Updated trends in policing effort and the number of confiscations for abalone including compliance data until March 2016

A. Brandão and D.S. Butterworth

Marine Resource Assessment & Management Group (MARAM)
Department of Mathematics and Applied Mathematics
University of Cape Town
Rondebosch 7701, Cape Town

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Abstract

GLM methods are applied to compliance data for confiscations (and abandonments) and for policing effort to estimate recent trends in the amount of abalone that is poached. The results suggest that poaching remains high for Zones A-D but has decreased over the last two years for Zones E-G; nevertheless the estimated poaching levels are well above the target for the recovery plan.

Introduction

The Generalised Linear Models (GLMs) applied previously by Brandão and Butterworth (2015) are updated to include further data now available. The aim of these GLMs is to obtain overall annual rates of change in number of confiscations (which throughout this paper include abandonments) and in policing effort in a manner that takes into account possible monthly effects and, in the case of policing effort, the fact that various types of policing exercises are carried out.

Data

Monthly data on confiscations and policing effort obtained from one of the Directorates within the CD (Directorate: Compliance) for the period of April 2008 to March 2016 are used in the present analyses. Data for the period April 2015 to March 2016 are new compared to those used for the analyses carried out by Brandão and Butterworth (2015).

Compliance data are available for the "All Zones (A to G)" (Cape Town to Arniston) region including Saldanha Bay, as well as disaggregated into two regions: Zones A-D and Zones E-G. The policing effort types included in the analyses are as selected by scientists from the abalone working group as being

those most likely to have resulted in abalone confiscations. These are: vehicles inspected, slipway inspections, coastal patrols, road blocks and sea patrols.

Methods

GLMs are used to investigate the variation of the number of confiscations of abalone as well as that in the extent of the policing effort that has occurred. Trends in the number of confiscations and in the policing effort are modelled in two ways: one by including the covariate "year" which is a factor which represents the year (i.e. a categorical nonlinear relationship is assumed between the number of confiscations/policing effort with the time period), and alternatively by including the covariate "Time" (essentially the date) which represents a continuous value for the year and month to which the data record applies (i.e. a linear relationship is assumed between the number of confiscations/policing effort and the date).

The expected policing effort (assuming a linear relationship with time) is modelled as:

$$\mathrm{E}(P) = \exp\left(\mu + \alpha_{month} + \beta_{type} + \gamma Time\right) \quad (1)$$

where

P is the policing effort, assumed to have an overdispersed Poisson distribution,

μ is the intercept,

α_{month} is the month effect,

β_{type} is the type of policing effect, where the "type" factor is associated with the different types of policing such as coastal patrols, permit checks, restaurant inspections, road blocks, sea patrols, slipway inspections and vessels inspections, and

$Time$ is the time (date) representing the year and month to which the data applies, and γ is the associated coefficient.

When an other than linear (categorical) relationship is assumed between policing effort and time, the expected policing effort is modelled as:

$$\mathrm{E}(P) = \exp\left(\mu + \alpha_{month} + \beta_{type} + \delta_{year}\right) \quad (2)$$

where

δ_{year} is the year effect (2008 to 2016).

A weight is applied to each of the above GLMs to account for different levels of variance (beyond Poisson) in the data for the different measures of policing. The weight applied to the data is given by the inverse of the estimated overdispersion parameter obtained by fitting the GLM of Equation (1) (without the "type" factor) to each separate data set for the different types of policing employed.

The same procedure as for policing effort is applied to the number of confiscations. The one difference in the GLMs is that the β_{type} effect does not apply in this case. No weighting of the data is therefore conducted for confiscations.

Note that throughout "year" refers to Model-year, e.g. 2009 means the period October 2008 to September 2009.

Results

Table 1 shows the parameter estimates for the GLMs fitted to the policing effort data and to the number of confiscations for the "All Zones (A to G)".

For policing effort, whether a linear or nonlinear function is assumed over time, a slight negative trend is evident (Table 1 and Figure 1). An decrease of 1.1% per year is obtained assuming a linear relationship, instead of the increase of 1.2% estimated previously. Under the categorical (other than linear) approach, a slight decrease remains apparent since 2012.

For the number of confiscations, an increasing trend (22% per year) is obtained if a linear relationship if assumed (Table 1). Under the categorical analysis, an increase is also evident (Table 1 and Figure 1). Although a substantial drop is estimated for 2012, there have been substantial increases for both 2013 and for 2014, a slight drop in 2015 and an increase again in 2016 though note the large CI for 2016 for which only six months of data are available at this time.

