

Results for the updated trends in policing effort and the number of confiscations for West Coast rock lobster using the “old” database for the period 2008 to 2017

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Abstract

GLM methods are applied to compliance data (the “old” database) on confiscations (and abandonments) and on policing effort to estimate recent trends in the amount of rock lobster that is poached. Data for the period in 2016 when Operation Phakisa was launched with associated greatly enhanced levels of marine policing has been omitted from the analyses. The policing effort “sea patrols” has been omitted from the analyses as it has been deemed not to be relevant to rock lobster. The impact of omitting this policing effort type is minimal. The net effect of adding two further years of data suggests that the extent of poaching has increased slightly for Super-area 8+, but dropped more in the Super-areas 3+4+5+6+7.

Introduction

At a previous Task Team meeting the following calculations were requested to evaluate poaching trends given the “old” (confiscations not linked to the type of policing) and the “new” (confiscations linked to policing effort type) databases:

- i) Update the poaching analyses as before using the updated “old database”.
- ii) Run an analysis on the “new database” and obtain results for the poaching trend – this will also provide the relative efficiencies of the different policing effort types.
- iii) Rerun analysis on the “old database”, but now using the relative effort efficiencies estimated in ii).
- iv) Compare the overall “trends” between i), ii) and iii).

This paper gives results for task (i). At a Task Team meeting it was suggested that one of the policing effort types that has been used in previous analyses (e.g. Brandão *et al.* 2016), “sea patrols”, is not relevant for rock lobster and should be omitted from future analyses. This has been done in the

analyses presented in this paper. Results are compared to those when this policing effort type is incorporated in the analyses to determine the impact of omitting this type from analyses.

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 December 2017 are used in the present analyses. Data for the period April 2016 to December 2017 are new compared to those used for the analyses carried out by Brandão *et al.* (2016). The first three months of the 2016 compliance data have been omitted from the analyses to remove the effect of the greatly enhanced policing levels during those months when Operation Phakisa was launched. Data for the first three months of 2018 are also omitted as it has been shown that trends for the first three months of a year can be considerably different from those obtained for a complete year, and hence provide a misleading impression.

Methods

Generalized linear models (GLMs) are used to investigate the variation in the number of confiscations of rock lobster as well as that in the policing effort that has occurred. Trends in the number of confiscations and in the policing effort are modelled in two ways: one by having 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 having the covariate “Time” (essentially the date) which represents a continuous value for the year and month for which the data record applies (i.e. a linear relationship is assumed between the number of confiscations/policing effort with the date). (Note that “year” refers to a calendar year throughout this document.)

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

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

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, restaurant inspections, slipway inspections, FPE inspections and vehicles inspections, and

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

When a nonlinear relationship is assumed between policing effort and time, the expected policing effort is modelled as:

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

where

δ_{year} is the year effect (2008 to 2017).

A weight is applied to each of the GLMs above 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. There is no weighting of the data in these confiscations.

Results

Tables 1-5 show the parameter estimates for the GLMs fitted to the policing effort data and to the number of confiscations for Super-areas 3+4, 5+6+7, 8+, 3+4+5+6+7 and 3+4+5+6+7+8+ respectively. Figures 1–5 show the trend for policing effort, the number of confiscations plus abandonments and the ratio of the number of confiscations plus abandonments to policing effort for these Super-areas. For comparison, the impact of including policing effort “sea patrols” on policing trends and on poaching trends are also shown in these Figures. The effect on these trends is minimal.

Table 6 shows a summary of the change in poaching levels from 2009 to 2017 for the continuous log-linear model and the percentage change from the average of 2009 and 2010 to the average of 2016 and 2017 for the poaching indices for the discrete year factor model.

For policing effort, whether a linear or nonlinear function is assumed over time, a slight positive trend is evident (Table 1 and Figure 1) for Super-area 3+4, but a slight decreasing trend in Super-areas 5+6+7, 3+4+5+6+7 and 3+4+5+6+7+8+ if a linear function is assumed over time (Tables 2, 4 and 5) and no trend for Super-area 8+ (Table 3). For a nonlinear function over time, slight downward to stable trends for Super-areas 8+, 3+4+5+6+7 and 3+4+5+6+7+8+ (Figures 3 to 5) and a continuing downward trend for Super-area 5+6+7 (Figure 2).

For the number of confiscations, whether a linear or nonlinear function is assumed over time, a downward trend is evident for Super-areas 3+4, 5+6+7 and 3+4+5+6+7. A downward trend since 2013 is evident for Super-area 3+4+5+6+7+8+. For Super-area 8+, a non-linear function assumed over time shows a downward trend since 2013 but a positive trend is evident if a linear function over time is assumed (Table 3 and Figure 3).

Previously final assessments of poaching trends were separated for Super-areas 3+4+5+6+7 and for Super-area 8+, and based on the trends shown in the earlier versions of Figures 4 and 3 respectively. Figures 6a and b compare the new results to those from two years previously (Brandão et al. 2016).

The net effect of adding two further years of data suggests that the extent of poaching has increased slightly for Super-area 8+, but dropped more in the northerly Super-areas.

Reference

Brandão, A., Johnston, S.J. and Butterworth, D.S. 2016. Trends in policing effort and the number of confiscations for West Coast rock lobster. Fisheries/2016/JUL/SWG-WCRL/10.

Table 1. GLM parameter/coefficient (and standard error) estimates for Super-area 3+4.

