Preliminary results of observer effect on pelagic fleet taking into account observer data from 1999 to 2011

S. Somhlaba*+, A. Brandão+ D.S. Butterworth+, J. van der Westhuizen*

Introduction

A detailed update of the study of the data collected by scientific observers onboard the pelagic vessels is currently underway. The use of small pelagic commercial data base and an observer data base to investigate the effect of observers onboard commercial vessels has been an ongoing study since the mid-2000s (e.g. see Somhlaba *et al*, 2005, 2006, 2007). This paper updates those studies by including data from the more recent years 2008 to 2011.

Catch rates defined as catch divided by trip duration from the small pelagic commercial data base are used to investigate a possible effect that observer might have on the behavior of skippers. The analysis seeks to establish whether there is any evidence which suggest that the catch rates of vessels with an observer on board are appreciably different from the catch rates of vessels without observers, and whether the associated difference can be quantified.

Methodology

General Linear models (GLMs) were applied on data for the years 1999 to 2011 for sardine. Sardine catch rates are calculated using recorded tonnage and instances of zero sardine catches are ignored in this paper since these instances are still being investigated. All proportions of sardine in each haul are used in the calculations irrespective of whether these proportions are dominant or not within each haul. Then a variable type which classifies the sardine proportion into directed and bycatch is defined which depends on the tonnage of co-occurring species within each haul (see text for detailed explanation). To model catch rates a model consisting of a constant alone (the intercept μ) was evaluated. This was followed by adding the observer factor; a dummy variable showing the presence or the absence of an observer. Then all the other factors were added using the forward selection method as described by McCullagh and Nelder (1989). Thus, each factor was added one at a time and the deviance (-2 log likelihood) reduction calculated; the factor that led to the greater reduction in deviance was retained, as long as this reduction was statistically significant (as determined by the 5 % χ^2 value for one degree of freedom). At the next step, with the selected factor included, each factor was added in turn and the process repeated. The observer factor was kept throughout as this was the primary factor of interest. The basic GLM model considered is given in equation (1):

$$ln\left(\frac{Catch^{prop,sardine}}{TripHour}\right) = \mu + \alpha_{Obs} + \beta_{year} + \gamma_{month} + \delta_{catchType} + \theta_{timeCat} + \vartheta_{vessel} + \varphi_{int} + \varepsilon \quad (1)$$

where : $Catch^{prop,sardine}$ is the proportion of sardine catch in each haul

$TripHour$ is the duration of the trip in hours

μ is the intercept

α_{Obs} is an observer factor with two levels $Obs = \{presence, absence\}$

*Department of Agriculture Forestry and Fisheries, Private Bag X2, Rogge Bay, 8012
+MARAM(Marine Resource Assessment and Management Group) Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701

β_{year} is the year factor with 13 levels $year = \{1999, \ldots, 2011\}$
γ_{month} is the month factor with 12 levels $month$={1,2,…,12}
$\delta_{catchType}$ is the catch description factor with 6 levels (see text for details)
$\theta_{timeCat}$ is the time category factor with 5 levels (see text for different levels)
ϑ_{vessel} is the vessel factor with 151 levels
φ_{int} is the interaction term for the year, month and catch type with observer factor
ε is the error term assumed to be normally distributed and constant variance.

Different levels of catch description factor $\delta_{catchType}$ are categorized into directed catch for sardine if the tonnage in each haul is dominated by sardine, otherwise they are categorized as bycatch. Bycatch is divided further into other categories, so that $\delta_{catchType}$ is categorized as follows:

$catchType_{DC}$: is the directed catch when sardine is dominant in the haul
$catchType_{BRH}$: is the sardine bycatch caught with round herring when round herring is dominant in the haul
$catchType_{BA}$: is the sardine bycatch caught with anchovy when anchovy is dominant in the haul
$catchType_{BHMC}$: is the sardine bycatch caught with horse mackerel when horse mackerel is dominant in the haul
$catchType_{BC}$: is for any other bycatch not categorized as above

Time category is the factor which takes into account traveling time from the last haul to the port. The time category factor is used as proxy for the port effect in the GLMs models, since these times are measured for every trip. This factor is stratified as follows:

$$\theta_{timeCat} \leq 6\ hours$$
$$6\ hours < \theta_{timeCat} \leq 12\ hours$$
$$12 hours < \theta_{timeCat} \leq 18\ hours$$
$$18 hours < \theta_{timeCat} \leq 24\ hours$$
$$\theta_{timeCat} > 24\ hours$$

*Department of Agriculture Forestry and Fisheries, Private Bag X2, Rogge Bay, 8012
+MARAM(Marine Resource Assessment and Management Group) Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701

Results and Discussions

In this paper only the main effects and three interactions are considered. These interactions are observer*month,, observer*year and observer*catch description.

When considering the main effects of the GLMs, the observer effect is generally negative and statistically significant at 5% level except when the time Cat and vessel factors are removed. The variance explained increases with the addition of each factor , particularly with catchType (**Table** 1).