The instantaneous annual rates of increase obtained from the linear GLM are:

Confiscations: 22% (s.e. = 3.7%)
Policing effort: -1.1% (s.e. = 0.9%)

Together these suggest that removals from poaching have been increasing at an instantaneous rate of 22.7% p.a. (s.e.=3.8%) over the last seven years. This corresponds to a net increase of 26% over one and 58% over two years.

Disaggregated by Region

The analyses above pool data across all regions. Results might be biased if there has been a shift in policing effort allocation across regions over time. This has been addressed by disaggregating the compliance data by regions (Zones A-D and Zones E-G) and repeating the GLM analyses.

The results of these further GLMs are shown in Table 2-3 for Zones A-D and Zones E-G respectively. Figure 1 shows the results for the categorical analysis for Zones A-D as well as for the "All Zones (A to G)" as a whole (Cape Town to Arniston plus Saldanha Bay). The lowest row of plots in this Figure show the poaching level index as the ratio of the categorical factor estimates for confiscations and for effort each year, normalised as the average over the 2008 and 2009 years, together with the targeted decrease in poaching for 2010 to 2016 under the current abalone recovery plan. Figure 2 shows the similar plots for Zones E-G.

For Zones A-D there is an estimated slight decrease in effort over the last four years, with peaks in 2009 and 2012. However in broad terms for both A-D and the region overall there is an estimated approximate doubling of poaching over the 2009 to 2011 period. There is an appreciable (though not

statistically significant) drop in poaching in 2012, followed by estimated large increases in both 2013 and in 2014 and then a drop in 2015 (though this estimate is still higher than that estimated in 2013) and an increase in poaching again in 2016 (with the highest estimate of poaching in the time series).

Results in Table 3 and Figure 2 similarly indicate a large increase in poaching in Zones E-G until 2011 and a large (though not statistically significant) drop in 2012 again followed by an increase in 2013 and a large further increase in 2014, followed by a drop in the last two years (with a large drop in poaching estimated for 2016, in the region of that estimated for 2013).

For all regions, the estimated poaching levels are well above the target poaching level required under the abalone recovery plan, with levels in the last year having drastically increased in Zones A-D but decreased in Zones E-G.

Reference

Brandão, A. and Butterworth, D.S. 2015. Updated trends in policing effort and the number of confiscations for abalone including compliance data until March 2015. FISHERIES/2015/AUG/SWG-AB/08.

Table 1. GLM parameter/coefficient (and standard error) estimates for "All Zones (A to G)" (Cape Town to Arniston) and Saldanha Bay.

	Policing effort (year factor)	Policing effort (linear)	Confiscations (year factor)	Confiscations (linear)
January	0.301 (0.101)	0.302 (0.102)	-0.030 (0.539)	-0.048 (0.559)
February	0.162 (0.104)	0.164 (0.105)	0.787 (0.456)	0.750 (0.473)
March	0.085 (0.106)	0.088 (0.107)	1.021 (0.441)	0.967 (0.457)
April	0.116 (0.106)	0.114 (0.106)	0.533 (0.501)	0.457 (0.517)
May	0.070 (0.108)	0.068 (0.108)	0.719 (0.483)	0.625 (0.498)
June	0.106 (0.107)	0.105 (0.107)	0.675 (0.487)	0.563 (0.502)
July	0.149 (0.106)	0.149 (0.106)	1.354 (0.439)	1.225 (0.451)
August	0.285 (0.102)	0.286 (0.102)	0.873 (0.470)	0.726 (0.484)
September	-0.179 (0.114)	-0.177 (0.115)	1.024 (0.459)	0.858 (0.472)
October	0.165 (0.104)	0.163 (0.105)	1.207 (0.431)	1.243 (0.447)
November	0.104 (0.106)	0.103 (0.107)	0.954 (0.445)	0.972 (0.461)
December	0	0	0	0
Time (yr^{-1})	—	-0.001 (0.001)	—	0.018 (0.003)
2008	-0.127 (0.108)	—	-0.884 (0.597)	—
2009	-0.062 (0.083)	—	-0.679 (0.437)	—
2010	0	—	0	—
2011	0.045 (0.081)	—	0.314 (0.333)	—
2012	0.116 (0.079)	—	-0.397 (0.400)	—
2013	-0.107 (0.084)	—	0.289 (0.335)	—
2014	-0.124 (0.084)	—	0.969 (0.298)	—
2015	-0.057 (0.083)	—	0.706 (0.310)	—
2016	-0.168 (0.107)		1.051 (0.346)	
coastal	0.218 (0.070)	0.218 (0.070)	—	—
road	-3.844 (0.116)	-3.844 (0.117)	—	—
sea	-4.761 (0.125)	-4.761 (0.127)	—	—
slipway	0.055 (0.068)	0.055 (0.068)	—	—
vehicles	0	0	—	—

Table 2. GLM parameter/coefficient (and standard error) estimates for Zones A to D.

