Harvests

The purpose of this background report is to provide the detail used in developing reasonable estimates of the size and nature of the oyster harvesting industry, both aquaculture and public fishery, that will emerge following implementation of the different alternatives being considered for the EIS. The results draw on the economic analysis documents that were developed as supporting material for the EIS (Lipton, et al. 2006; Lipton 2008) and the corresponding peer review comments relevant to those documents (Anderson 2007) along with the manuscript by Dedah et al. (2007) included with those comments.

The analysis that follows acknowledges the great deal of uncertainty regarding oyster markets under all the scenarios considered. The approach taken here is to develop simple and logical approaches based on existing data and studies, reflecting the large uncertainties that exist in making these types of predictions.

1) What is the projected demand for Chesapeake Bay oysters? Will prices go up, down or remain the same when Chesapeake oyster production is expanded? What is our best estimate of what those prices will be at different levels of Chesapeake production? How will demand differ between *C. virginica* and *C. ariakensis*?

Background

Oysters are produced all over the world and in all regions of the United States. The market is complex with a variety of species being produced. *Crassostrea virginica* and *Crassostrea gigas* are the two major species marketed in the United States, with the latter mainly being produced on the Pacific coast. Final preparation and consumption of oysters include, raw on the halfshell, cooked and prepared on the halfshell (e.g. Oysters Rockefeller), steamed or roasted in the shell, and oysters which are shucked at a processing plant and packed into pint or gallon containers and then subsequently prepared for consumption as items such as fried oysters, oyster stews, as an ingredient in stuffings, and other culinary delights.

Any comprehensive study of the oyster market would begin with determining the prices and quantities of these products that form the oyster market. We are unaware of any modern comprehensive set of data on prices and quantities of final consumption of oyster products. For example, we do not have any data on the prices and consumption of raw oysters. As presented in Lipton, Kirkley and Murray (2006), there is information on wholesale prices of oysters sold as shellstock and shucked oysters sold by the gallon, but there is no contemporaneous quantity information that can be used for modeling demand at the retail or wholesale level.

The best source of data on oyster production and prices is at the harvest level. Data is readily available monthly by state and species. Thus, oysters that are sold to the final consumer in a variety of forms at different price levels are represented by a single oyster harvest price estimate. This creates a lot of error in our measurement of oyster price, and particular in any demand model that attempts to relate oyster harvest levels and prices. With these data limitations we felt it was appropriate to take a simple approach to addressing the above questions.

Analysis

In the initial analysis Lipton, Kirkley and Murray (2006) (LKM) used a simple reduced form inverse demand model that treats Chesapeake Bay price as an endogenous variable that is regressed on annual production from the Chesapeake region and all other producing regions of the country. Oyster quantities are assume to be exogenous is this model. The justification for the assumption of exogeneity is that the abundance of oysters in a year is largely determined by uncontrollable natural factors. From a statistical viewpoint, the model performed well, predicting 80% of the variability in Chesapeake Bay oyster price. The peer review comments expressed concern about this approach and provided a copy of a paper presented at the Southeastern Region Agriculture Economics meeting (Dedah et al. 2007) that also uses inverse demand, but the different regions of the country are modeled in separate regressions that are related using seemingly unrelated regression techniques. The Dedah et al. approach also adds economic structure by constraining the models to conform to what is referred to as an “almost ideal demand” system to ensure that it better adheres to economic principles.

While the model specifications differed, they provided very similar results regarding the impact of Chesapeake production on Chesapeake price. The price flexibility from the LKM study based on annual data was -0.37. The price flexibility estimate of -076 from the Dedah et al. study was based on quarterly production data. Given that virtually all Chesapeake production occurs in only two quarters, the Dedah et al. price flexibility for Chesapeake Bay when adjusted to an annual flexibility would be -0.38. Both approaches are limited to predicting how the market will respond given that they are premised on current industry structure. The development of a much larger level of regular Chesapeake production concurrent with the large production levels in the Gulf of Mexico and from the West coast will create market conditions outside the levels of either recent or historic observed data.