	Policing effort (year factor)	Policing effort (linear)	Confiscations (year factor)	Confiscations (linear)
January	0.101 (0.127)	0.193 (0.128)	-0.382 (0.520)	-0.391 (0.636)
February	-0.154 (0.136)	-0.068 (0.137)	0.314 (0.432)	0.320 (0.527)
March	-0.053 (0.132)	0.025 (0.133)	0.963 (0.383)	0.986 (0.465)
April	-0.067 (0.124)	-0.008 (0.125)	0.225 (0.421)	0.096 (0.521)
May	0.099 (0.119)	0.151 (0.120)	-1.079 (0.624)	-1.192 (0.770)
June	-0.046 (0.123)	-0.002 (0.125)	-3.651 (1.975)	-3.747 (2.435)
July	0.062 (0.120)	0.098 (0.121)	-2.153 (0.974)	-2.234 (1.201)
August	0.079 (0.119)	0.109 (0.121)	-1.238 (0.663)	-1.302 (0.818)
September	-0.062 (0.124)	-0.040 (0.125)	-2.995 (1.440)	-3.043 (1.775)
October	0.148 (0.118)	0.163 (0.119)	-3.134 (1.538)	-3.166 (1.897)
November	0.170 (0.117)	0.177 (0.118)	-0.769 (0.559)	-0.785 (0.689)
December	0	0	0	0
Time (yr⁻¹)	—	0.007 (0.001)	—	-0.016 (0.005)
2008	—	—	—	—
2009	-0.129 (0.144)	—	-1.355 (0.571)	—
2010	0	—	0	—
2011	0.456 (0.116)	—	-1.367 (0.391)	—
2012	0.369 (0.118)	—	-2.195 (0.556)	—
2013	0.309 (0.120)	—	-3.002 (0.810)	—
2014	0.474 (0.116)	—	-0.978 (0.337)	—
2015	0.672 (0.112)	—	-1.297 (0.380)	—
2016	0.685 (0.118)	—	-2.387 (0.909)	—
2017	0.676 (0.112)	—	-1.731 (0.454)	—
coastal	0.818 (0.117)	0.818 (0.118)	—	—
FPE	-3.280 (0.187)	-3.280 (0.189)	—	—
restaurant	-3.286 (0.188)	-3.290 (0.190)	—	—
slipway	0.872 (0.117)	0.872 (0.118)	—	—
vehicles	0	0	—	—

Table 2. GLM parameter/coefficient (and standard error) estimates for Super-area 5+6+7.

	Policing effort (year factor)	Policing effort (linear)	Confiscations (year factor)	Confiscations (linear)
January	0.518 (0.113)	0.477 (0.116)	0.618 (0.503)	0.390 (0.501)
February	0.277 (0.120)	0.245 (0.123)	0.354 (0.533)	0.146 (0.532)
March	0.301 (0.119)	0.278 (0.122)	0.589 (0.506)	0.401 (0.503)
April	0.456 (0.109)	0.383 (0.113)	0.251 (0.492)	0.091 (0.504)
May	0.567 (0.107)	0.504 (0.110)	0.181 (0.500)	0.042 (0.512)
June	0.405 (0.110)	0.350 (0.114)	-3.018 (1.709)	-3.137 (1.746)
July	0.517 (0.108)	0.472 (0.111)	-4.077 (2.857)	-4.176 (2.919)
August	0.581 (0.107)	0.545 (0.110)	-2.837 (1.568)	-2.916 (1.602)
September	0.278 (0.113)	0.251 (0.117)	-1.336 (0.809)	-1.396 (0.826)
October	0.625 (0.106)	0.606 (0.109)	-1.681 (0.931)	-1.721 (0.951)
November	0.565 (0.107)	0.556 (0.110)	-0.967 (0.703)	-0.987 (0.718)
December	0	0	0	0
Time (yr⁻¹)	—	-0.009 (0.001)	—	-0.020 (0.005)
2008	—	—	—	—
2009	-0.185 (0.081)	—	0.364 (0.456)	—
2010	0	—	0	—
2011	-0.066 (0.072)	—	-0.418 (0.433)	—
2012	-0.162 (0.074)	—	-0.937 (0.514)	—
2013	-0.346 (0.078)	—	-0.681 (0.470)	—
2014	-0.465 (0.080)		-0.687 (0.471)	
2015	-0.592 (0.084)		-0.639 (0.464)	
2016	-0.883 (0.103)		-2.580 (1.484)	
2017	-0.880 (0.092)		-2.441 (0.963)	
coastal	-0.873 (0.094)	-0.873 (0.096)	—	—
FPE	-2.922 (0.099)	-2.920 (0.102)	—	—
restaurant	-3.202 (0.119)	-3.200 (0.122)	—	—
slipway	-0.652 (0.097)	-0.652 (0.099)	—	—
vehicles	0	0	—	—

Table 3. GLM parameter/coefficient (and standard error) estimates for Super-area 8+.

	Policing effort (year factor)	Policing effort (linear)	Confiscations (year factor)	Confiscations (linear)
January	0.219 (0.104)	0.232 (0.105)	0.654 (0.581)	0.741 (0.613)
February	0.183 (0.105)	0.196 (0.106)	1.708 (0.500)	1.780 (0.526)
March	0.163 (0.105)	0.176 (0.106)	-0.606 (0.824)	-0.544 (0.872)
April	0.122 (0.100)	0.117 (0.102)	1.100 (0.513)	1.200 (0.545)
May	0.154 (0.100)	0.150 (0.101)	0.534 (0.559)	0.621 (0.594)
June	0.220 (0.098)	0.217 (0.100)	0.365 (0.578)	0.440 (0.614)
July	0.251 (0.098)	0.248 (0.099)	-0.691 (0.768)	-0.628 (0.816)
August	0.290 (0.097)	0.288 (0.098)	-2.186 (1.397)	-2.140 (1.480)
September	0.070 (0.102)	0.069 (0.103)	0.403 (0.574)	0.440 (0.609)
October	0.104 (0.101)	0.103 (0.102)	-0.143 (0.652)	-0.118 (0.692)
November	0.058 (0.102)	0.057 (0.103)	-0.712 (0.774)	-0.700 (0.822)
December	0	0	0	0
Time (yr⁻¹)	—	-0.001 (0.001)	—	0.013 (0.004)
2008	-0.014 (0.096)	—	-0.511 (0.836)	—
2009	-0.028 (0.088)	—	-0.705 (0.729)	—
2010	0	—	0	—
2011	0.193 (0.084)	—	0.452 (0.536)	—
2012	0.115 (0.085)	—	-0.403 (0.662)	—
2013	-0.048 (0.089)	—	1.131 (0.482)	—
2014	-0.118 (0.090)		0.396 (0.542)	
2015	0.046 (0.087)		0.726 (0.511)	
2016	-0.115 (0.099)		1.222 (0.526)	
2017	0.025 (0.087)		0.786 (0.506)	
coastal	0.524 (0.071)	0.524 (0.072)	—	—
FPE	-2.417 (0.097)	-2.417 (0.098)	—	—
restaurant	-2.306 (0.080)	-2.306 (0.081)	—	—
slipway	0.218 (0.069)	0.218 (0.070)	—	—
vehicles	0	0	—	—