	Policing effort (year factor)	Policing effort (linear)	Confiscations (year factor)	Confiscations (linear)
January	0.216 (0.133)	0.216 (0.134)	-0.388 (0.604)	-0.409 (0.610)
February	0.093 (0.137)	0.095 (0.138)	0.887 (0.456)	0.846 (0.461)
March	0.115 (0.136)	0.118 (0.137)	1.138 (0.441)	1.076 (0.446)
April	0.069 (0.138)	0.081 (0.138)	0.679 (0.496)	0.610 (0.498)
May	-0.082 (0.144)	-0.070 (0.143)	0.868 (0.479)	0.778 (0.480)
June	-0.022 (0.141)	-0.008 (0.141)	0.825 (0.483)	0.714 (0.484)
July	0.104 (0.137)	0.119 (0.137)	1.078 (0.464)	0.947 (0.464)
August	0.211 (0.134)	0.226 (0.134)	1.044 (0.466)	0.892 (0.466)
September	-0.279 (0.151)	-0.263 (0.151)	0.545 (0.510)	0.372 (0.511)
October	0.054 (0.138)	0.053 (0.139)	1.366 (0.430)	1.407 (0.435)
November	-0.127 (0.144)	-0.128 (0.146)	1.053 (0.446)	1.074 (0.450)
December	0	0	0	0
Time (yr^{-1})	—	-0.001 (0.001)	—	0.021 (0.003)
2008	0.264 (0.140)	—	-0.441 (0.585)	—
2009	0.284 (0.113)	—	-0.365 (0.448)	—
2010	0	—	0	—
2011	0.084 (0.118)	—	0.267 (0.381)	—
2012	0.309 (0.112)	—	-0.157 (0.423)	—
2013	0.073 (0.118)	—	0.597 (0.357)	—
2014	0.045 (0.119)	—	1.216 (0.327)	—
2015	0.213 (0.115)	—	1.006 (0.335)	—
2016	0.118 (0.144)		1.367 (0.363)	
coastal	0.376 (0.091)	0.376 (0.092)	—	—
road	-3.834 (0.143)	-3.834 (0.144)	—	—
sea	-4.838 (0.168)	-4.838 (0.169)	—	—
slipway	0.101 (0.090)	0.101 (0.091)	—	—
vehicles	0	0	—	—

Table 3. GLM parameter/coefficient (and standard error) estimates for Zones E to G.

	Policing effort (year factor)	Policing effort (linear)	Confiscations (year factor)	Confiscations (linear)
January	0.386 (0.116)	0.387 (0.124)	0.860 (0.764)	0.855 (0.863)
February	0.219 (0.120)	0.222 (0.129)	0.088 (0.886)	0.080 (1.000)
March	0.023 (0.126)	0.028 (0.135)	0.134 (0.876)	0.117 (0.992)
April	0.135 (0.124)	0.109 (0.132)	-0.750 (1.150)	-0.760 (1.310)
May	0.202 (0.122)	0.177 (0.130)	-0.610 (1.100)	-0.620 (1.240)
June	0.217 (0.122)	0.194 (0.129)	-0.650 (1.120)	-0.680 (1.260)
July	0.178 (0.123)	0.157 (0.130)	1.981 (0.688)	1.953 (0.776)
August	0.363 (0.118)	0.343 (0.125)	-0.940 (1.240)	-0.980 (1.400)
September	-0.098 (0.131)	-0.116 (0.140)	1.910 (0.691)	1.870 (0.778)
October	0.211 (0.121)	0.208 (0.129)	-0.480 (1.040)	-0.470(1.170)
November	0.300 (0.118)	0.298 (0.127)	0.266 (0.851)	0.272 (0.963)
December	0	0	0	0
Time (yr^{-1})	—	-0.002 (0.001)	—	0.006 (0.006)
2008	-0.640 (0.131)	—	-3.660 (2.320)	—
2009	-0.498 (0.095)	—	-1.992 (0.888)	—
2010	0	—	0	—
2011	-0.005 (0.083)	—	0.402 (0.399)	—
2012	-0.134 (0.086)	—	-1.168 (0.634)	—
2013	-0.304 (0.090)	—	-0.966 (0.587)	—
2014	-0.390 (0.092)	—	0.156 (0.420)	—
2015	-0.405 (0.093)	—	-0.472 (0.498)	—
2016	-0.492 (0.123)		-1.120 (1.010)	
coastal	0.020 (0.086)	0.020 (0.092)	—	—
road	-3.849 (0.141)	-3.849 (0.151)	—	—
sea	-4.684 (0.144)	-4.684 (0.154)	—	—
slipway	0.005 (0.085)	0.005 (0.091)	—	—
vehicles	0	0	—	—

