

## Article

# Error Distribution Model to Standardize LPUE, CPUE and Survey-Derived Catch Rates of Target and Non-Target Species

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**Table S1.** Deviance analysis table of explanatory variables for GLM formulations for thornback ray *Raja clavate* (RJC), blackbelly rosefish *Helicolenus dactylopterus* (BRF), and common mora *Mora moro* (RIB) catch rates (LPUE; kg landing<sup>-1</sup> vessel<sup>-1</sup>) from the Azorean commercial fishery. Significant ( $P < 0.05$ ) factors and interaction that accounted for 5% or more of the variability are in bold.

	RJC					BRF					RIB				
	d.f.	Res Dev	Δ Dev.	% Dev.	p-value	d.f.	Res Dev	Δ Dev.	% Dev.	p-value	d.f.	Res Dev	Δ Dev.	% Dev.	p-value
<b>Gamma (LPUE + c)</b>															
Null		12056.2					17216.2					17843.0			
Year	32	10074.1	1982.2	<b>19.6</b>	< 0.001	32	18795.3	0.0	0.0	1.000	32	21249.4	0.0	0.0	< 0.001
Year Quarter	3	10045.9	28.2	0.3	< 0.001	3	18896.1	0.0	0.0	1.000	3	9577.5	11671.9	<b>59.2</b>	< 0.001
Year Quarter Vessel	4	6132.7	3913.2	<b>38.7</b>	< 0.001	4	3859.9	15036.2	<b>86.5</b>	< 0.001	4	6460.0	3117.5	<b>15.8</b>	< 0.001
Year Quarter Vessel Métier	10	3912.2	2220.5	<b>21.9</b>	< 0.001	10	3364.0	496.0	2.9	< 0.001	10	5156.6	1303.4	<b>6.6</b>	< 0.001
Year Quarter Vessel Métier Target	1	3792.6	119.6	1.2	< 0.001	3	2808.9	555.0	3.2	< 0.001	3	4819.4	337.2	1.7	< 0.001
Year Quarter Vessel Métier Target Year × Quarter	96	3164.4	628.2	<b>6.2</b>	< 0.001	96	2632	176.9	1.0	< 0.001	96	3995.0	824.4	4.2	< 0.001

	RJC					BRF					RIB				
	d.f.	Res Dev	Δ Dev.	% Dev.	p-value	d.f.	Res Dev	Δ Dev.	% Dev.	p-value	d.f.	Res Dev	Δ Dev.	% Dev.	p-value
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel	127	2521.6	642.8	<b>6.4</b>	< 0.001	127	1932.4	699.6	4.0	< 0.001	127	2336.0	1659.0	<b>8.4</b>	< 0.001
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier	294	1935.8	585.8	<b>5.8</b>	< 0.001	294	1558.9	373.5	2.1	< 0.001	294	1540.4	795.6	4.0	< 0.001
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier Year × Target	0	1935.8	0.0	0.0		28	1513.7	45.2	0.3	< 0.001	0	1540.4	0.0	0.0	
<b>Gamma (LPUE + 1)</b>															
Null		7.0					1563.0					49.9			
Year	32	6.9	0.1	2.9	< 0.001	32	1040.0	523	<b>37.8</b>	< 0.001	32	46.9	2.9	<b>8.1</b>	< 0.001
Year Quarter	3	6.9	0.0	0.1	0.495	3	1039.8	0.2	0	0.606	3	46.8	0.2	0.5	< 0.001
Year Quarter Vessel	4	6.6	0.3	<b>6.8</b>	< 0.001	4	671.1	368.7	<b>26.6</b>	< 0.001	4	43.9	2.9	<b>8.0</b>	< 0.001
Year Quarter Vessel Métier	10	6.3	0.3	<b>6.5</b>	< 0.001	10	618.8	52.3	3.8	< 0.001	10	42.5	1.4	3.9	< 0.001
Year Quarter Vessel Métier Target	1	5.9	0.4	<b>9.2</b>	< 0.001	3	413.5	205.3	<b>14.8</b>	< 0.001	3	24.0	18.5	<b>51.4</b>	< 0.001
Year Quarter Vessel Métier Target Year × Quarter	96	5.7	0.2	<b>5.2</b>	< 0.001	96	379.9	33.6	2.4	< 0.001	96	22.8	1.2	3.5	< 0.001
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel	127	3.1	2.6	<b>63.7</b>	< 0.001	127	231.2	148.7	<b>10.7</b>	< 0.001	127	15.6	7.2	<b>20.0</b>	< 0.001
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier	294	2.8	0.2	<b>5.6</b>	0.997	294	193.2	38.0	2.7	< 0.001	294	13.9	1.6	4.6	0.600
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier Year × Target	0	2.8	0.0	0.0		28	178.4	14.8	1.1	< 0.001	0	13.9	0.0	0.0	
<b>Lognormal (LPUE + c)</b>															
Null		4167.6					4330.4					2834.6			
Year	32	4109.4	58.2	2.2	< 0.001	32	4127.2	203.2	<b>6.9</b>	< 0.001	32	2708.4	126.1	<b>8.0</b>	< 0.001
Year Quarter	3	4086.9	22.5	0.9	< 0.001	3	4125.6	1.6	0.1	0.276	3	2704.2	4.3	0.3	0.009
Year Quarter Vessel	4	3779.5	307.4	<b>11.7</b>	< 0.001	4	3165.2	960.4	<b>32.7</b>	< 0.001	4	2518.3	185.9	<b>11.9</b>	< 0.001
Year Quarter Vessel Métier	10	2053.8	1725.7	<b>65.5</b>	< 0.001	10	2382.2	783.0	<b>26.7</b>	< 0.001	10	2131.2	387.1	<b>24.7</b>	< 0.001
Year Quarter Vessel Métier Target	1	2021.5	32.3	1.2	< 0.001	3	1858.2	523.9	<b>17.8</b>	< 0.001	3	1985.8	145.4	<b>9.3</b>	< 0.001
Year Quarter Vessel Métier Target Year × Quarter	96	1990.0	31.5	1.2	0.974	96	1833.0	25.2	0.9	0.997	96	1965.0	20.8	1.3	1.000