A second round of peer review comments was still concerned with the underlying validity of the inverse demand model, even if the estimated price flexibility was a good approximation of the “true” value. In response, additional changes were made to the inverse demand specification including adding a real disposable income variable and incorporating imports of fresh or frozen oysters. Because of data availability, the use of import data required changing the dates included in the regression from 1950-2006 to 1975-2006. The advantage of using the longer time period is that it includes some observations at higher levels of production that might be anticipated with a restored resource in Chesapeake Bay. This was the main rationale for using the 1950-2006 data, production in the original analysis. By the 1980’s, Chesapeake production was only 37% of the average production of the 1950’s, whereas, including some data from the 1970’s allows us to include observations where production was still around 65% of the 1950’s level. Production from 2000-2006 was only 2% of the 1950’s level. The 1975-2006 time period seems like a reasonable compromise to trade-off accounting for structural shifts and including observations near the level at which production projections are going to be made for the analysis. The model used is then:

$$(1)\ P_{ch} = \alpha + \beta_1 X_{ch} + \beta_2 X_{ma} + \beta_3 X_{ne} + \beta_4 X_{sa} + \beta_5 X_g + \beta_6 X_{pa} + \beta_7 TT + \beta_8 INC + \beta_9 VG + \beta_{10} IMP + \varepsilon$$

where P_{ch} is the annual real price in Chesapeake Bay, X are per capita annual landings subscripted by the producing region (ma=Mid-Atlantic, other than Chesapeake; ne= New England; sa = South Atlantic; g= Gulf of Mexico), TT is a year time trend variable, INC is real per capita disposable income, VG is zero for the period 1975-1990 and is equal to the per capita Gulf production for

1991-2006, IMP are imports of fresh/frozen or fresh/frozen/salted/brine oyster products, α and β's are parameters to be estimated and ε is the error term. The model was estimated using ordinary least squares.

Results

The revised model has a significantly greater own price flexibility than was original estimated, so these new results require significant updating of the projections in the EIS. The model explanatory power actually increases to an r^2 of 0.89 (n=32) from an r^2 of 0.75 (n=57).

Table 1. Model results from inverse demand for Chesapeake Bay oyster production.

	Coefficients	*Standard Error*	*t Stat*
Intercept	-0.77543	2.24424	-0.34552
X_{ch}	-26.14640	6.50971	-4.01652**
X_{ma}	91.12326	28.38465	3.21030**
X_{ne}	17.98797	13.15814	1.36706
X_{sa}	-24.96263	52.19655	-0.47824
X_g	-7.12168	4.34319	-1.63973
X_{pa}	30.61914	11.96673	2.55869**
INC	0.00042	0.00019	2.27427**
VG	-17.52835	4.66819	-3.75485**
IMP	-31.35519	39.23607	-0.79914
TT	-0.15412	0.08389	-1.83713**

**indicates coefficient is significance at the 95% confidence level

The key variable for the analysis that follows is the own (Chesapeake) bay price coefficient which is significant and of expected sign (negative). Two of the significant parameter estimates, Mid-Atlantic production and Pacific production are unexpectedly positive indicating that increased production from these regions is predicted to increase price in the Chesapeake region. Since Mid-Atlantic production has been historically small compared to other producing regions, even with the high coefficient, this impact on Chesapeake price is small. Given the relatively larger production of Pacific oysters, the positive effect on Chesapeake price is potentially more problematic. From a predictive point of view, since production from other regions is held constant throughout the analysis, this does not pose a problem. However, the unexpected sign may be indicative of more structural complexity in the oyster market that is not being captured in this simple approach. In particular, the assumption of exogenous production from this region which is so heavily dependent on aquaculture as opposed to natural production might explain the results. Coefficient estimates may be biased if this is the case.

The estimated price flexibility under the revised analysis is -0.24, and the 95% confidence range is from -0.10 to -0.41. The demand schedule with 95% confidence limits is presented in Figure 1.