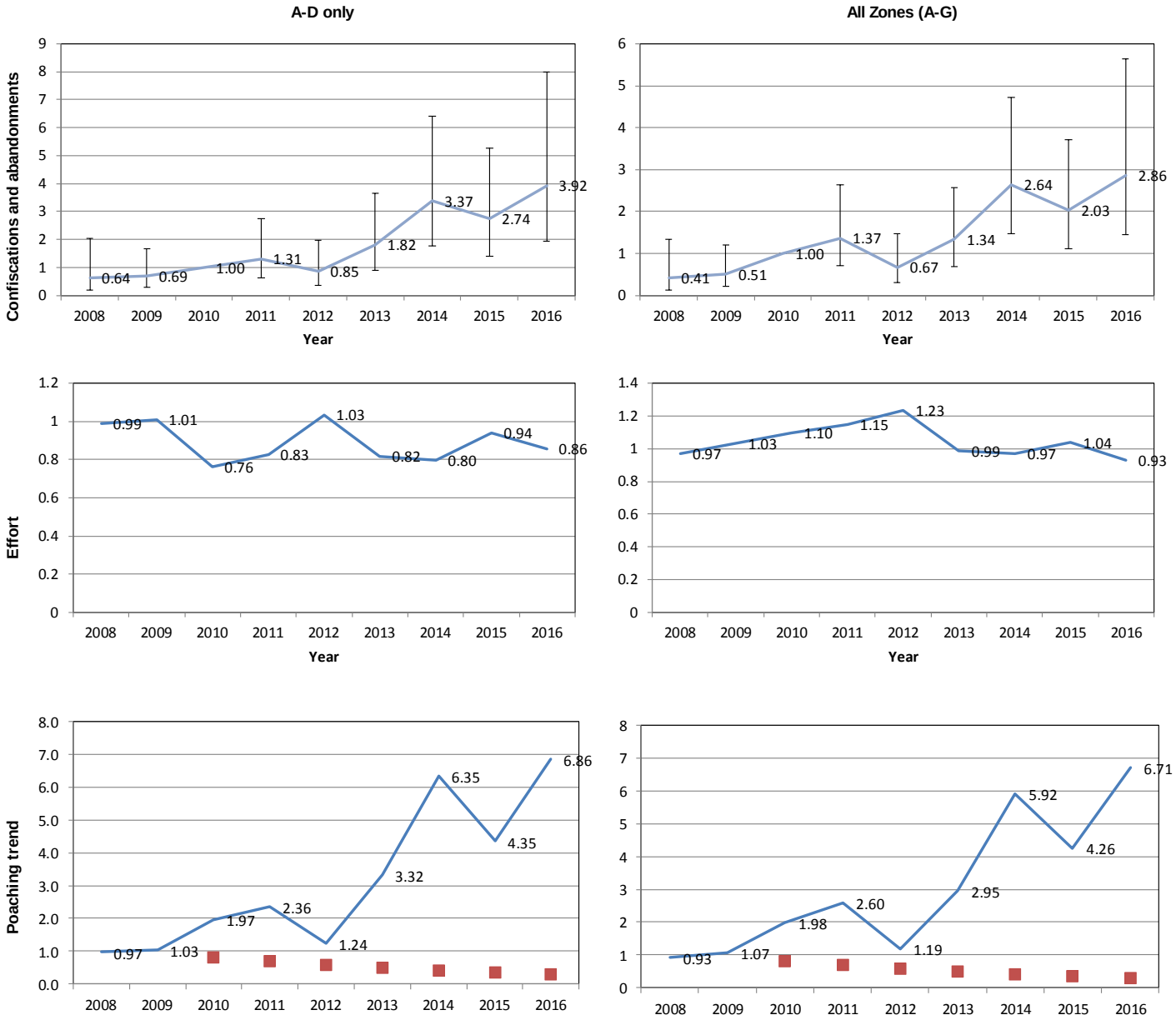

Figure 1. Comparison of estimates of annual factors from the categorical model of equation (2) where these are estimated for each Model-year. Results are shown first for confiscations (and abandonments) and then for policing effort, with the lowest pair of plots reflecting the ratios as an index of the annual level of poaching, and the squares reflecting the 15% annual decrease in poaching sought under the current abalone recovery plan. The left side plots are for Zones A-D only, whereas the right side plots are for "All Zones (A to G)". The confiscation plots are normalised to the 2010 values with 95% CIs shown for the other Model-years. The effort and poaching index are normalised to their 2008-2009 average values.