	RJC					BRF					RIB				
	d.f.	Res Dev	Δ Dev.	% Dev.	p-value	d.f.	Res Dev	Δ Dev.	% Dev.	p-value	d.f.	Res Dev	Δ Dev.	% Dev.	p-value
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel	127	1766.3	223.7	<b>8.5</b>	< 0.001	127	1638.3	194.7	<b>6.6</b>	< 0.001	127	1641.7	323.3	<b>20.6</b>	< 0.001
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier	294	1534.3	232.1	<b>8.8</b>	< 0.001	294	1431.1	207.2	<b>7.1</b>	< 0.001	294	1266.2	375.5	<b>23.9</b>	< 0.001
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier Year × Target	0	1534.3	0.0	0.0		28	1395.0	36.0	1.2	< 0.001	0	1266.2	0.0	0.0	
<b>Lognormal (LPUE + 1)</b>															
Null		5.4					408.7					28.5			
Year	32	5.3	0.1	2.1	< 0.001	32	394.8	13.9	<b>5.2</b>	< 0.001	32	27.9	0.6	3.4	< 0.001
Year Quarter	3	5.3	0.0	0.0	0.959	3	394.6	0.2	0.1	0.149	3	27.8	0.1	0.3	0.002
Year Quarter Vessel	4	5.1	0.2	<b>6.8</b>	< 0.001	4	325.3	69.3	<b>25.9</b>	< 0.001	4	27.0	0.8	<b>5.0</b>	< 0.001
Year Quarter Vessel Métier	10	4.9	0.2	<b>7.3</b>	< 0.001	10	299.9	25.4	<b>9.5</b>	< 0.001	10	26.4	0.6	3.5	< 0.001
Year Quarter Vessel Métier Target	1	4.6	0.3	<b>11.3</b>	< 0.001	3	205.5	94.4	<b>35.3</b>	< 0.001	3	16.5	9.9	<b>59.7</b>	< 0.001
Year Quarter Vessel Métier Target Year × Quarter	96	4.5	0.1	3.3	0.021	96	203.0	2.5	0.9	0.998	96	16.2	0.3	2.0	0.419
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel	127	2.7	1.8	<b>63.6</b>	< 0.001	127	171.3	31.7	<b>11.8</b>	< 0.001	127	12.8	3.3	<b>20.0</b>	< 0.001
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier	294	2.6	0.2	<b>5.7</b>	< 0.001	294	152.0	19.3	<b>7.2</b>	< 0.001	294	11.8	1.0	6.2	0.348
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier Year × Target	0	2.6	0.0	0.0		28	141.0	11.0	4.1	< 0.001	0	11.8	0.0	0.0	
<b>Tweedie</b>															
Null		683.3					23724.1					1366.8			
Year	32	594.2	89.2	<b>14.8</b>	< 0.001	32	18026.9	5697.2	<b>27.6</b>	< 0.001	32	858.4	508.4	<b>38.8</b>	< 0.001
Year Quarter	3	593.5	0.7	0.1	< 0.001	3	17989.6	37.3	0.2	< 0.001	3	810.7	47.7	3.6	< 0.001
Year Quarter Vessel	4	398.2	195.3	<b>32.5</b>	< 0.001	4	8929.3	9060.3	<b>43.8</b>	< 0.001	4	419.6	391.1	<b>29.8</b>	< 0.001
Year Quarter Vessel Métier	10	244.5	153.7	<b>25.6</b>	< 0.001	10	6304.2	2625.1	<b>12.7</b>	< 0.001	10	198.3	221.3	<b>16.9</b>	< 0.001
Year Quarter Vessel Métier Target	1	235.3	9.2	1.5	< 0.001	3	5968.6	335.6	1.6	< 0.001	3	187.1	11.2	0.9	< 0.001
Year Quarter Vessel Métier Target Year × Quarter	96	186.0	49.2	<b>8.2</b>	< 0.001	96	5469.4	499.2	2.4	< 0.001	96	155.6	31.5	2.4	< 0.001

