Anglerfish Discarding Behavior in Spanish North Atlantic Coast Fisheries

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Abstract

Discard behavior in Spanish north Atlantic (ICES VIIIc, IXa) coastal fisheries concerning anglerfish species (Black anglerfish, L. budegassa and White anglerfish, Lophius piscatorius) is revisited herein. Results indicate that Angler discards basically depends on their length size. Year effect significantly conditioned discard behavior after 2000. Species differences in discard patterns were found also significant, being the less valuable white angler discarded at larger lengths than the black species. Diferent onboard sorting behavior indicates that fishers recognize angler species even at low length sizes, conditioning the degree of adoption of the assessment tools with regards to their relative market value.

Keywords: Anglerfish, Discards, Onboard sorting, MLW

1. Introduction

Bottom trawl fishing involves in many cases the capture of high numbers of fish species and sizes. Once hauled on board, catch are split by the crew into retained/discarded fractions. The sorting criteria is usually conditioned by a complex combination of factors such as legal rules, landing prizes, hold capacity, fishing strategy or targets, affecting discards alone or interacting ones each others (Rochet and Trenkel, 2005).White anglerfish *Lophius piscatorius* and black anglerfish *L. budegassa*, are high valuable species for fishers operating in the north-Atlantic Iberian waters. Their stocks are managed using tools such as yearly TACs, which set maximum allowable landings in Spanish ports, and Minimum Landing Weight (MLW=$500gr$ [CR $2406/96$]) defining intra-species sorting behavior. This poster updates a previous work on the subject (Díaz *et al*, 2008) aiming to obtain a better understanding on how these and other factors interacts during the anglerfishes onboard sorting process.

2. Material and Methods

Data source

- Data obtained by the 'Spanish Discards Sampling Programme' , covering mainly Trawl métiers operating in ICES $VIII_c$ and North IX_a .
- Hierarchial sampling design using fishing trip as Primary Sampling Unit.
- Anglerfish species sampled from both retained/discarded fractions. The onboard observers identify the species (Figure 1), recording total Length (cm) from every sampled individual.



Figure 1: *Similar external appearance makes difficult the species recognition. A close observation of the peritoneum is needed for juvenile individuals identification.*

Model settings

- Given a sampled individual, the response variable Y represents its final destination after the catch sorting (retained [$Y = 1$] or discarded [$Y = 0$]).
- The main goal is to known the influence of a set of fixed covariates on the retention probability ($p(Y = 1|X_1, \ldots, X_p)$).
- Sources of variation affecting $p(Y = 1|X_1 \ldots X_p)$ included as random effects in order to avoid pseudo-replication:

$$p(\mathbf{X}) = \frac{exp(\beta_0 + \sum_{i=1}^{p} \beta_i X_i + \sum_{j=1}^{q} b_j X_j)}{1 + exp(\beta_0 + \sum_{i=1}^{p} \beta_i X_i + \sum_{j=1}^{q} b_j X_j)} \quad (1)$$

Estimation method

- model type: Generalized Linear Mixed Model
- Estimation method: Laplace aproximation
- Package: lme4
- Function: glmer()
- Link: Logit
- offset: $\gamma = \frac{\log rf.r}{\log rf.d}$
- Contrast: 'Treatment' (Reference levels: Year=1994, Species= *L. budegassa*)

3. Results

- Length-based sampling statistics can be found in Table 1 and Figure 2 left. These results indicate that length size is the main factor conditioning the onboard sorting patterns.
- Sorting decision is taken at narrow length range (Figure 2 right).
- Except in 1994, lower retention rates are observed in the western area ($ICES-VIII_c$) for both species. More reddish points can be seen for white anglerfish since year 2000 (Figure 3).
- A total of 12 different models were fitted by using a set of covariates recorded at haul level. Likelihood Ratio test (Table 2) identified the model **mm11** as the best fitted:

$$logit(p(\mathbf{X})) = \beta_0 + \beta_k \cdot year_k + \beta_s \cdot specie_s + \beta_i \cdot l + \beta_j \cdot A + \gamma + b_{it} \cdot l * trip_t$$