Table 4. GLM parameter/coefficient (and standard error) estimates for Super-areas 3+4+5+6+7.

	Policing effort (year factor)	Policing effort (linear)	Confiscations (year factor)	Confiscations (linear)
January	0.335 (0.138)	0.339 (0.138)	0.396 (0.427)	0.225 (0.422)
February	0.090 (0.146)	0.096 (0.147)	0.350 (0.432)	0.197 (0.427)
March	0.143 (0.144)	0.152 (0.144)	0.736 (0.398)	0.603 (0.392)
April	0.234 (0.133)	0.212 (0.134)	0.243 (0.405)	0.092 (0.410)
May	0.365 (0.130)	0.347 (0.130)	-0.046 (0.434)	-0.178 (0.439)
June	0.209 (0.134)	0.194 (0.135)	-3.160 (1.504)	-3.274 (1.516)
July	0.320 (0.131)	0.307 (0.131)	-3.098 (1.460)	-3.193 (1.472)
August	0.367 (0.130)	0.356 (0.130)	-2.085 (0.912)	-2.161 (0.920)
September	0.126 (0.137)	0.118 (0.137)	-1.598 (0.739)	-1.654 (0.745)
October	0.420 (0.128)	0.414 (0.129)	-1.926 (0.851)	-1.964 (0.858)
November	0.391 (0.129)	0.388 (0.129)	-0.907 (0.566)	-0.926 (0.570)
December	0	0	0	0
Time (yr⁻¹)	—	-0.003 (0.001)	—	-0.019 (0.004)
2008	—	—	—	—
2009	-0.172 (0.115)	—	-0.030 (0.389)	—
2010	0	—	0.000 (0.000)	—
2011	0.078 (0.099)	—	-0.705 (0.354)	—
2012	-0.015 (0.102)	—	-1.282 (0.437)	—
2013	-0.156 (0.105)	—	-1.139 (0.414)	—
2014	-0.163 (0.106)		-0.796 (0.365)	
2015	-0.138 (0.105)		-0.858 (0.373)	
2016	-0.264 (0.119)		-2.508 (1.083)	
2017	-0.267 (0.109)		-2.089 (0.614)	
coastal	0.235 (0.120)	0.235 (0.120)	—	—
FPE	-2.246 (0.133)	-2.246 (0.134)	—	—
restaurant	-2.870 (0.161)	-2.870 (0.162)	—	—
slipway	0.316 (0.122)	0.316 (0.122)	—	—
vehicles	0	0	—	—

Table 5. GLM parameter/coefficient (and standard error) estimates for Super-areas 3+4+5+6+7+8+.

	Policing effort (year factor)	Policing effort (linear)	Confiscations (year factor)	Confiscations (linear)
January	0.325 (0.125)	0.290 (0.125)	0.447 (0.425)	0.439 (0.422)
February	0.165 (0.130)	0.134 (0.130)	1.001 (0.383)	0.995 (0.380)
March	0.187 (0.129)	0.159 (0.129)	0.390 (0.430)	0.384 (0.427)
April	0.189 (0.121)	0.163 (0.122)	0.628 (0.387)	0.620 (0.388)
May	0.284 (0.118)	0.261 (0.119)	0.194 (0.422)	0.187 (0.423)
June	0.214 (0.120)	0.195 (0.121)	-0.642 (0.532)	-0.648 (0.533)
July	0.292 (0.118)	0.276 (0.119)	-1.595 (0.761)	-1.600 (0.761)
August	0.336 (0.117)	0.323 (0.118)	-2.119 (0.954)	-2.123 (0.955)
September	0.103 (0.123)	0.094 (0.124)	-0.431 (0.498)	-0.434 (0.498)
October	0.302 (0.118)	0.295 (0.119)	-0.928 (0.587)	-0.930 (0.587)
November	0.267 (0.119)	0.264 (0.119)	-0.835 (0.568)	-0.836 (0.568)
December	0	0	0	0
Time (yr⁻¹)	—	-0.003 (0.001)	—	-0.001 (0.003)
2008	0.793 (0.155)	—	-0.887 (0.893)	—
2009	-0.042 (0.105)	—	-0.411 (0.416)	—
2010	0	—	0	—
2011	0.118 (0.094)	—	-0.326 (0.356)	—
2012	0.030 (0.096)	—	-1.022 (0.448)	—
2013	-0.119 (0.100)	—	-0.097 (0.334)	—
2014	-0.148 (0.100)		-0.401 (0.364)	
2015	-0.073 (0.098)		-0.260 (0.349)	
2016	-0.202 (0.112)		-0.184 (0.428)	
2017	-0.160 (0.101)		-0.577 (0.385)	
coastal	0.032 (0.096)	0.015 (0.096)	—	—
FPE	-2.546 (0.113)	-2.562 (0.113)	—	—
restaurant	-2.587 (0.118)	-2.590 (0.118)	—	—
slipway	0.150 (0.096)	0.142 (0.096)	—	—
vehicles	0	0	—	—

Table 6. Summary of change in poaching levels from 2009 to 2017 (and 95% confidence intervals) for the continuous log-linear model and the percentage change from average of 2009 and 2010 to the average of 2016 and 2017 for the poaching indices for the discrete year factor model.

