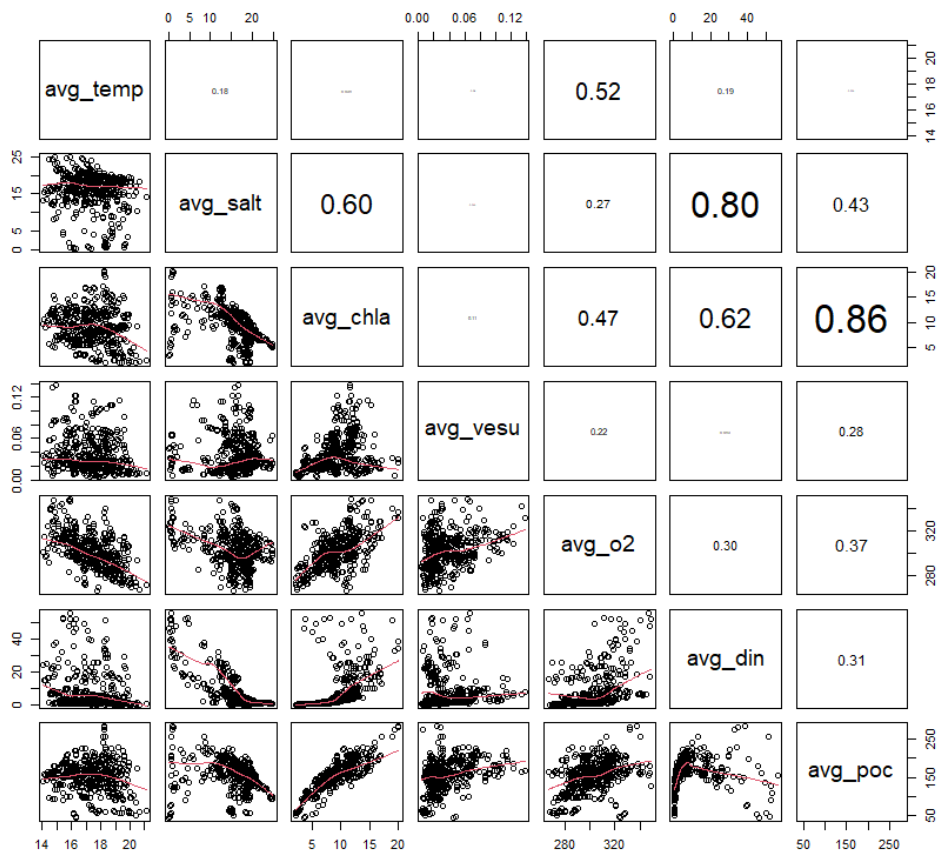


Environmentally-determined production frontiers and lease utilization in Virginia's eastern oyster aquaculture industry