EDA

		Retained				Discarded			
Species	Year	l_{min}	l_{mean}	l_{max}	σ_l	l_{min}	l_{mean}	l_{max}	σ_l
Lophius budegassa	1994	18.00	40.30	91.00	10.90	5.00	14.00	28.00	4.90
	1997	12.00	38.20	98.00	12.40	6.00	15.10	24.00	5.40
	1999	23.00	44.50	79.00	9.10	10.00	15.70	23.00	3.10
	2000	18.00	45.70	87.00	11.10	11.00	18.00	31.00	4.90
	2003	15.00	43.30	103.00	10.00	8.00	13.00	16.00	1.90
	2004	24.00	45.50	85.00	10.40	13.00	18.90	23.00	3.80
	2005	18.00	44.80	98.00	12.90	12.00	16.50	36.00	4.00
	2006	19.00	37.30	98.00	12.70	16.00	23.50	30.00	3.80
	2007	16.00	40.70	83.00	7.80	15.00	19.50	27.00	4.10
	2008	27.00	46.10	88.00	8.80	15.00	23.60	31.00	5.30
	2009	20.00	50.00	89.00	12.70	9.00	16.20	40.00	4.60
	2010	18.00	40.30	120.00	15.00	6.00	17.40	31.00	5.90
Lophius piscatorius	1994	16.00	56.20	135.00	24.00	5.00	17.90	30.00	3.00
	1997	22.00	63.40	131.00	17.90	8.00	18.10	27.00	5.20
	1999	32.00	71.30	127.00	16.10	10.00	11.00	12.00	1.00
	2000	24.00	69.60	136.00	23.30	6.00	16.20	24.00	4.90
	2003	16.00	48.10	125.00	16.90	13.00	23.30	31.00	4.50
	2004	22.00	54.60	129.00	15.00	10.00	18.00	43.00	3.70
	2005	20.00	52.10	128.00	18.30	11.00	20.30	33.00	4.90
	2006	20.00	54.20	115.00	17.00	12.00	21.70	29.00	3.10
	2007	18.00	51.50	130.00	19.40	12.00	19.50	29.00	3.40
	2008	21.00	55.00	117.00	17.40	11.00	19.70	35.00	8.50
	2009	22.00	59.00	122.00	18.40	10.00	19.50	42.00	5.10
	2010	16.00	46.90	120.00	19.80	10.00	16.90	28.00	4.00

Table 1: *Summary statistics for sampled anglerfish species in both catch fractions along the sampling series.*

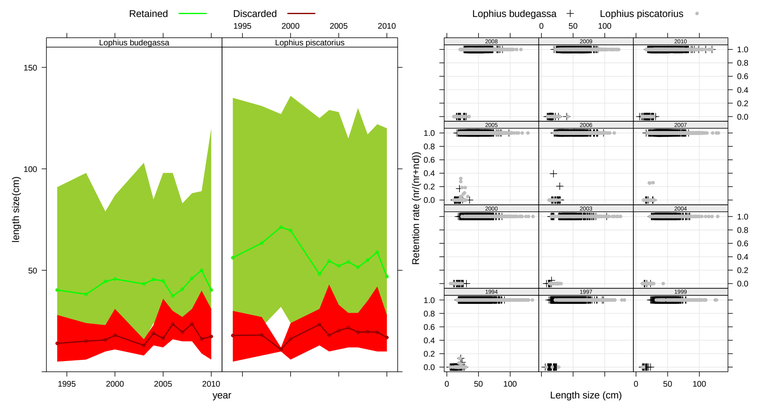


Figure 2: *left:Mean and range length for discarded (red) and retained (green) anglerfish catch fractions, right:Observed retention rate by length class and species.*

