UNIVERSITY OF MARYLAND EXTENSION

extension.umd.edu FS 1103 | November 2019

Nutrient Credit Trading Could Expand Maryland Oyster Aquaculture

Researchers from the University of Maryland Center for Environmental Science (UMCES) conducted a study to evaluate the potential effect of nutrient credit trading on the growth and profitability of Maryland's aquaculture industry. Nutrient credit trading is a market approach to lowering the cost of meeting the pollution caps that have been established to restore aquatic habitat in the Chesapeake Bay. Oyster aquaculture producers are eligible to sell credits in this emerging market, which creates the potential for economic and environmental benefits.

Oyster aquaculture in Maryland has grown steadily since the process for obtaining aquaculture leases was streamlined in 2010 (Figure 1). Maryland oyster production, however, remains well below Virginia's, suggesting that the industry has room to grow. A robust oyster aquaculture industry could supplement the Chesapeake Bay's wild harvest to create a reliable year-round oyster supply, help preserve coastal fishing communities and improve water quality, since oysters filter water while feeding.

Maryland has an emerging nutrient credit trading market that offers an economic incentive to expand aquaculture production because it could increase the expected market value of harvest. The trading market was enabled by recent regulation (COMAR 26.08.11 2018) that allows entities engaged in agriculture, aquaculture, stormwater control, and environmental restoration to sell credits that they voluntarily create and that are not being used for other legal requirements. Legally enforceable caps on nutrients and sediment delivery to the Chesapeake Bay were set using a Total Maximum Daily Load (or TMDL) that was established to achieve clean water goals and restore aquatic habitat. A trading market can reduce the cost of meeting the caps by allowing those who can reduce nutrients and sediment at low cost to sell credits to offset the high costs of regulated entities, such as counties and municipalities with permits that limit pollution emissions from stormwater runoff.

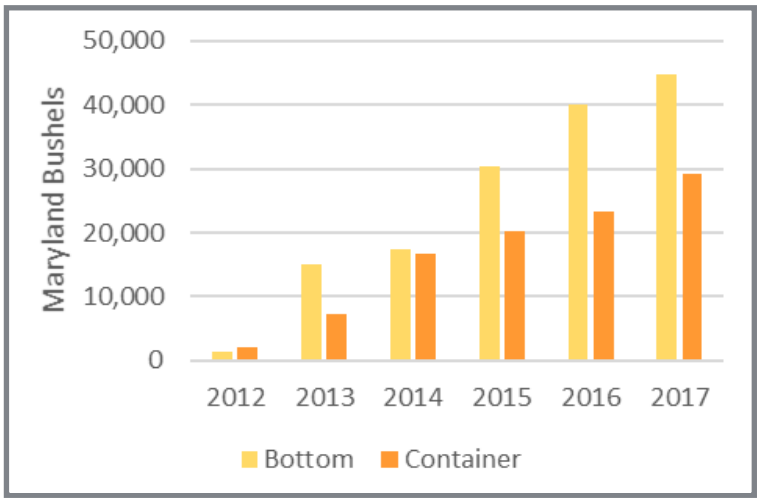

Figure 1. Maryland oyster aquaculture production increased steadily between 2012 and 2017. Bottom culture refers to oysters produced on leased bottom. Container culture is production that uses cages or bags to hold oysters. Containers can be placed on bottom or suspended in the water column. Source Data: Maryland Department of Natural Resources.

Economic Modeling Suggests More Rapid Aquaculture Industry Growth Possible with Sufficiently High Credit Prices and Trading Activity

Aquaculture producers are currently eligible to sell nitrogen (N) and phosphorus (P) credits based on the nutrients sequestered in oyster tissue. The nutrients in the shell are not available to be traded since it is hoped that shell will be returned to the Bay to grow future oysters, rather than removed from the system. The nutrient reduction varies by oyster size and other conditions. As an example, if an operation harvested 10,000 bushels of natural (diploid) oysters of typical market size, they would produce roughly 545 pounds of N (about 250 kg) that year using an N sequestration rate of 0.09 grams of

N per oyster (Cornwell et al. 2016) and assuming 275 oysters per bushel. Phosphorus is also eligible to be traded, but sediment credits have not yet been established.

New research by UMCES researchers into the potential economic effect of nutrient credit trading shows that if N credit prices are sufficiently high and all production is eligible for trading, oyster aquaculture could be influenced to grow more quickly than current trends. However, the amount of additional growth depends strongly on the combination of credit selling price and how much production is eligible for or receives credits. For example, a credit price of $190/lb N, and an assumption of all production being used for credits, generated an estimated 60% increase in production (by year 15 of a growth scenario), compared to baseline conditions without trading. However, a $10/lb N credit price had minimal effect on industry growth.