Discussion of Results

Our analysis as modified by the peer review comments as well as the Dedah paper agree that significant increases in Chesapeake oyster production will lead to lower prices in the region. While the data presented here will be used for subsequent analysis, it is important to mention reasons why the actual performance of the Chesapeake market may differ from what is predicted.

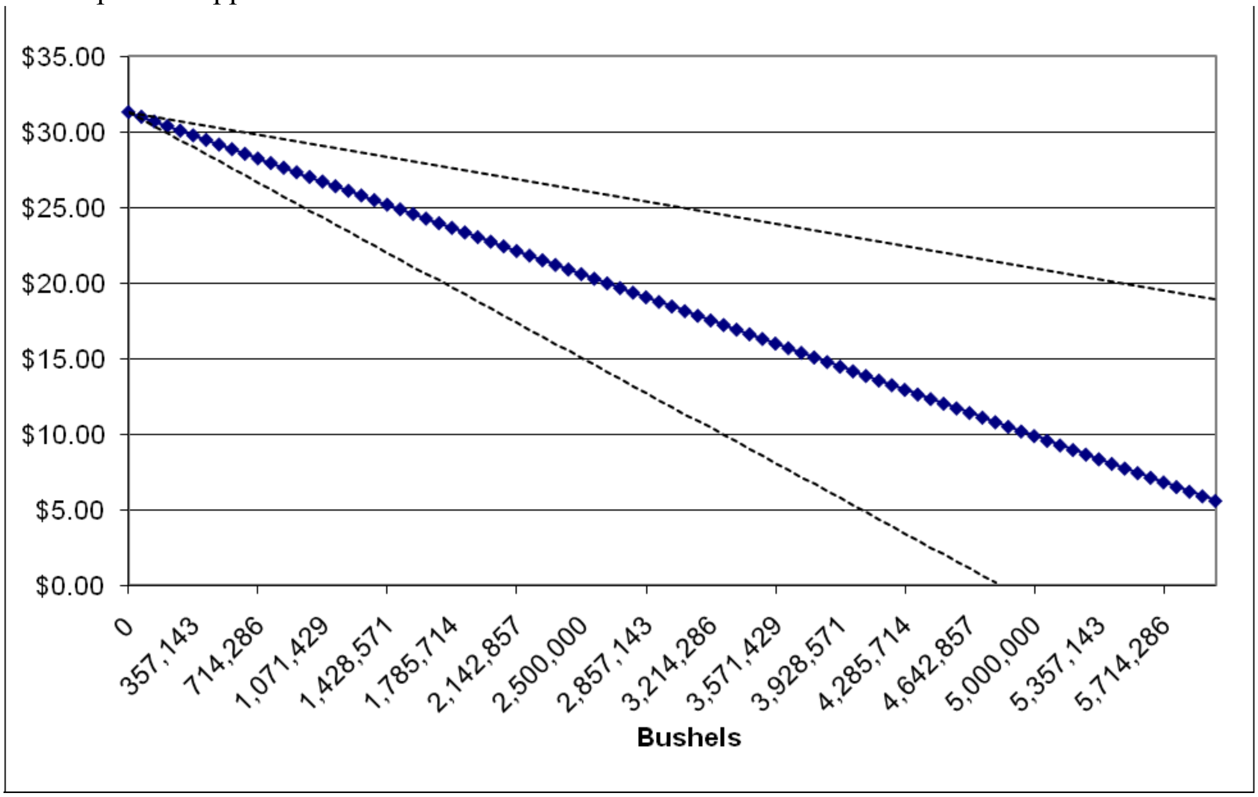
Some reasons why the responsiveness of Chesapeake Bay oyster prices to Chesapeake production will be less than predicted (higher price for a given increase in quantity) include:

- A greater share of future Chesapeake oyster production is sold in the higher valued halfshell market
- Other major producing regions have production declines such as occurred in the Gulf as a result of hurricanes in 2005
- The oyster industry engages in effective marketing and retailing that increases the demand for oysters and expands the market