	RJC					BRF					RIB				
	d.f.	Res Dev	Δ Dev.	% Dev.	p-value	d.f.	Res Dev	Δ Dev.	% Dev.	p-value	d.f.	Res Dev	Δ Dev.	% Dev.	p-value
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel	127	135.6	50.5	<b>8.4</b>	< 0.001	127	4788.7	680.8	3.3	< 0.001	127	95.5	60.1	<b>4.6</b>	< 0.001
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier	294	82.4	53.2	<b>8.9</b>	< 0.001	293	3115.9	1672.8	<b>8.1</b>	< 0.001	294	54.9	40.6	3.1	< 0.001
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier Year × Target	0	82.4	0.0	0.0		28	3058.1	57.8	0.3	< 0.001	0	54.9	0.0	0.0	
<b>Binomial (proportion of positive catches)</b>															
Null		5222.4					5447.5					3191.8			
Year	32	5193.8	28.6	0.8	0.639	32	5385.7	61.8	1.7	0.001	32	2729.5	462.3	<b>17.2</b>	< 0.001
Year Quarter	3	5170.8	23.1	0.7	< 0.001	3	5383.2	2.5	0.1	0.471	3	2729.4	0.2	0.0	0.984
Year Quarter Vessel	4	5120.7	50.0	1.4	< 0.001	4	5355.8	27.4	0.7	< 0.001	4	2716.9	12.4	0.5	0.014
Year Quarter Vessel Métier	10	2100.5	3020.3	<b>86.0</b>	< 0.001	10	2650.2	2705.6	<b>73.7</b>	< 0.001	10	1051.7	1665.2	<b>61.9</b>	< 0.001
Year Quarter Vessel Métier Target	1	2097.7	2.7	0.1	0.100	3	2643.0	7.2	0.2	0.065	3	1051.2	0.5	0.0	0.917
Year Quarter Vessel Métier Target Year × Quarter	96	2012.6	85.1	2.4	0.778	96	2573.8	69.2	1.9	0.982	96	980.3	70.9	2.6	0.974
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel	127	1711.4	301.2	<b>8.6</b>	< 0.001	127	2315.2	258.6	<b>7.0</b>	< 0.001	127	812.1	168.2	<b>6.2</b>	0.008
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier	294	26023.5	0.0	0.0	1.000	294	1775.5	539.7	<b>14.7</b>	< 0.001	294	500.4	311.8	<b>11.6</b>	0.228
Year Quarter Vessel Métier Target Year × Quarter Year × Vessel Year × Métier Year × Target	0	26023.5	0.0	0.0		28	1775.5	0.0	0.0	1.000	0	500.4	0.0	0.0	
<b>Gamma (positive catches)</b>															
Null		7314.1					22245.6					4741.9			
Year	32	6320.4	993.7	<b>15.8</b>	< 0.001	32	19658.8	2586.9	<b>12.4</b>	< 0.001	22	4348.0	393.9	<b>12.9</b>	< 0.001
Year Quarter	3	6300.0	20.4	0.3	< 0.001	3	19621.7	37.1	0.2	< 0.001	3	4322.9	25.1	0.8	< 0.001
Year Quarter Vessel	4	3151.7	3148.3	<b>49.9</b>	< 0.001	4	5891.3	13730.3	<b>66.0</b>	< 0.001	4	2897.4	1425.4	<b>46.5</b>	< 0.001
Year Quarter Vessel Métier	9	2246.0	905.7	<b>14.4</b>	< 0.001	10	2761.5	3129.8	<b>15.0</b>	< 0.001	7	2305.1	592.3	<b>19.3</b>	< 0.001
Year Quarter Vessel Métier Target	1	2220.3	25.7	0.4	< 0.001	3	2626.4	135.1	0.6	< 0.001	3	2300.9	4.2	0.1	0.240
Year Quarter Vessel Métier Target Year × Quarter	96	1914.5	305.8	<b>4.9</b>	< 0.001	96	2471.7	154.7	0.7	0.032	63	2206.6	94.4	3.1	0.006

c: 10% of the mean catch rate; d.f.: degrees of freedom; Res. Dev.: residual deviance;  $\Delta$  Dev.: change in deviance; % Dev.: percent of deviance explained;  $p$ -value: based on chi-squared ( $\chi^2$ ) distribution and used to determine the explanatory variables that contributed significantly ( $p < 0.05$ ) to the deviance explained.