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Predicting Oyster Production: A Comparison of Natural Recruitment and Aquaculture

Abstract

The Chesapeake Bay oyster resource and fishery have shown wide temporal population fluctuations generating controversy regarding restoration methods. Disagreements stem from a lack of accurate and defensible data upon which to base decisions. Many commercial oyster harvesters favor dredging using metal scrapes towed by powered harvest vessels as a beneficial practice. Harvesters state that expanding this type of dredging throughout the Bay would lead to increased biomass and public harvest. Scientific and environmental communities dispute this claim, pointing to differences between bottom renovation and recruitment. This has created problems for managers who must consider multiple factors in regulating fisheries. To understand the effect of dredging on populations, we analyzed data from scientific studies to predict the likely outcome of these activities. This paper evaluates the cost-effectiveness and effects on production of restoration options. We compare power dredging and natural recruitment to rebuild biomass to contemporary aquaculture techniques.

Maryland Has Long-term Data on Spatial and Temporal Variation in Natural Spat Production

We used data from surveys for computations in this report. One weakness in spat production data is that they are qualitative and do not allow accurate calculation of the total number of new oysters in the population. These qualitative data are spat per bushel of shell found during sampling cruises.

Estimating the size of a new year-class of oysters on a reef requires two types of data. The first is the number of oysters found in a unit of reef substrate (e.g., bushels) and second is the total volume of reef substrate. Researchers conducted a few surveys to determine the amount of shell on a reef but these do not cover all oyster production areas of the Bay. The surveys also do not provide the data required to determine the spatial extent of shell on a discrete reef site. Additional studies that refine these data will allow more substantial analyses. We found one study that indicated that bagless dredging decreased the amount of suitable shell an average of 22% (8-29%).

Image credit: Edwin Remsberg

To compare the effects of power dredging on recruitment and production, we made assumptions based on prior studies. There are 2,200 bushels of shell in an acre-inch and 275 adult oysters in a market bushel.

We used data generated from restoration projects in Maryland compared with information from experts in other regions to generate and verify the estimates of the survival of newly recruited oysters to harvestable size. For natural oyster recruitment to occur, there must be:

1. Competent oyster larvae at the correct developmental stage in the water column;

2. Water quality at the setting location conducive for settlement and larval survival;
3. Suitable substrate for larval oysters to attach and metamorphose into spat.

If any of these components are lacking, significant oyster settlement will not occur.

Knowing How Much Shell is Available for Larvae to Set on is Critical

Data show a range of 0 to 3,238 bushels of available shell per acre. We chose the mean of 1,500 bushels of available shell per acre. With 1,500 bushels per acre of available shell at a site, we used the amount of shell and expected natural spatfall to predict the actual number of oysters likely to be produced.

Using survey data from 2000 thru 2012, we estimated total oyster production for different regions of the Bay. Table 1 shows comparisons of three areas with different recruitment histories to calculate natural spat production and potential harvest. The table also includes Bay-wide average and two scenarios using hatchery seed. These are compared with hatchery plantings of 1 million and 2 million spat/acre. Current practices for deployment of hatchery seed are a minimum of 1 million/acre for oyster leases and up to 4 million/acre for sanctuaries.

These comparisons show that, in certain circumstances, natural recruitment can provide significant increases in biomass. In extreme circumstances, natural recruitment compares favorably with hatchery-based production. The principal difficulties lie in selecting the site and choosing the proper year. An examination of natural recruitment calculations illustrates the high variability that normally exists in the Maryland portion of the Chesapeake Bay.

Table 2 illustrates the risk of relying upon natural recruitment for restoring areas other than the top five. While individual oyster bars sometimes experience higher recruitment, the values in Table 2 average all samples within a given region for each year. Since these are averages, some sites will be expected to have higher recruitment while some will remain lower. Variation between sites within a region adds further risk and uncertainty to the predictable success of any restoration project.

Table 1. Comparison of spatfall by region to aquaculture production with an estimation of spat production and potential resultant harvest

Region	Estimated Spatfall (spat/bushel)	Number of Spat Produced per Acre	Number of Bushels Produced per Acre
Upper Bay (above Bay Bridge)	0.15	225	0.66
Average of the Top 10 Best Regions	223	334,500	985
Average of the Top 5 Best Regions	335	502,500	1,480
Bay-Wide Average	42	63,000	186
Hatchery Seed planted at 1 million/acre	10,000	1,000,000	884
Hatchery Seed planted at 2 million/acre	10,000	2,000,000	1,767

Table 2. Annual variation in natural spatfall in Maryland from 2000 through 2012

	Upper Bay	Top 5 Regions	Top 10 Regions	Bay-wide Average
Predicted spatfall in spat/bu of shell	0.15	335	223	42
Percent of years where average is > 100 spat/bu (%)	0	62%	38%	0
Percent of years where average is > 250 spat/bu (%)	0	31%	31%	0
Percent of years where average is > 500 spat/bu (%)	0	0	0	0

Analysis Shows There are Regions of the Maryland Portion of the Chesapeake Bay that Will Not Benefit from Dredging Alone

In those areas, natural recruitment should not be considered as a reasonable solution to population enhancement. It is difficult to predict exact numbers of oysters produced under power dredging or natural recruitment due to bar-to-bar variation within regions of the Bay. The unpredictability of natural spatfall and resulting harvests will, in most regions and years, provide poor benefit-to-cost for the required expenditure of public funds. Our analysis further indicates that there are regions where producers should avoid dredging or other bottom preparation activities if the principal objective is to increase oyster biomass by applying cost-effective methods.

Our analysis does not incorporate some potential multi-year benefits that may accrue from oyster restoration activities. The numbers generated in this exercise assume that all shell or oysters will be harvested from a given site despite the inefficiency of harvest equipment and methods currently in use. For example, when estimating harvest numbers for an acre of oyster bottom, there will be oysters left after harvesting has reduced the density of oysters on the bottom below a profitable level. Additionally, the oysters and shell that remain in situ will potentially serve as cultch for future larval oysters to attach.

Given the poor record of regular natural recruitment in many regions of Chesapeake Bay, there are still extensive regions where that method alone is not likely to result in any significant increase in oysters.

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