Researchers looked solely at the effect of nitrogen credits because of uncertainty at the time of model development about whether regulators would allow N and P credits to be "stacked" or sold separately. Policies have recently been established to allow for stacking and therefore, the potential effects of credit trading would be magnified because phosphorus (P) credits typically have a higher market price than N and the sum of N and P credit prices could be substantial.

Researchers Built a Model to Make Future Projections Using Available Data on Oyster Producer Costs, Annual Harvests and Prices

UMCES researchers developed scenarios of market conditions based on data from credit markets around the U.S. and from data on local costs of nutrient and sediment removal practices. Using models and scenarios, they projected oyster aquaculture production, profits and total N removal under alternative credit market conditions.

To represent baseline industry conditions without trading, researchers first predicted the total industry growth trend by fitting a relationship between aquaculture production from 2012 to 2017 and estimated economic profit per oyster or per bushel of oysters. They used economic profit as the driver of industry expansion since potential profit has been shown to encourage firm entry. However, overall industry growth depends on many factors (Siegfried and Evans 1994). The industry expansion that was modeled can be thought of either in terms of firms getting larger or additional firms entering the market since the model did not vary costs or profits by firm size, due to a lack of data to make such distinctions among firms.

Nutrient credit trading scenarios were modeled as an increase in price per oyster (or per bushel) and as industry growth in response to higher prices. Higher oyster production in the future could potentially lead to lower oyster prices if supply begins to overwhelm demand. However, historical annual average price per oyster (half-shell) or per bushel (shucked) have been relatively stable, regardless of changes in supply. Therefore, a fixed price for oysters was used for the analysis.

To evaluate if the amount of area appropriate for aquaculture leases might constrain industry growth over the 15-year model timeline, researchers evaluated suitable lease locations using Geographic Information System analysis. A prior model of potential aquaculture lease areas (Carlozo 2014) was refined by selecting lease areas that were more likely to be economically viable for production. Researchers removed areas that had muddy bottom types, were deeper than 3 meters for bottom culture or 8 meters for water column, and had low salinities, to reflect less desirable conditions for oyster growth and ease of operations. The analysis suggested that feasible leasable space remains abundant and would not constrain Maryland oyster aquaculture industry growth under any of the scenarios.

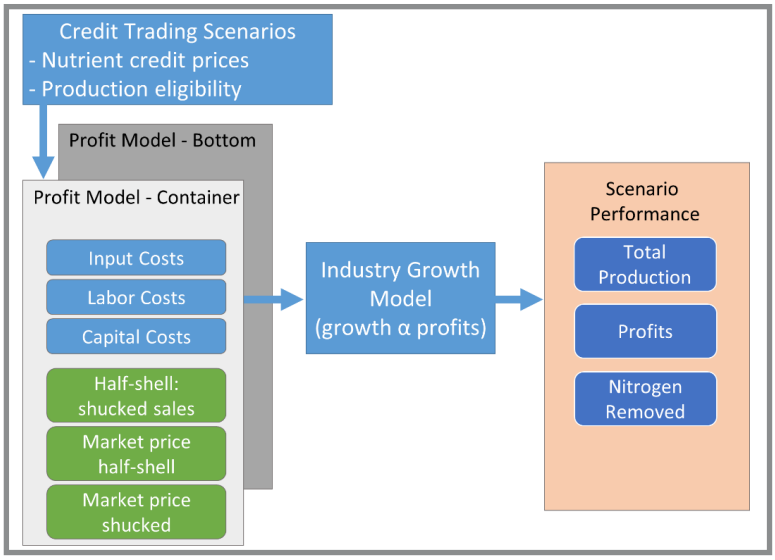

Figure 2: Economic model of nutrient credit trading includes two price and production eligibility scenarios

Regulation Creates Multiple Markets in Maryland with Diverse Supply, Demand and Price Conditions

Scenarios used to project future aquaculture industry growth reflected two illustrative credit prices, $10/lb and $190/lb N, that were chosen based on: 1) publicly disclosed prices paid in existing markets and 2) an estimate of buyer willingness to pay, assuming the buyer holds a stormwater (MS4) permit. A review of the limited data from water quality trading programs in other states generated a range of $3 - $20 per credit and a $10/lb N credit price was chosen as a mid-level value. An average

cost of $280/lb N/year was estimated from data on costs of installing and operating a range of stormwater management devices. This average value was adjusted to reflect willingness to pay by reducing the $280/lb N by 30% to $190/lb N, to cover *transaction costs* and a *risk premium*. The reduction reflects the assumption that buyers would want to see a substantial savings from trading, compared to their own costs of reducing nutrients, to cover the logistical costs and legal or other risks of buying credits. Sellers may desire similar price premiums before they will participate in markets.