Area	Continuous linear trend	Discrete year factor
Super-area 3+4	-89.5% (-96.2%; -71.1%)	-89.5%
Super-area 5+6+7	-64.6% (-86.7%; -6.0%)	-85.6%
Super-area8+	249.7% (75.0%; 598.9%)	294.2%
Super-area 3+4+5+6+7	-79.0% (-90.6%; -53.1%)	-87.6%
Super-area 3+4+5+6+7+8+	23.8% (-31.9%; 125.0%)	-0.8%

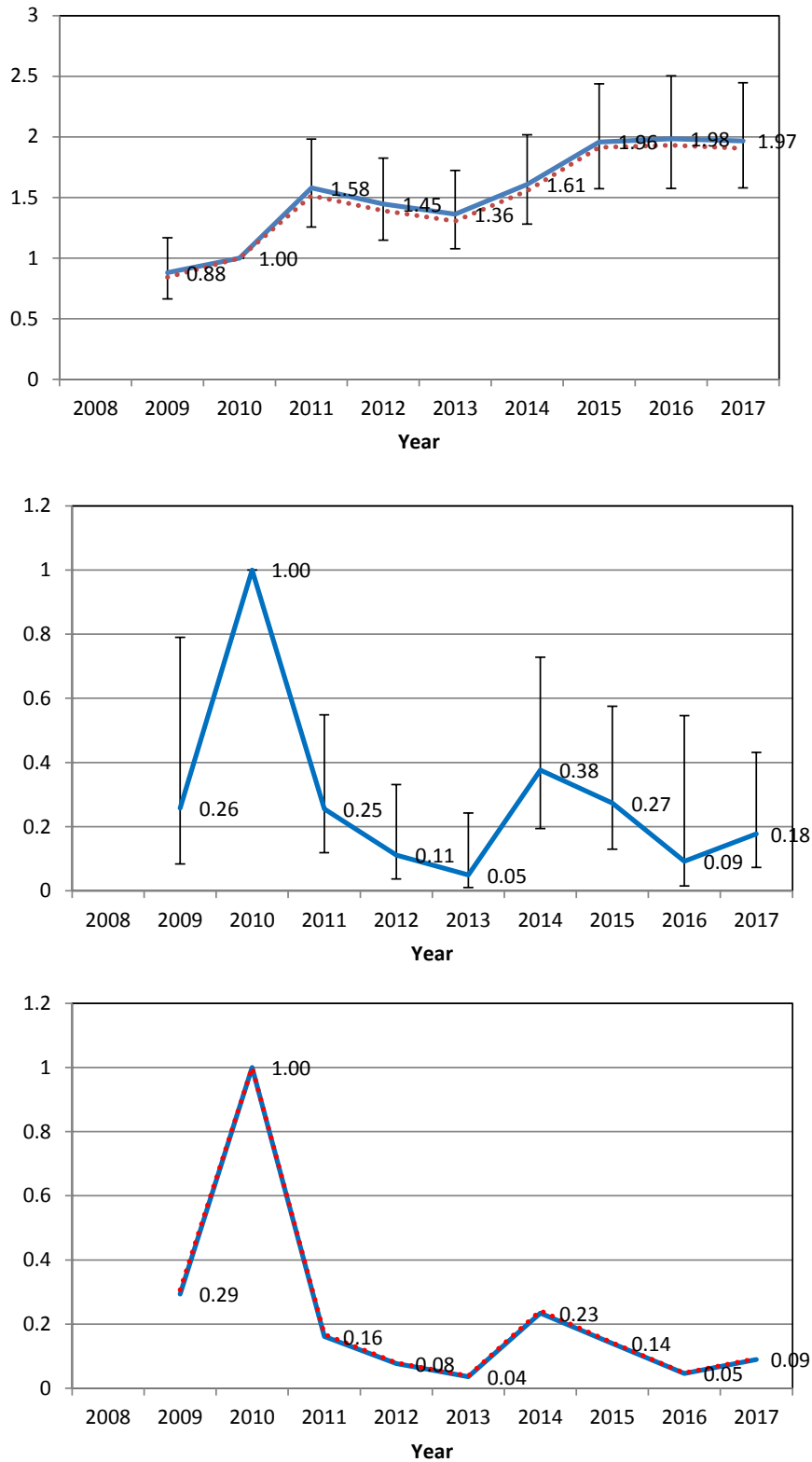


Figure 1. Year effect (together with 95% confidence limits) for policing effort (top), the number of confiscations plus abandonments (middle) and the ratio of the number of confiscations plus abandonments to policing effort (bottom) for Super-area 3+4. The red dashed line shows results when the policing effort “sea patrol” is included.