Some reasons why the responsiveness of Chesapeake Bay oyster prices to Chesapeake production will be greater than predicted (lower price for a given increase in quantity) include:

- Increasing concerns and awareness about food-borne illness
- Market infrastructure, particularly for new or expanded processing capability will be limited by competing nearshore land use.
- Labor limitations will limit expansion of processing sector (e.g., blue crab processor have uncertainties regarding continuing to use H2-B visa laborers to meet localized industry labor shortage)
- Other producing regions also expand oyster production beyond historical levels
- Imports become more of a factor
- Expansion of production of competing seafood products such as mussels and hard clams could lower demand for oysters

Figure 1. Oyster demand showing bushel prices versus Chesapeake bushels harvested. Dashed lines represent upper and lower bounds at 95% confidence limits.



Difference in demand for *C. virginica* and *C. ariakensis*

For evaluating the alternatives in the environmental impact statement, it is important to know if there would be a significant difference in the oyster demand outlined above if it was based on *C. ariakensis* as opposed to *C. virginica*. Previous studies (Grabowski et al., 2003; Bishop and Peterson 2005) have demonstrated that there may be some minor differences in consumer preferences for the two species, but it is not clear how these limited surveys would translate into an expanded oyster market.

From the point of view of production to meet this demand, there is evidence from the Virginia Seafood Council trials that the yield of shucked oysters (i.e., oysters per gallon or pint from a bushel harvested) is significantly greater for *C. ariakensis* compared with a bushel of *C. virginica*. A.J. Erskine (pers. comm.) has found from the Virginia Seafood Council trials that triploid *C. ariakensis* shucks out at about 182 oysters to the gallon compared with 400 *C. virginica*. This higher yield per bushel would result in a steeper demand curve than in figure 1, with higher prices per bushel and the market demand being met with fewer bushels harvested. The Virginia Seafood Council trials also revealed that concerns about shelf life of *C. ariakensis* shellstock due to that oyster gaping as compared to *C. virginica* were a real concern. Another limiting factor in marketing of *C. ariakensis* as a halfshell product is the prevalence of *Polydora* infestation. Given this difference, it would be reasonable to expect that production based on *C. ariakensis* would have a heavier weighting of shucked versus halfshell oysters when compared with production from *C. virginica*.

The higher shucking yield for *C. ariakensis* would make it a higher valued product than *C. virginica* in that market, but its diminished suitability as a halfshell product would work in the opposite direction in regard to the observed average price per month that our model is based on. Adding to the uncertainty, is not knowing how these differences would work themselves out in the marketplace in an industry that is orders of magnitude larger than the one we currently observe. Given these restrictions, we determined that using the simple Chesapeake Bay own price flexibility estimate for both *C. virginica* and *C. ariakensis* price predictions is the most reasonable approach and is how prices are predicted for each of the alternatives analyzed.

2) Given the projected demand for oysters, what will be the overall level of industry production? How will industry production be divided between different production technologies such as the public fishery, bottom culture, and off-bottom culture?

A stated goal of the Environmental Impact Statement is a restored oyster population that would be able to support a sustainable harvest of 4.9 million bushels a year. This does not imply that that has to be the actual level of harvest in order to meet the EIS goals, but the population would have to be large enough to support that level. In Figure 2, we plot the 4.9 million bushel a year level of production on the demand schedule. The prediction from the demand model is that at that level of production, prices will fall from current levels to about $10.22[1] per bushel, with the 95% confidence range of $9.75 - $21.14. The minimum observed real price for Chesapeake Bay oysters was $20.07 in 1974. Using that minimum price as an indicator of the minimum feasible market price suggests that there is a small probability (~7%) that the level of production indicated in the

[1] All prices in this document are expressed in 2006 dollars, using the Bureau of Labor Statistics consumer price index.