When interactions are considered with the full model given in **equation (1),** the effect of an observer is generally positive for earlier months of the year from January to April, though it is statistically significant at 5% level for January and February only. However this observer effect is generally negative for other months (**Table** 2). Considering interactions of the observer factor with years, observer has a positive effect in 2001, 2002, 2006 and 2007, being statistically significant only in 2001. Other years show negative effects with those for 2003 and 2005 statistically significant at 5% level.

Considering interactions with bycatch categories shows that the observer factor is positive and statistically significant only when sardine is caught with horse mackerel (**Table 2**)

Conclusions

Based on these preliminary results it is not clear cut that observer presence has a positive effect on catch rates. It is easier to interpret such positive impacts as indicative of higher catch rates when observers are present, which could be suggestive of slippage when they are not. However it is much harder suggest a reason for the negative impact estimates. These results are still very preliminary given the updated data, a further study which will be more detailed will be presented within the next few months.

References

McCullagh, P. Nelder, J.A. (1989) Generalized Linear Models. 2nd ed. London: Chapman & Hall. 149pp.

Somhlaba, S., Brandão, A., Butterworth, D.S. 2006. An indirect investigation of the possible influence of port on the estimastion of observer effects on catch rates in the pelagic fishery. Unpublished report MCM, South Africa. WG/MAY2006/PEL/04.

Somhlaba, S., Brandão, A., Butterworth, D.S. 2005. Overall results for the effect of the presence of an observer on catches made by the pelagic flee. Unpublished report MCM, South Africa. SWG/DEC2005/PEL/06.

*Department of Agriculture Forestry and Fisheries, Private Bag X2, Rogge Bay, 8012
+MARAM(Marine Resource Assessment and Management Group) Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701

Table 1: Estimates of the observer effect β (together with its standard error in parenthesis) when each factor is introduced into the model for sardine data; the percentage of variance explained when each factor is introduced is also shown. The estimate itself is highlighted in bold when the observer effect is statistically significant at 5% level.

species	model	Selected model	%variance explained	Observer effect and its std error
sardine	$\log_e\left(\frac{catch}{TripHour}\right)$	$\mu + \alpha_{Obs} + \varepsilon$	0.2	**-0.46**(0.038)
	$\log_e\left(\frac{catch}{hours}\right)$	$\mu + \alpha_{Obs} + \beta_{year} + \varepsilon$	3.4	**-0.50**(0.038)
	$\log_e\left(\frac{catch}{hours}\right)$	$\mu + \alpha_{Obs} + \beta_{year} + \gamma_{month} + \varepsilon$	6.1	**-0.52**(0.037)
	$\log_e\left(\frac{catch}{hours}\right)$	$\mu + \alpha_{Obs} + \beta_{year} + \gamma_{month} + \delta_{catchType} + \varepsilon$	57.7	-0.01(0.025)
	$\log_e\left(\frac{catch}{hours}\right)$	$\mu + \alpha_{Obs} + \beta_{year} + \gamma_{month} + \delta_{catchType} + \theta_{TimeCat} + \varepsilon$	59.4	**0.09**(0.025)
	$\log_e\left(\frac{catch}{hours}\right)$	$\mu + \alpha_{Obs} + \beta_{year} + \gamma_{month} + \delta_{catchType} + \theta_{TimeCat} + \vartheta_{vessel} + \varepsilon$	65.4	**-0.11**(0.023)

*Department of Agriculture Forestry and Fisheries, Private Bag X2, Rogge Bay, 8012
+MARAM(Marine Resource Assessment and Management Group) Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701

*Department of Agriculture Forestry and Fisheries, Private Bag X2, Rogge Bay, 8012
+MARAM(Marine Resource Assessment and Management Group) Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701

Table 2: Results from considering observer*month, observer*year and observer*catch description interactions for the sardine data. Estimates are given with their associated standard errors in parenthesis.

	sardine	
		$\log_e\left(\frac{catch}{hours}\right)$
Interaction	**Month**	**Observer Effect**
	Jan	**0.35** (0.078)
	Feb	**0.18** (0.069)
	Mar	0.020(0.067)
	Apr	0.080 (0.67)
	May	-**0.21**(0.67)
	Jun	0.021 (0.062)
	Jul	**-0.38** (0.067)
	Aug	**-0.36** (0.067)
	Sep	**-0.17** (0.068)
	Oct	-0.07 (0.073)
	Nov	-0.010 (0.073)
	Dec	-0.030 (0.075)
Interaction	**Year**	**Observer Effect**
	1999	-0.11(0.062)
	2000	-0.11(0.062)
	2001	**0.36**(0.061)
	2002	0.05(0.061)
	2003	**-0.19**(0.060)
	2004	-0.11(0.053)
	2005	**-0.35**.(0.060)
	2006	0.030(0.060)
	2007	0.050(0.061)
	2008	-0.13(0.062)
	2009	-0.15(0.063)
	2010	-0.080(0.062)
	2011	0.00
Interaction	**Catch type**	**Observer Effect**
	$catchType_{BRH}$	-0.10(0.044)
	$catchType_{BA}$	**-0.32**(0.038)
	$catchType_{BHMC}$	**0.73**(0.13)
	$catchType_{BC}$	-0.90(0.17)

*Department of Agriculture Forestry and Fisheries, Private Bag X2, Rogge Bay, 8012
+MARAM(Marine Resource Assessment and Management Group) Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701