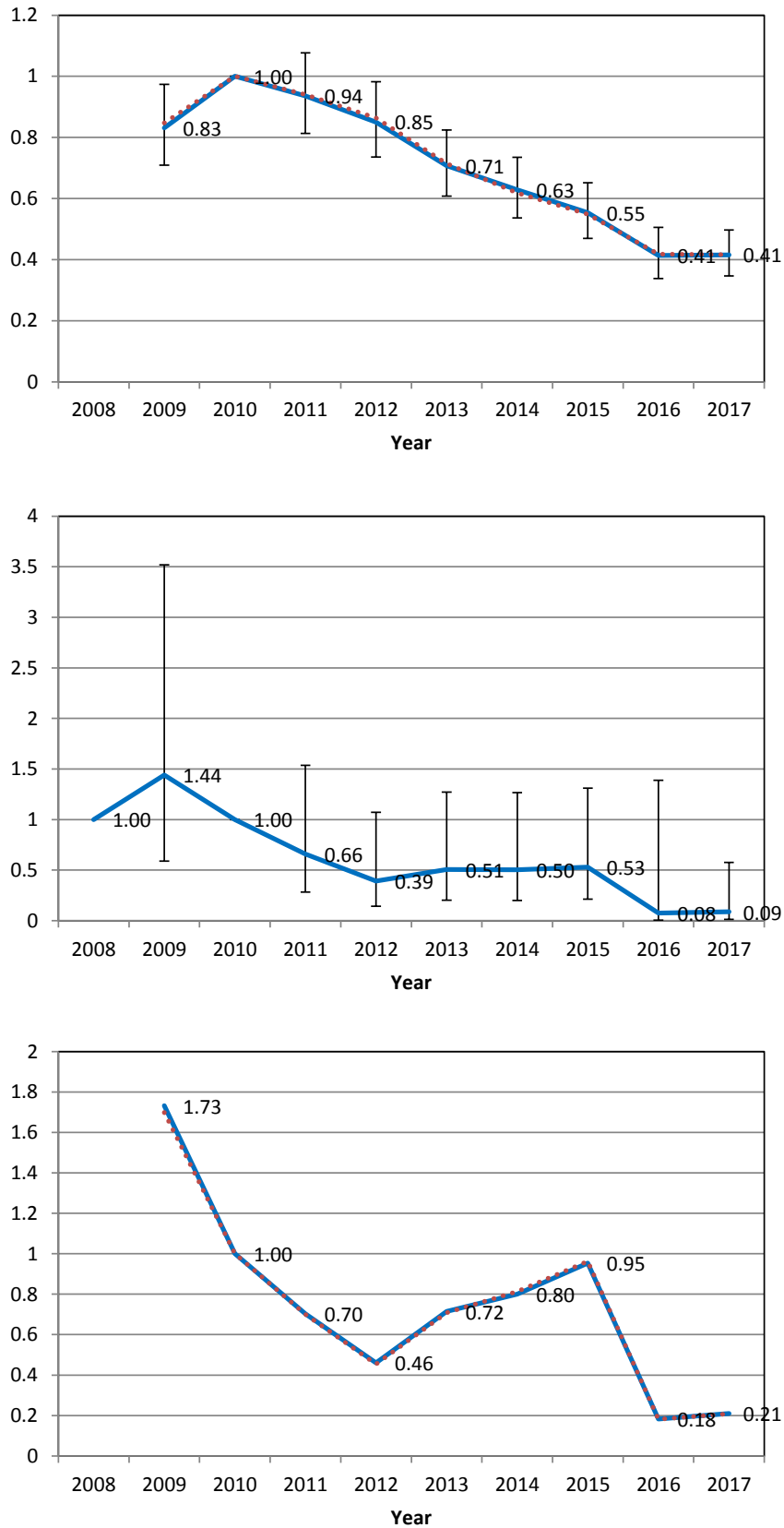


Figure 2. Year effect (together with 95% confidence limits) for policing effort (top), the number of confiscations plus abandonments (middle) and the ratio of the number of confiscations plus abandonments to policing effort (bottom) for Super-area 5+6+7. The red dashed line shows results when the policing effort “sea patrol” is included.