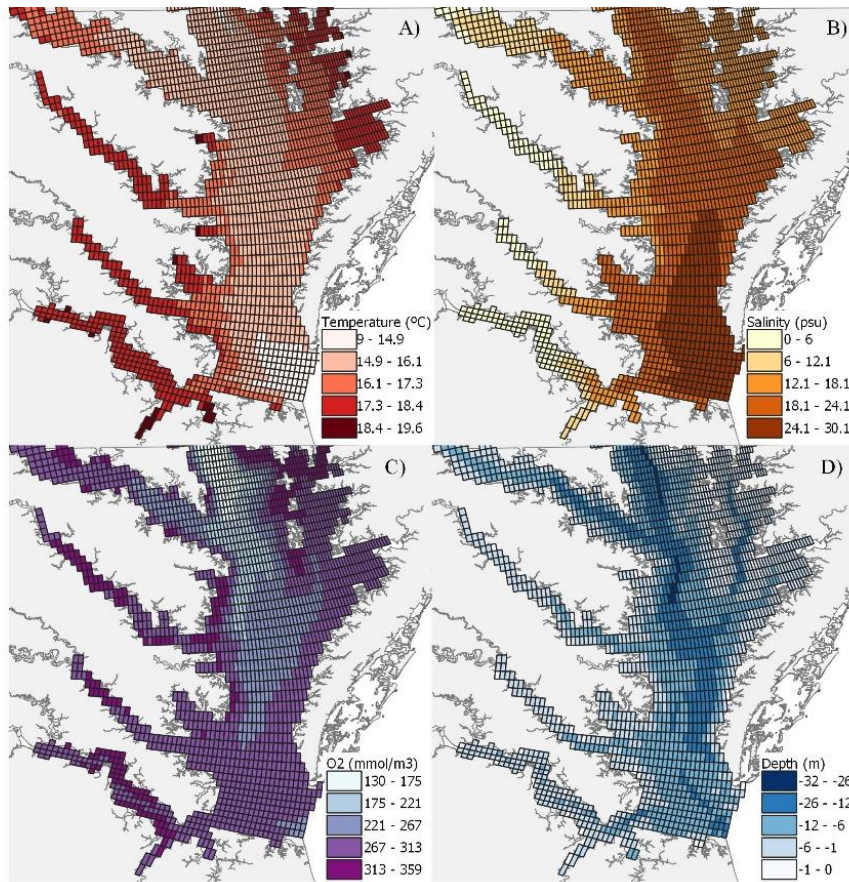
- Supplementary Material -

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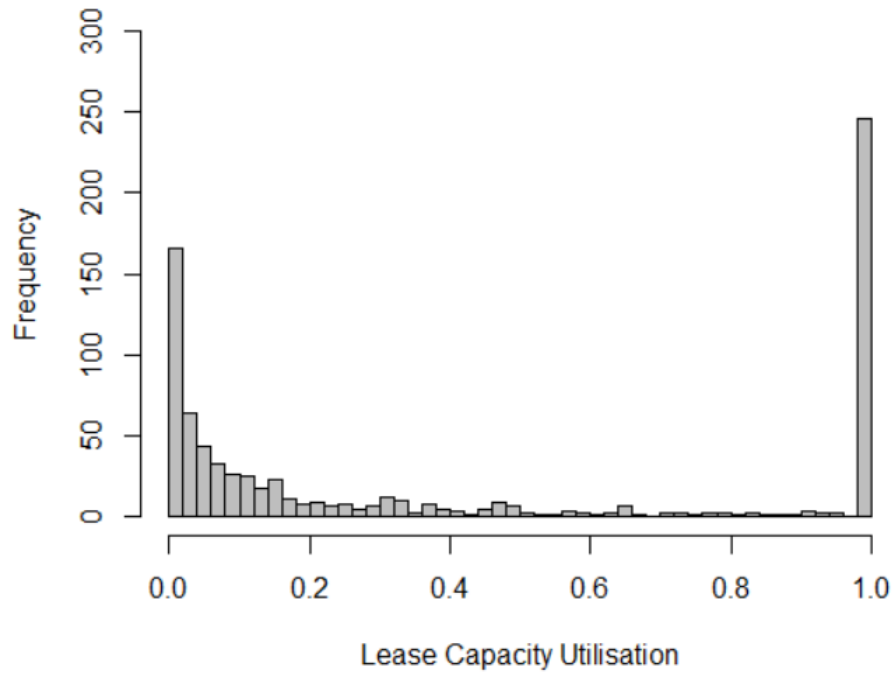
<https://doi.org/10.1016/j.aquaculture.2021.736883>



Supplementary Figure S1. ChesROMS environmental variables correlations.



**Supplementary Figure S2.** Average spring means of ChesROMS model output for bottom temperature (A), salinity (B), and O<sub>2</sub> (C) over the period 2003-2014, and average depth (D) for each corresponding grid cell.



**Supplementary Figure S3.** Frequency distributions of non-bias corrected lease use efficiency from the DEA model.

**Supplementary Table S1.** Translog SFA Error Components Frontier results (ignoring Z variables). Significance is denoted by:  $p < 0.001 = '***'$ ,  $p < 0.01 = '**'$ ,  $p < 0.05 = '*'$ ,  $p < 0.1 = '.'$ .