EIS goal is feasible. The quantity from the demand schedule corresponding to the minimum observed market price is 2.6 million bushels, comparable to average harvests in the 1970's, and the 95% confidence range is 1.7-5.4 million bushels.

As another indicator of likely production quantities from Chesapeake Bay, we also used data from the 2005 industry survey price scenario from LKM. In that study, oyster industry members suggested an equilibrium price of $19.36 per bushel. Using the estimated demand relationships, the industry member price prediction compared to the minimum observed price translates into slightly higher production of 2.8 million bushels with a 95% confidence rang of 1.8-5.8 million bushels. Given the uncertainties, we use 2.6 million bushels as the best estimate of the maximum Chesapeake Bay industry size resulting from an enhanced resource base.

How are the size and number of oyster producing firms determined?

Economic theory suggests that the size (in terms of quantity harvested) of an individual oyster producing firm will be determined by the relationship between production costs and the amount of oysters produced. That relationship will depend on the technology used to produce oysters and will have a point where the average cost per oyster produced is minimized. Each firm will produce at that minimum average cost point. For expository purposes supposes all firms are identical and have a minimum average cost of $20.07 when they produce 2,600 bushels annually. That would lead us to conclude that there would be 1,000 identical oyster firms producing at the minimum cost so that total industry production was 2.6 million bushels. At that point, all firms are producing at minimum cost and the total demand for oysters has been met, leading to market equilibrium.

Just like the market for oyster products, the production of oysters is much more complex than the simple example given above. For one, oyster production, particularly in the public fishery is highly regulated with limits on gear and limits on harvest. These limits often prevent firms from operating at production levels that minimize production costs. We also observe that firms are not identical in the gear that they use or in the skill of the oystermen in employing the gear. Private aquaculture production has an entirely different cost structure compared to the public fishery, and private aquaculture firms are employing a variety of techniques with varying levels of success. Combining the availability of these different oyster production techniques with a lack of systematic cost and returns data collection for each technique, makes it extremely difficult to determine the industry structure that would emerge from a restored oyster population. Below we examine what is known about production costs in order to shed some light on possible industry structure.

3) What might the production costs for intensive private oyster aquaculture be? What would be the difference between *C. virginica* and *C. ariakensis* production?

Lipton (2007) used data from the Virginia Seafood Council trials as the best representation of what production costs for intensive aquaculture would be in Chesapeake Bay. Since that report, two more production years have provided data on C. *ariakensis* performance, and the most recent trials included small scale trials with triploid *C. virginica*. By including all the trial data, we can begin to capture some of the variability and uncertainty of intensive aquaculture production costs and returns in Chesapeake Bay. For example, since the first round of trials, growers have experienced planting mortalities, mortality from predation, freezes and mortality from unknown causes. With limited information on full scale production of intensive oyster aquaculture in Chesapeake Bay, this pilot data remains the best source of information on which to predict production costs.

Some important qualitative information has been gleaned from the Virginia Seafood Council trials. Originally, it was thought that intensive oyster aquaculture would have to be geared towards a higher-priced half shell market because of relatively high operating costs compared with extensive aquaculture and the public fishery. However, the problem with *C. ariakensis* not closing as tightly as *C. virginica* and therefore having a shorter transportation life for the half shell market and the problem of shell scarring related to *Polydora* infestation has limited the suitability of *C. ariakensis* for the halfshell market. As a result, a much larger percentage of *C. ariakensis* was marketed as a shucked product in the most recent trials. Also, small scale trials (10,000 seed) were conducted with triploid *C. virginica*. Although extensive economic data similar to that from the *C. ariakensis* trials is not yet available, preliminary data showed that triploid *C. virginica* had very good survival compared with *C. ariakensis*, but slower growth.