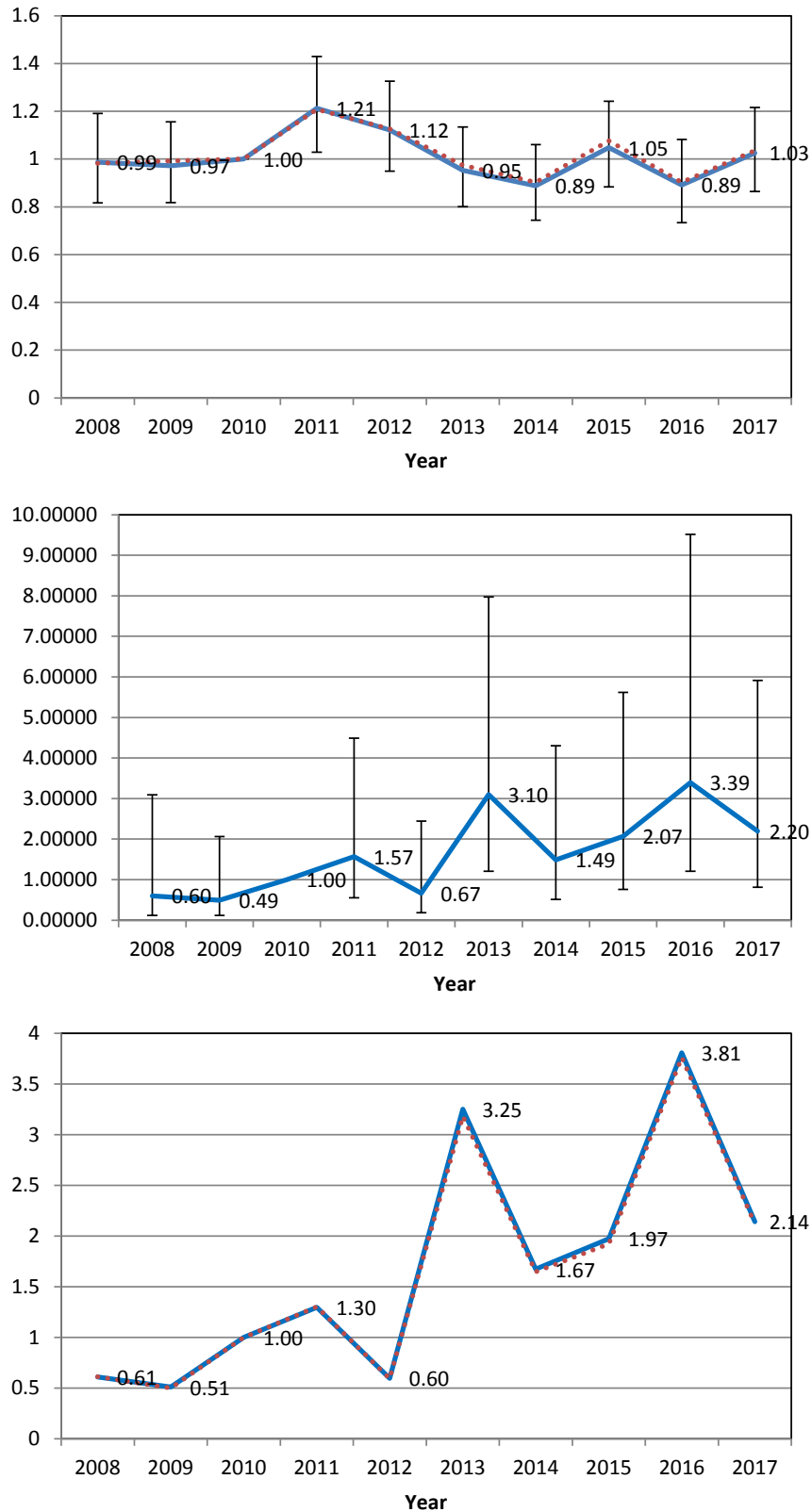


Figure 3. Year effect (together with 95% confidence limits) for policing effort (top), the number of confiscations plus abandonments (middle) and the ratio of the number of confiscations plus abandonments to policing effort (bottom) for Super-area 8+. The red dashed line shows results when the policing effort “sea patrol” is included.

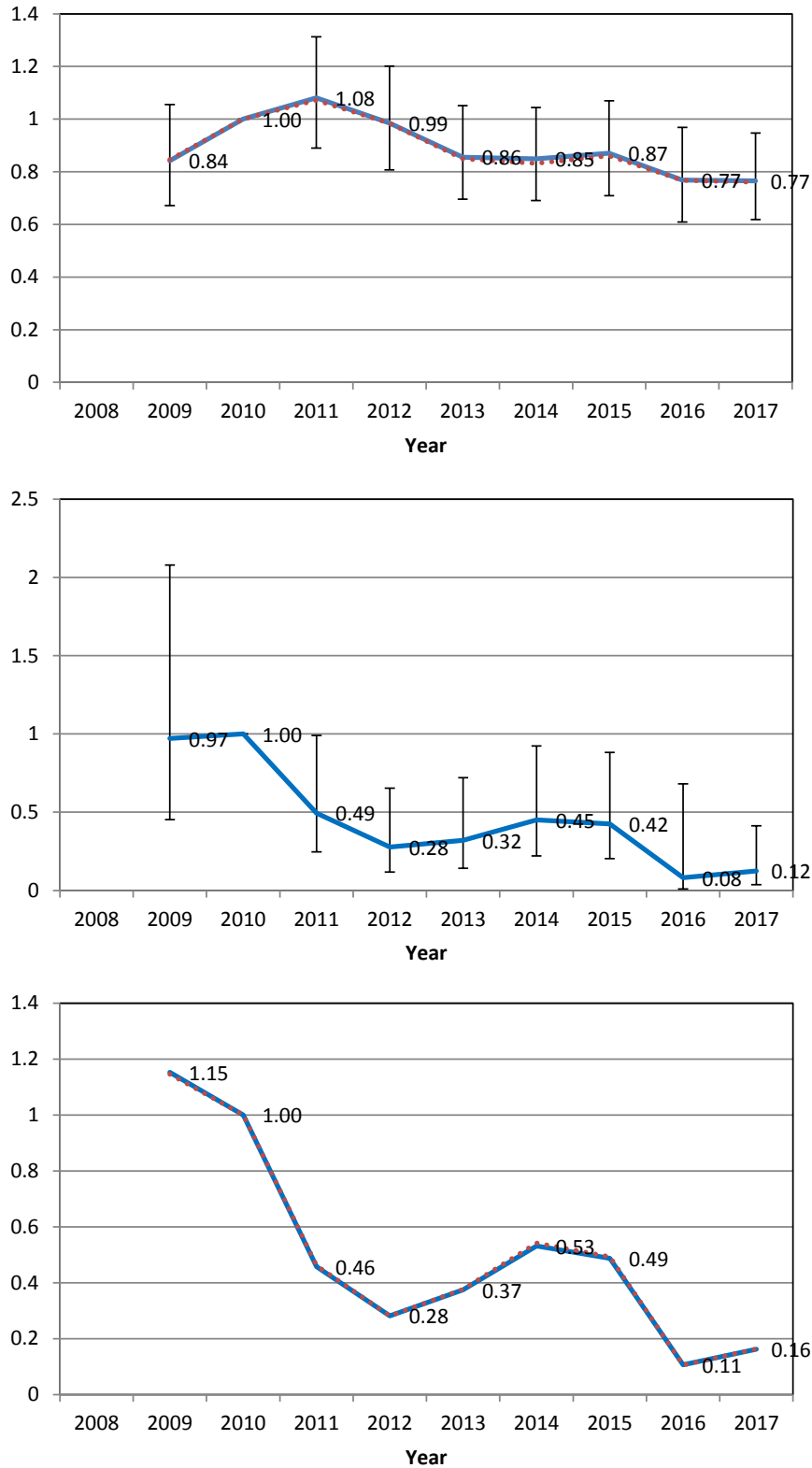


Figure 4. Year effect (together with 95% confidence limits) for policing effort (top), the number of confiscations plus abandonments (middle) and the ratio of the number of confiscations plus abandonments to policing effort (bottom) for Super-areas 3+4+5+6+7. The red dashed line shows results when the policing effort “sea patrol” is included.