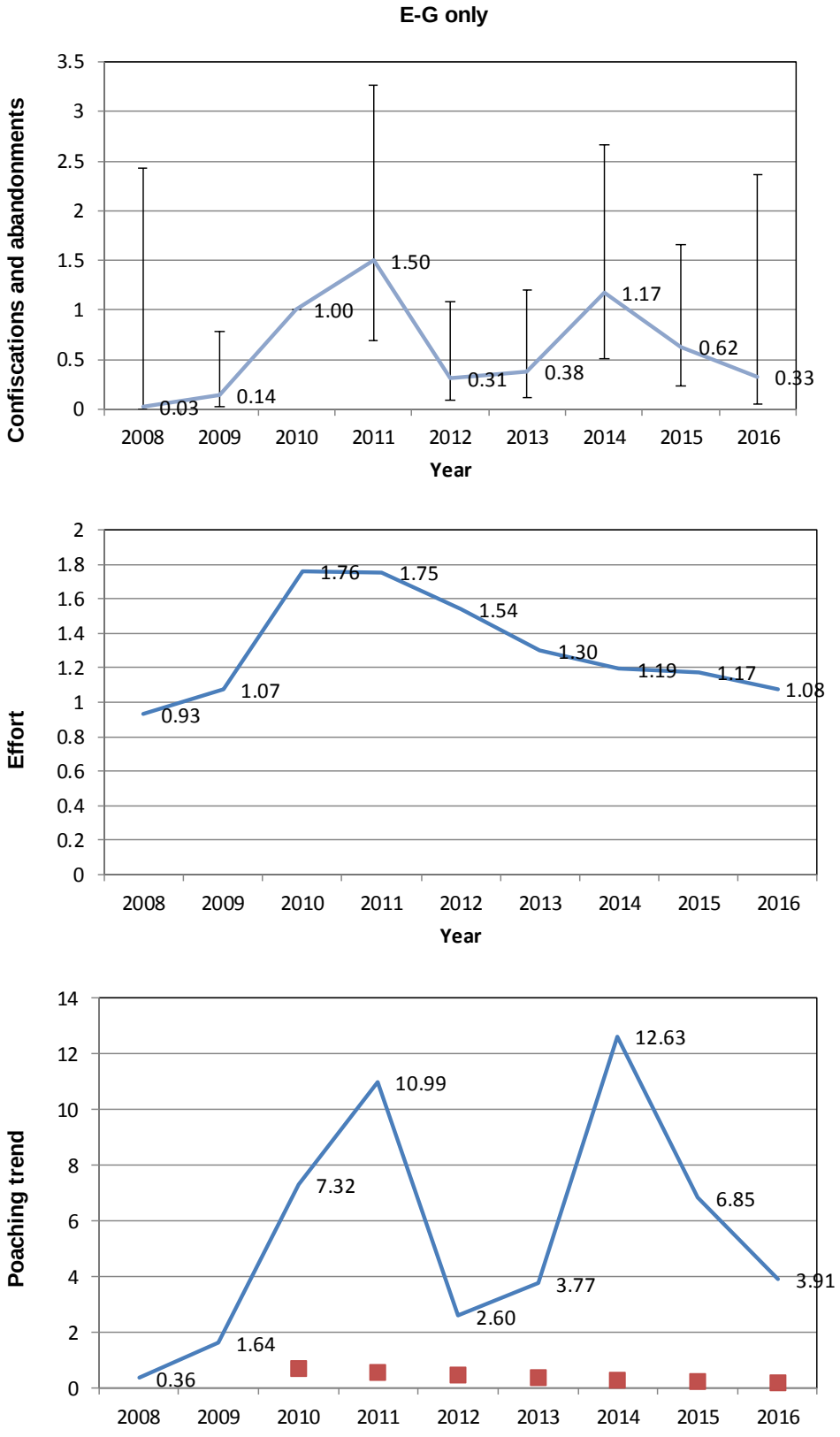

Figure 2. Comparison of estimates of annual factors from the categorical model of equation (2) where these are estimated for each Model-year for Zones E-G. Results are shown first for confiscations (and abandonments) and then for policing effort, with the lowest pair of plots reflecting the ratios as an index of the annual level of poaching, and the squares reflecting the 15% annual decrease in poaching sought under the current abalone recovery plan. The confiscation plots are normalised to the 2010 values with 95% CIs shown for the other Model-years. The effort and poaching index are normalised to their 2008-2009 average values.