The updated economic analysis of intensive aquaculture of triploid *C. ariakensis* is modified from the Lipton (2007) analysis of aquaculture alternatives. It is based on developing a representative firm based on the three separate Virginia Seafood Council trials. A variety of grow-out technologies and techniques have been employed in the VSC trials. We have not attempted to determine the economic performance of a single technology, but rather, combined these to represent our current state of uncertainty about which technology will emerge as the preferred technique. In all likelihood the industry will be comprised of variations on several technologies depending on the specific environmental conditions in an area and the market the grower is trying to meet. The following assumptions, drawn from the trial data are made about operations of our baseline representative firm:

1) The oyster firm plants 1.3 million oyster seed per year
2) Time from planting to market is 12 months
3) Total spending on durable and non-durables supplies is $63.5 thousand, this is broken into:
    a. Capital costs with a 5 year life = $57.2 thousand
    b. Maintenance and repair costs are 10% of the total supply costs = $6,350
    c. Non-durable supplies are 10% of capital costs = $5,720
4) Seed costs are initially set at $0.01 apiece as indicated in the VSC trials.
5) Average oyster survival to market is 77%, with a standard deviations of 21%
6) The average price of oysters sold is $0.20 with a standard deviation of $0.05
7) Operations require approximately 250 man-hours per month. The peer review was concerned about the low wage rate used ($10/hour). We adjusted the wage rate to range from $10-$15 an hour with a mean of $12.50.
8) Monthly fuel costs are $165 with a $3.55 standard deviation.
9) The cost of capital to initiate the operation is modeled by a ten-year loan of $100,000 at an 8.5% interest rate.
10) As indicated in Lipton (2007), no management costs were included in the initial analysis of the VSC trials. We included a $40,000 per year management charge to the enterprise along with $4,000 in other miscellaneous fees such as accounting, legal, and insurance.

<u>The Baseline Firm (VSC Data)</u>

There is only a 26% probability that the firm described above would be solvent over a ten-year time period. The problem is that paying a management fee of $40,000 in the first year depletes the cash reserves to the point where the firm needs much higher than average oyster survival and sales in the first few years to continue operations into the future. Therefore, we determined that the enterprise would need a $150,000 loan as opposed to the $100,000 used in the previous analysis. Once that adjustment was made, there was a 100% probability of success. This firm, as described above, formed the baseline for further adjustments for the EIS analysis.

Seed and Market Prices

There is no well functioning private market for hatchery produced oyster seed in the Chesapeake region for which to obtain estimates of seed prices. We have been assuming $0.01 per seed. In a December 20, 2007 Oyster Recovery Partnership presentation to the Maryland Oyster Advisory Commission, a seed price of $0.02 apiece was assumed.[2] To reflect this uncertainty in seed prices, we have increased the estimated seed cost to aquaculture enterprises to $0150 average with a standard deviation of $0.05 After this adjustment is made, we start running scenarios by dropping the output price to determine the point where the probability of a firms economic survival starts to drop significantly.

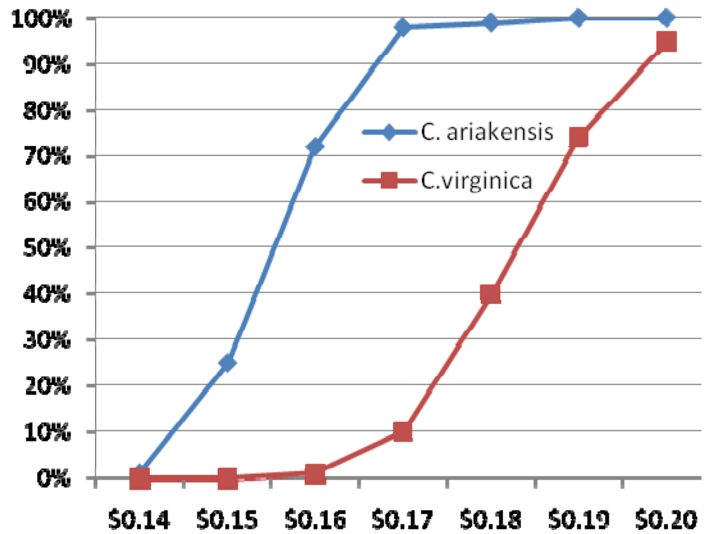
C. ariakensis compared to *C. virginica* intensive culture

With only limited data on triploid *C. virginica* grown in these intensive systems, we kept all cost and operating assumptions the same as for *C. ariakensis* with the exception of time to market. For triploid *C. virginica* we assumed time to market to be 18 months. The additional six months to market had a significant impact on the probability of economic success of the aquaculture enterprise at prices lower than the current $0.20 per oyster (Figure 2).