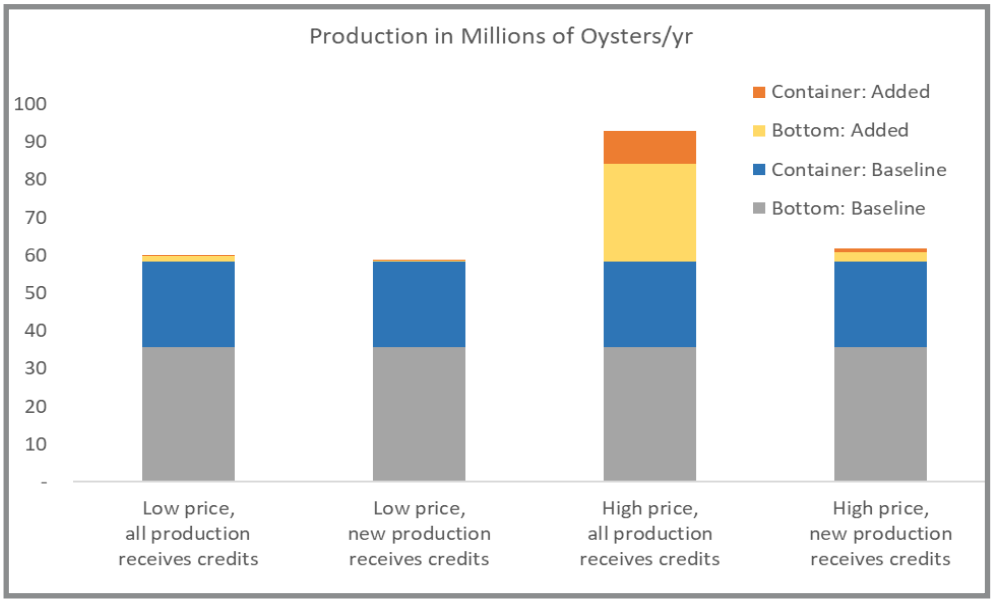

Figure 3: Oyster production by nutrient trading scenario at the end of the 15-year timeline

Nutrient and sediment credit selling prices are uncertain for several reasons. As in any market, price is set as an interplay of buyers' willingness to pay a given price and sellers' willingness to produce credits at a given price. Both the low and high credit prices used in the analysis could be representative of trading conditions for a given aquaculture operation in Maryland because the current trading rules (which are currently under review) create many geographically distinct markets with different supply and demand conditions.

Maryland has designated three large trading zones (Potomac, Patuxent, and Eastern and Western Shores of the bay), that have the potential to generate markets with multiple purchasers and sellers. However, the trading regulations also state that if a water body (such as a stream reach) is impaired, trading must take place within the local watershed. That waterbody impairment could be established by the Chesapeake Bay TMDL or local TMDLs that address other concerns. Since many water bodies are impaired, trading areas are relatively small (see map at go.umd.edu/TMDLWatersheds), which will lead to substantial price variations across markets. Low credit prices are likely to occur where wastewater treatment plants offer sufficient low-cost credits to meet demand. High credit prices may occur in watersheds where all sellers have high costs of producing credits.

The economic scenarios modeled also reflected two different rules about how much oyster production was eligible to produce credits, to reflect alternative state policies or low credit market participation. One trading rule was that all oyster production was eligible for credits and a second rule was that only new production, relative to the prior year, was eligible. Maryland's current regulations allow aquaculture producers to register credits for all their annual production. However, some states have considered rules that would only allow producers to register growth in production for credits, as a way to encourage greater nutrient removal. Results for the second rule are also generally representative of the effect on industry growth, if only a subset of producers participate in credit trading.

Results Show Impact of Nutrient Credit Trading Depends on Credit Price and Amount of Production Traded

- Under a relatively high credit price of $190/lb N credit with all production eligible for credits, total annual industry profits increased by almost 190% and annual production was almost 60% higher by year 15, compared to baseline conditions (Figure 3).
- A low credit price of $10/lb N credit had minimal effect on production, regardless of whether just new or all production was eligible for credits.
- Nitrogen removal was proportional to production and peaked at almost 7,000 lbs N/yr by year 15 in the peak production scenario.