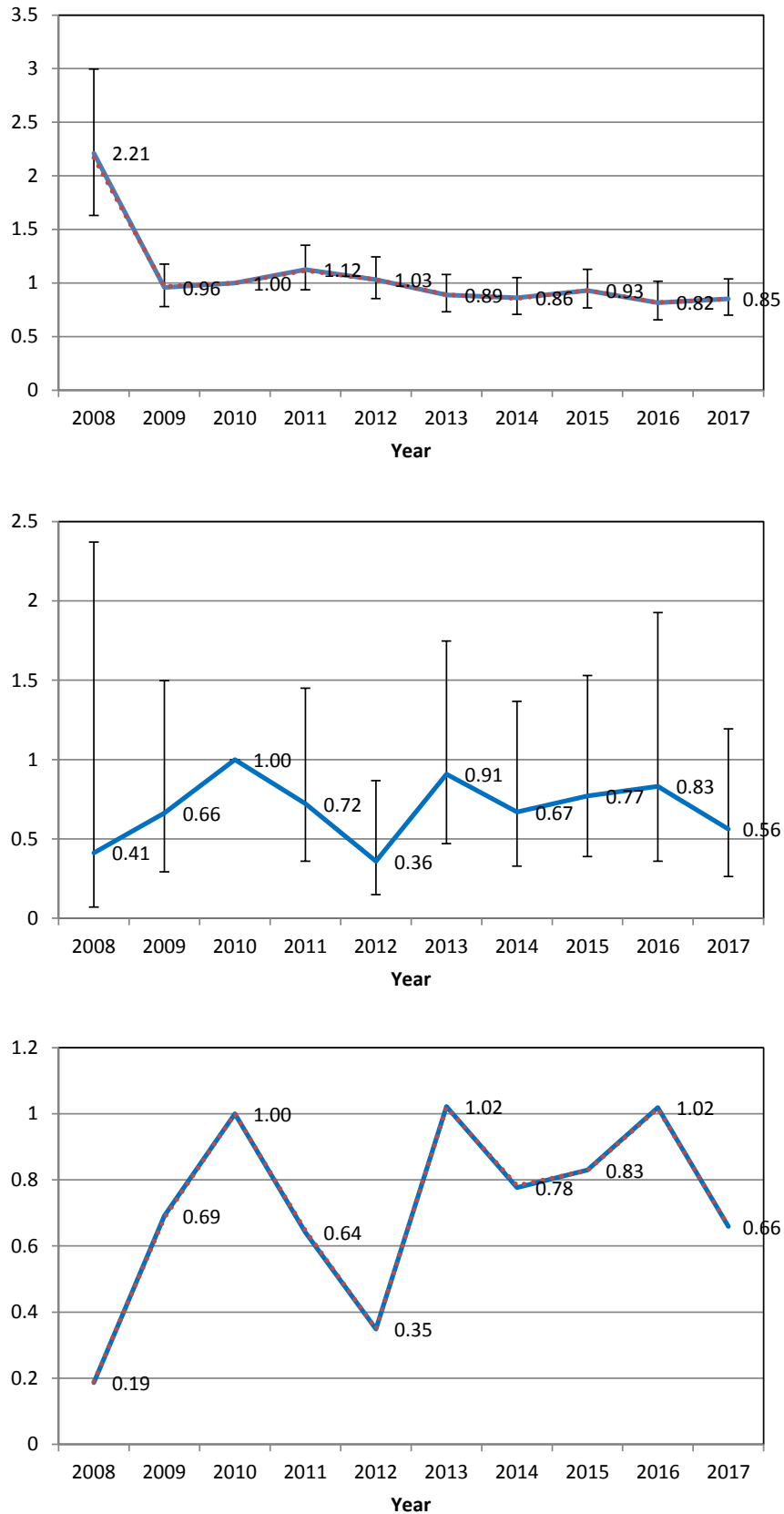


Figure 5. Year effect (together with 95% confidence limits) for policing effort (top), the number of confiscations plus abandonments (middle) and the ratio of the number of confiscations plus abandonments to policing effort (bottom) for Super-areas 3+4+5+6+7+8+. The red dashed line shows results when the policing effort “sea patrol” is included.