Based on the limited costs and returns data for triploid oyster production in Chesapeake Bay, it appears that triploid *C. ariakensis* can be a viable economic enterprise at a minimum price of $0.16-$0.17, and triploid *C. virginica* at a price of $0.19-$.20 per oyster. Although these are our best estimates, it should be clear from the analysis that conditions outside the range of assumptions used in the modeling can lead to markedly different results. For example, an actual oyster seed price closer to $0.02 or an average mortality closer to 50% would make either of these enterprises more risky than shown here.

[2] http://www.dnr.state.md.us/fisheries/oysters/mtgs/122007/meeting122007.html

Figure 2. Probability of economic success for intensive oyster aquaculture of *C. ariakensis* and C. *virginica* at different output prices.



4) What are the private industry costs of harvesting natural or publicly-maintained oyster beds?

At the other end of the spectrum from the intensive oyster aquaculture production examined above, is the harvest of wild oysters from naturally-populated oyster bars or from oyster bars that have been enhanced through public restoration and repletion efforts. As long as the abundance was sufficiently dense on the oyster bars, this would clearly be the lowest cost oyster production technology since it only entails the cost of harvesting. Wieland (2006) estimated oyster harvesting costs for different gear types in Chesapeake Bay. Daily operating costs ranged from $176 a day for shaft tongers to $375 a day for dredgers. Obtaining a cost per oyster to compare with other production methods is difficult because it will depend on the density of oysters and any restrictions on harvest. For illustration, Wieland (2006) used the average 2005 and 2006 catch per day by gear type. His cost per bushel estimates ranged from a low of $16.60 for shaft tongers to a high of $29.76 per bushel for dredge boats. The variability in estimating the cost per oyster is even greater because there is no standard estimate of the number of oysters in a bushel. Throughout our analysis, we have been using a figure of 275 oysters per bushel. We have seen other estimates of up to 400 oysters per bushel. One of the things that is not clear in these various estimates is whether they include only market size oysters or all live oysters. Harvest costs per oyster, based on Wieland's (2006) cost estimates and catch per day range from as low as $0.04 per oyster based on 400 oysters per bushel to $0.11 per oyster for a high cost dredge operation at 275 oysters per bushel.

5) What are the costs of extensive aquaculture production of oysters in Chesapeake Bay? How do these costs differ for triploid *C. virginica* versus triploid *C. ariakensis*? How do these costs differ for disease-resistant hatchery seed?

Almost all the recent harvest from Chesapeake Bay is based on some form of extensive aquaculture. In this form of aquculture, suitable bottom is found or made suitable by placing shell or bagless dredging to return shell to the surface. Oyster seed on shell is either obtained from natural seed areas or from hatchery seed that has been set on shell. The seed is placed on the bottom where it remains until reaching market size. Variations on this form of aquaculture are practiced by private growers who lease bottom (mostly Virginia) or by the state (mostly Maryland) in support of a "public" fishery. High mortality, principally due to disease has rendered this from of aquaculture as it has traditionally been practiced not viable. If survival rates were similar to the rates in intensive aquaculture, production costs would likely fall inbetween harvesting from a healthy wild fishery and intensive aquaculture. To get these survival rates up, growers are interested in using disease-resistant hatchery produced oysters and/or faster growing triploid oysters that may reach market size before succumbing to disease mortality (*C. virginica*) or are not as susceptible to disease mortality (*C. ariakensis*).