Baseline production, without trading, is shown with grey and blue bars and the new production encouraged by nutrient trading incentives is shown with orange and yellow bars.

The estimates of nutrient trading on industry growth depend on multiple assumptions that could change as the market develops. The full report examines growth under a broader suite of factors that could complicate market development. Further, the assumption that price remains the same may not hold if the market grows quickly. Therefore, results should be viewed only as possible futures.

Since Policies Are Still Under Review, MDE Website Provides Most Up to Date Information on Nutrient Trading

Aquaculture producers who are interested in generating nutrient credits can review trading guidelines on the Maryland Department of the Environment (MDE) trading website mde.maryland.gov/programs/Water/WQT. The information presented here was accurate as of publication date but will not be updated as information changes.

Aquaculture producers can see the watershed in which they are eligible to trade at this website: go.umd.edu/TMDLWatersheds. Any regulated emitter of nutrients and sediments that discharges in that watershed (including any county that has area in the watershed) is a potential trading partner, if they have not already met their permit requirements. The presence of a major wastewater treatment plant within the watershed is likely to suppress the price of nutrient credits since these entities have been observed to register low cost credits.

Several adjustments to the credit purchase may be required, based on the locations of the buyer and seller. A simple minor adjustment is that 5% of all nutrient and sediment reductions are applied to a reserve fund at the time that credits are registered and are not part of the sale. A major adjustment made to credits is that the permittee's emissions and the credit seller's reductions are converted to the amount of nutrients and sediments delivered to tidal waters. Aquaculture producers who are in tidal waters will receive full credit for reductions. However, emitters will only be required to buy the amount of nutrients delivered to tidal waters, not the total emitted, after accounting for land use conditions and water flow paths. Reductions must be verified by MDE or an approved third-party verification firm and then certified by the Maryland Department of the Environment (MDE) before being registered as credits in an online database and made available for purchase.

Acknowledgements

The authors would like to thank Matt Parker, Taylor Hollady, Greg Busch, Ward Slacum, Karen Hudson, Carole Engle, Chris Hayes, Elizabeth Price, Nicole Carlozo, Don Webster, Tom Miller, Marcia Berman, Olivia Devereux, and anonymous reviewers. The authors, alone, are responsible for content.

References

Carlozo, N., 2014. *Integrating Water Quality and Coastal Resources into Marine Spatial Planning in the Chesapeake and Atlantic Coastal Bays*. Maryland Department of Natural Resources: Chesapeake and Coastal Service.

Code of Maryland Regulations (COMAR) 26.08.11, 2018. *Maryland Water Quality Trading Program*. Available from Maryland Department of the Environment.

Cornwell, J., Rose, J., Kellogg, L., Luckenbach, M., Bricker, S., Paynter, K., Moore, C., Parker, M., Sanford, L., Wolinski, B., Lacatell, A., Fegley, L., Hudson, K., 2016. *Oyster BMP Expert Panel First Incremental Report: Panel Recommendations on the Oyster BMP Nutrient and Suspended Sediment Reduction Effectiveness Determination Decision Framework and Nitrogen and Phosphorus Assimilation in Oyster Tissue Reduction Effectiveness for Oyster Aquaculture Practices*. U.S. EPA Chesapeake Bay Program.

Siegfried, J.J., Evans, L.B., 1994. Empirical studies of entry and exit: A survey of the evidence. *Review of Industrial Organization* 9:121–155.

Further Information

Weber, M.A., Wainger, L.A., Parker, M., Hollady, T., 2018. *The potential for nutrient credit trading or economic incentives to expand Maryland oyster aquaculture*. Report to Maryland Sea Grant, Award#NA14OAR4170090. CBL Technical Report TS-718-18, UMCES, Solomons, MD.

LISA WAINGER
Corresponding Author
wainger@umces.edu

MATTHEW WEBER
mweber@umces.edu

This publication, *Nutrient Credit Trading Could Expand Maryland Oyster Aquaculture* (FS 1103), is a collaboration between the University of Maryland Extension, the University of Maryland Center for Environmental Science, and the Chesapeake Biological Laboratory

The information presented has met UME peer review standards, including internal and external technical review.

For help accessing this or any UME publication contact: itaccessibility@umd.edu

For more information on this and other topics, visit the University of Maryland Extension website at extension.umd.edu