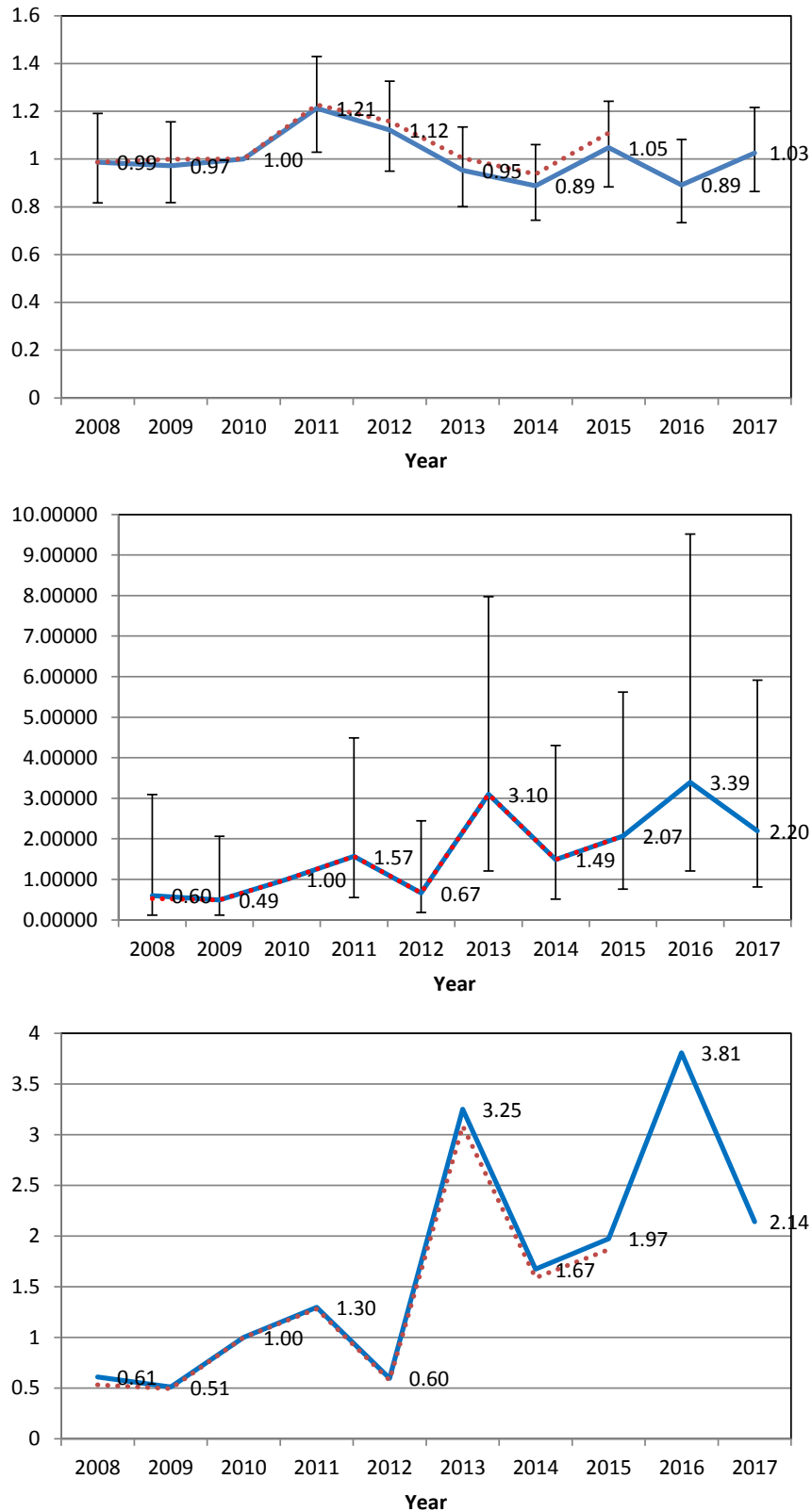


Figure 6a. Year effect (together with 95% confidence limits) for policing effort (top), the number of confiscations plus abandonments (middle) and the ratio of the number of confiscations plus abandonments to policing effort (bottom) for Super-area 8+. The red dashed line shows results from two years previously (Brandão et al. 2016).

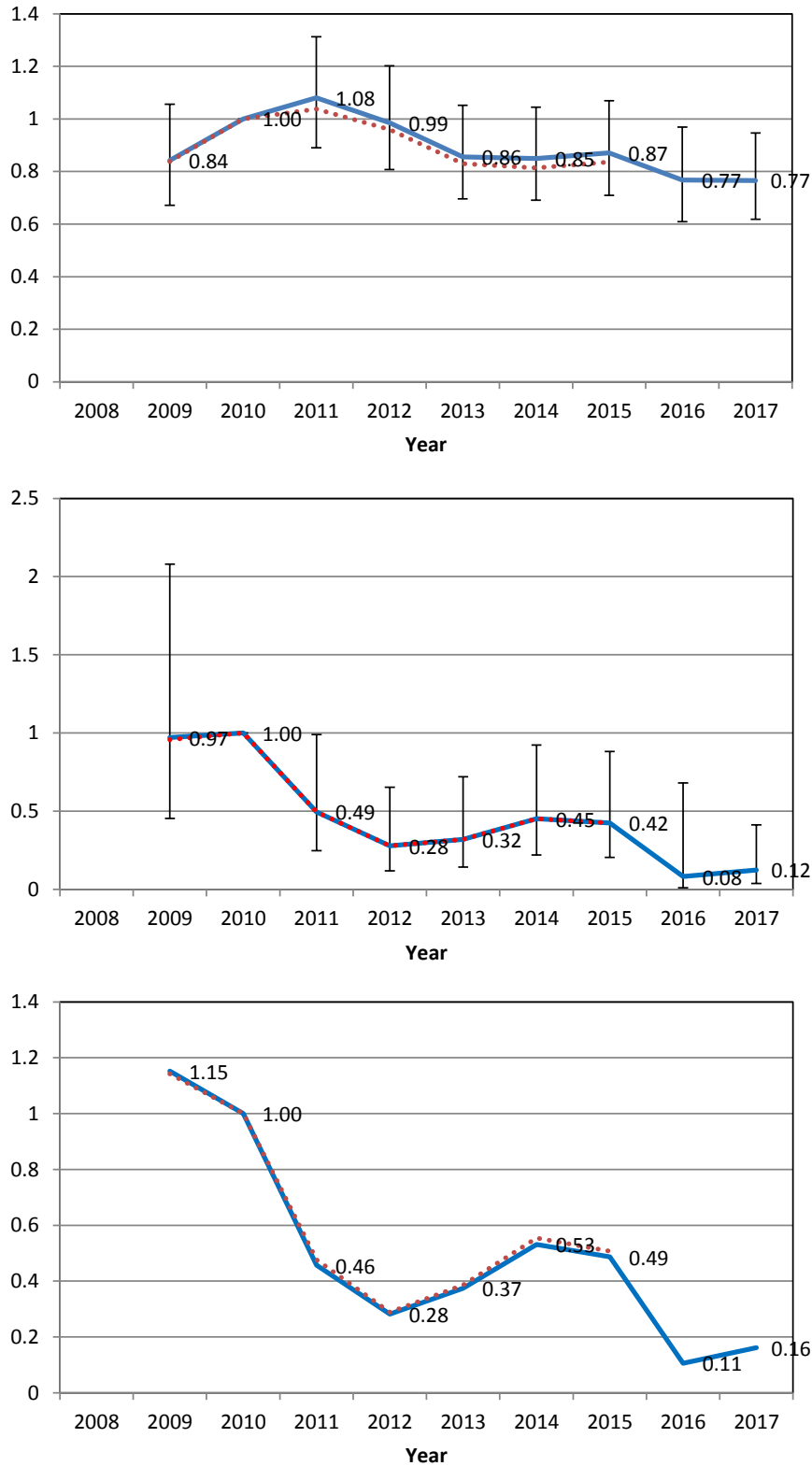


Figure 6b. Year effect (together with 95% confidence limits) for policing effort (top), the number of confiscations plus abandonments (middle) and the ratio of the number of confiscations plus abandonments to policing effort (bottom) for Super-areas 3+4+5+6+7. The red dashed line shows results from two years previously (Brandão et al. 2016).