Production cost data for extensive oyster aquaculture in Chesapeake Bay that would allow for a detailed analysis is very limited. The data provided at the February 2006 Aquaculture Workshop was simply for a cost to obtain wild oyster seed that then experienced a high mortality. We showed that based on typical mortalities in Chesapeake Bay, the cost per bushel harvested was on average, $82/bushel while the price received was about $30. While we could calculate what survival would have to be to break even on seed costs (16%), no information was available on additional costs such as labor. Thus, we were not able to run the simulations like the ones based on the extensive data from the Virginia Seafood Council trials.

We do not have to run the aquaculture simulations to know that oysters with greater survival and faster growth will outperform, on an economic basis, higher mortality, slower growing oysters at the same market price. However, without knowing the production cost of this type of operation, it is not possible to determine the level of production, if any, that is feasible.

6) What is the potential role of aquaculture in achieving a restored Chesapeake Bay oyster industry of 2.6 million bushels a year? How will the roles differ for an industry based on *C. virginica* compared with *C. ariakensis*?

The hypothesized restored oyster fishery of 2.6 million bushels is assumed to consist of the same breakdown of product for the shucked and halfshell market as we estimate to historically be the case for Chesapeake Bay. From the industry survey in LKM (2006), it was estimated that 70% of Chesapeake oysters are shucked with the rest going to the halfshell market.[3] The inverse demand model predicts that under the equilibirum oyster market, average oyster prices will decline about 35% from current levels. If current halfshell prices are around $0.24 each, then current shucked oysters must be priced at about $0.05 each to equal the weighted average price. A decline in weighted average price of 35%, keeping the same ratio of shucked to halfshell product, would lead to about a $0.03 a piece price for shucked and a $0.16 each price for halfshell. Referring to Figure 2, the halfshell price, based on current estimates of production costs, is feasible for *C. ariakensis*, but not for *C.virginica*.

C. virginica production would still be feasible at smaller aggregate production levels. For example, oveall industry production of 1.1 million bushels is predicted to lead to a price decline of about 21%, which would keep halfshell prices near $0.19 each. At this price level aquaculture firm

[3] Muth et al. 2000 used a 25% to halfshell estimate for Atlantic, other than New England, oyster production. Their figure was based on discussion with industry experts.

survival probability is about 75%, but declines precipitously at lower prices. The halfshell market would be 30% of the 1.1 million bushels, or 330,000 bushels. This would support approximately 94 of our representative aquaculture firms producing about 3,500 bushels of *C. virginica* for the halfshell market.

Assuming *C. ariakensis* production being feasible for the "fully restored" 2.6 million bushel oyster market would result in a halfshell market of about 780,000 bushels supplied by about 223 of our representative aquaculture firms. As mentioned previously, the viability of C. ariakensis as a halfshell oyster may be diminished by marketing issues related to shelf life and susceptibility to *Polydora* infestation scarring the shells. Results from the Virginia Seafood Council trials also indicate a large percentage of C. ariakensis being marketed for the shucked market. The one measure of 120% greater shucking yield from triploid *C. ariakensis* compared to *C. virginica* raises the possibility that *C. ariakensis* might be a viable oyster for the shucked market. For example, if shucking yield alone is the determining factor in processor's willingness-to-pay for shucked oysters then a processor paying $0.05 each for *C. virginica* would also be willing-to-pay $0.11each for *C. ariakensis*. Intensive aquaculture does not appear to be feasible at that low price, but a more extensive and lower cost aquaculture of *C. ariakensis* might be feasible. At a C. virginica price for the shucked market of $0.07 each, the equivalent C. ariakensis price would be over $0.15 each. At this price, intensive aquaculture of C. ariakensis has a 25% probability of economic success according to the Monte Carlo simulations. As was stated in the outset, reported oyster prices are aggregated from a variety of markets, so it is not unreasonable to assume that a portion of the oysters for the shucked market sell for higher prices than represented by the averages, and thus, may allow for feasible aquaculture production for at least a portion of the shucked market.

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