Variables	Estimate	Std. Error	P-value	Signif.
<i>Production frontier</i>				
Intercept	1374.422	1.457	<2.2e-16	***
Ln lease size	0.353	0.092	1.18E-04	***
Ln temperature	224.375	44.195	3.84E-07	***
(Ln temperature) <sup>2</sup>	-29.807	9.982	0.003	**
Ln temperature * Ln salinity	6.765	3.651	0.064	.
Ln temperature * Ln O <sub>2</sub>	-50.946	7.231	1.84E-12	***
Ln temperature * Ln POC	21.506	2.648	<2.2e-16	***
Ln temperature * Ln depth	12.630	3.612	4.72E-04	***
Ln salinity	-112.821	41.760	0.007	**
(Ln salinity) <sup>2</sup>	0.310	0.390	0.426	
Ln salinity * Ln O <sub>2</sub>	15.232	5.977	0.011	*
Ln salinity * Ln POC	0.596	0.624	0.339	
Ln salinity * Ln depth	1.389	0.749	0.064	.
Ln O <sub>2</sub>	-180.510	19.444	<2.2e-16	***
(Ln O <sub>2</sub> ) <sup>2</sup>	-5.429	6.717	0.419	
Ln O <sub>2</sub> * Ln POC	47.628	3.227	<2.2e-16	***
Ln O <sub>2</sub> * Ln depth	43.559	3.365	<2.2e-16	***
Ln POC	-310.553	18.826	<2.2e-16	***
(Ln POC) <sup>2</sup>	-3.639	1.550	0.019	*
Ln POC * Ln depth	-3.606	2.151	0.094	.
Ln depth	-269.922	15.416	<2.2e-16	***
(Ln depth) <sup>2</sup>	0.242	1.780	0.892	
<i>Variance parameters</i>				
$\sigma^2 (= \sigma_u^2 + \sigma_v^2)$	3.113	0.494	3.01E-10	***
$\gamma (= \sigma_u^2 / \sigma^2)$	0.607	0.065	<2.2e-16	***
Time	0.011	0.011	0.325	
Log-likelihood	-1463.536			
Mean efficiency	0.137			

**Supplementary Table S2.** SFA production frontier and inefficiency model according to a Cobb-Douglas production function. Significance is denoted by:  $p < 0.001 = \text{'***'}$ ,  $p < 0.01 = \text{'**'}$ ,  $p < 0.05 = \text{'*'}$ ,  $p < 0.1 = \text{'.'}$ . Lower values of the depth indicator correspond to deeper areas.

Variables	Estimate	Std. Error	P-value	Signif.	Marg. Effect
<i>Production frontier</i>					
Intercept	-27.584	10.978	0.012	*	
Ln lease size	0.415	0.052	2.03E-15	***	
Ln temperature	-0.089	0.878	0.919		
Ln salinity	0.653	0.114	9.85E-09	***	
Ln O <sub>2</sub>	5.801	1.673	0.001	***	
Ln POC	-0.397	0.240	0.098	.	
Ln depth indicator	-0.513	0.491	0.296		
<i>Inefficiency model</i>					
Intercept	-11.780	5.271	0.025	*	
Ln number of leases	-0.730	0.131	2.44E-08	***	1.461
Lease age	-0.197	0.106	0.064	.	0.395
Alternative gear	0.259	0.238	0.278		-0.518
Both aquaculture	0.001	0.319	0.998		-0.002
Ln distance to leaseholder ZIP code	0.236	0.092	0.010	*	-0.472
Adjacent to Baylor	-0.907	0.253	3.46E-04	***	1.815
Fraction leased area by others	0.744	0.848	0.380		-1.490
Fraction deep area	1.754	0.426	0.000	***	-3.512
SAV present	0.315	0.213	0.141		-0.630
Ln population density	0.210	0.102	0.040	*	-0.420
Ln average income	1.017	0.472	0.031	*	-2.036
<i>Variance parameters</i>					
$\sigma^2 (= \sigma_u^2 + \sigma_v^2)$	3.707	0.445	< 2.2e-16	***	
$\gamma (= \sigma_u^2 / \sigma^2)$	0.808	0.048	< 2.2e-16	***	
Log-likelihood	-1,534.643				
Mean efficiency	0.228				