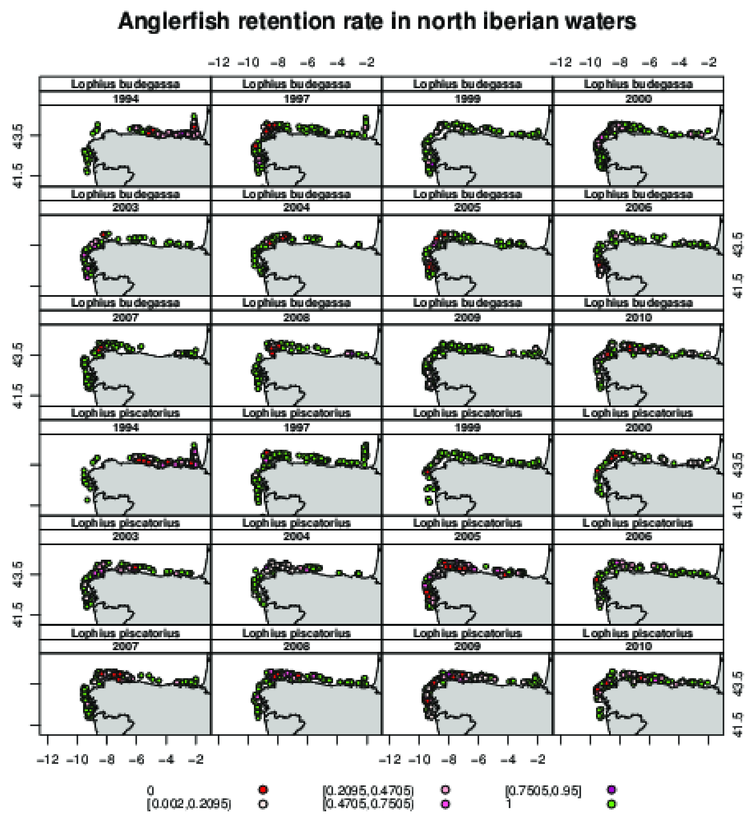


Figure 3: *Spatio-temporal trends in retention rate for anglerfish species.*

Model selection

	Df	AIC	BIC	logLik	Chisq	Chi Df	Pr(>Chisq)
mm1	5	847.38	887.21	-418.69			
mm2	6	817.87	865.67	-402.94	31.51	1	>0.001
mm3	7	1088.05	1143.81	-537.02	0.00	1	1.000
mm4	8	1087.20	1150.92	-535.60	2.85	1	0.091
mm5	8	807.43	871.15	-395.71	279.77	0	> 0.001
mm6	9	1089.23	1160.84	-535.62	0.00	1	1.000
mm7	9	1089.23	1160.84	-535.62	0.00	0	1.000
mm9	15	1049.09	1168.40	-509.54	52.15	6	>0.001
mm8	18	1053.56	1196.74	-508.78	0.00	2	1.000
mm10	19	808.60	959.95	-385.30	0.19	1	0.665
mm11	**18**	**806.79**	**950.17**	**-385.39**	**246.78**	**0**	**> 0.001**
mm12	16	817.00	944.45	-392.50	234.09	1	> 0.001

Table 2: *results from LRT for model selection.*

Model outputs

	b	se	z	pval
(Intercept)	-12.017	1.193	-10.066	>0.001***
year:1997	0.756	1.036	0.729	0.466
year:1999	-1.376	2.231	-0.617	0.537
year:2000	-1.764	0.988	-1.786	0.074.
year:2003	-2.196	1.128	-1.947	0.051.
year:2004	-3.142	1.138	-2.760	0.005**
year:2005	-1.971	0.797	-2.471	0.013 *
year:2006	-2.328	1.055	-2.207	0.027*
year:2007	-1.226	0.946	-1.296	0.195
year:2008	-3.875	0.984	-3.934	>0.001***
year:2009	-3.555	0.946	-3.758	>0.001***
year:2010	-2.022	0.879	-2.300	0.021*
length	0.698	0.044	15.784	>0.001***
sp: *Lophius piscatorius*	-0.942	0.336	-2.79	0.005**
N	-0.004	0.003	-1.363	0.172

Table 3: *Fixed effects coefficients extracted from the winner model (N= Numbers caught per haul).*

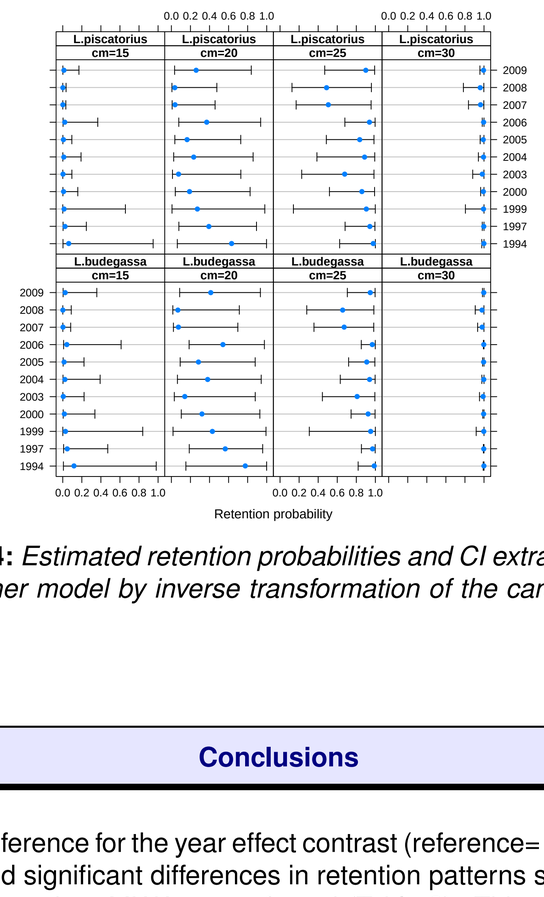


Figure 4: *Estimated retention probabilities and CI extracted from the winner model by inverse transformation of the canonical results.*

Conclusions

- The inference for the year effect contrast (reference= 1994), estimated significant differences in retention patterns since 2000, the year when MLW was enforced (Table 3). This result suggest a shift in the fleet discard behavior induced by legal rules, forcing the fishers to through back to the sea more juveniles from the catch than before the MLW enforcement.
- Anglerfish length-weight relationship estimates that the MLW=$500gr$ corresponds to $\sim 30cm$ length-class individuals. Model results indicate that retention probability for $30cm$ individuals is always above 50% (Figure 4). We conclude that the anglerfish high gastronomic and economic value deters fishermen to fully implement the rule.
- The model yield higher discard probability for the less valuable white angler than for the model reference black angler (Table 3). This result supports the 'value effect' hypothesis; fishers prefers to retain black angler juveniles rather that white ones, even though the difficulty of species recognition in juveniles, when peritoneum is masked by sludge that enters by the gills opening during the fishing process.

References

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XIII International Symposium on Oceanography of the Bay of Biscay, April $11^{th}-13^{th}$, 2012, Santander, Spain.