

Trends in policing effort and the number of confiscations for West Coast rock lobster

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Introduction

To obtain overall annual rates of increase in number of confiscations 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, Generalized Linear Models (GLMs) are applied to these data, as summarised in Table 1.

Methods

Generalized linear models (GLMs) were used to investigate the variation of the number of confiscations of rock lobster as well as that 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 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).

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, 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 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 2011).

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 being that the β_{type} effect does not apply in this case. No weighting of the data is performed in this case.

Results

Table 2 shows the parameter estimates for the GLMs fitted to the policing effort data and to the number of confiscations.

For policing effort, whether a linear or nonlinear function is assumed over time, a positive trend is evident (Table 2 and Figure 1). An increase of 31% per year is obtained assuming a linear relationship. Under the categorical (nonlinear) approach, a steady increase is still apparent.

For the number of confiscations, an increasing trend (66% per year) is obtained if a linear relationship is assumed (Table 2). However the results are more complex under a categorical analysis, with a maximum in 2010 (Table 2 and Figure 2), though note the large CI for 2011 for which only three months of data are available.

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

Confiscations: 65.6% (s.e. = 19.1%)

Policing effort: 30.8% (s.e. = 3.7%)

Together these suggested that removals from poaching have been increasing at an instantaneous rate of 34.8% p.a. (s.e.=19.5%) over the last three years. This corresponds to a net increase of 41.6% over one year, or 100.6% over two.

Johnston (2011) applied simple log-linear regression analysis to the policing and confiscations data, pooling data on 3-monthly intervals. After correcting for an error in the 2011 confiscations data, and also for some lesser errors in the effort data, the corresponding values for instantaneous annual rates of increase for the data as shown in Table 1 are:

Confiscations¹: 93.6% (s.e. = 41.4%)

Policing effort²: 29.3% (s.e. = 5.3%)

where the effort figure is an inverse variance weighted average over all of the indices which have been reported for all 12 quarters.

Together these suggested that removals from poaching have been increasing at an instantaneous rate of 64.3% p.a. (s.e.=41.8%) over the last three years, corresponding to a net increase over one year of 90% or over two years of 262%. The new analyses presented in this document thus suggest a somewhat lower annual rate of increase in such removals.

Reference

Johnston, S.J. 2011. Super-area breakdown of West Coast rock lobster confiscations and policing records. Fisheries/2011/May/SWG-WCRL/23.

¹ Increased from Johnston (2011).

² Hardly changed from Johnston (2011).

Table 1. Confiscations and policing effort on a monthly basis.

	Confiscations (# lobster)	Vehicles inspected	Permit checks	Slipway inspections	Coastal patrols	Road blocks	Sea patrols	Restaurant inspections
April 08	507	419	979	474	707	12	0	30
May 08	217	409	896	456	676	10	1	44
June 08	1510	349	528	322	571	2	0	47
July 08	14	407	596	345	592	3	0	87
Aug 08	46	342	383	249	467	5	1	27
Sep 08	493	230	214	127	149	3	0	29
Oct 08	513	378	347	221	349	9	5	28
Nov 08	60	265	151	143	143	5	1	27
Dec 08	392	380	765	248	269	8	0	21
Jan 09	269	464	1144	265	357	10	6	16
Feb 09	277.1	351	781	266	368	12	3	31
Mar 09	825	434	416	197	243	4	4	23
April 09	6928	1485	1172	546	470	34	5	29
May 09	850	1193	719	436	490	47	13	69
June 09	1048	364	910	505	570	11	4	58
July 09	96	223	901	744	886	2	2	82
Aug 09	264	858	850	765	858	116	0	100
Sep 09	14	287	498	377	490	10	8	53
Oct 09	103	577	935	572	608	17	14	101
Nov 09	972	946	1597	520	769	20	9	65
Dec 09	478	678	1597	581	663	16	6	29
Jan 10	9226	1195	1091	842	1160	20	12	44
Feb 10	8269	538	861	421	675	5	4	81
Mar 10	13729	363	931	676	653	8	14	53
Apr 10	8398	176	458	386	566	7	1	101
May 10	581	423	185	377	466	11	0	108
Jun 10	207	268	474	429	510	13	2	132
July 10	138	1107	668	669	675	18	2	133
Aug 10	1159	372	823	762	844	18	2	94
Sep 10	86	196	423	357	451	5	8	106
Oct 10	1032	798	478	563	686	13	8	62
Nov 10	1929	1065	1328	610	703	27	14	53
Dec 10	5270	428	2115	738	714	25	14	46
Jan 11	5942	475	1351	894	1691	17	9	67
Feb 11	11408	144	794	787	715	7	15	55
Mar 11	5071	226	719	788	792	9	7	70

Table 2. GLM parameter/coefficient (and standard error) estimates.

	Policing effort (year factor)	Policing effort (linear)	Confiscations (year factor)	Confiscations (linear)
January	-0.067 (0.146)	0.236 (0.138)	0.518 (0.569)	0.867 (0.629)
February	-0.376 (0.155)	-0.099 (0.149)	0.775 (0.552)	1.069 (0.609)
March	-0.401 (0.156)	-0.150 (0.150)	0.758 (0.553)	0.998 (0.611)
April	-0.028 (0.145)	0.177 (0.150)	0.947 (0.548)	1.385 (0.639)
May	0.011 (0.144)	0.191 (0.148)	-1.320 (1.010)	-0.930 (1.160)
June	-0.065 (0.147)	0.089 (0.150)	-0.798 (0.835)	-0.470 (0.959)
July	0.196 (0.138)	0.325 (0.141)	-3.210 (2.360)	-2.940 (2.700)
August	0.165 (0.139)	0.267 (0.142)	-1.430 (1.060)	-1.210 (1.210)
September	-0.360 (0.159)	-0.283 (0.162)	-2.340 (1.560)	-2.170 (1.790)
October	-0.023 (0.145)	0.028 (0.148)	-1.320 (1.010)	-1.210 (1.160)
November	-0.007 (0.145)	0.018 (0.147)	-0.729 (0.815)	-0.675 (0.932)
December	0	0	0	0
Time (yr⁻¹)	—	0.308 (0.037)	—	0.656 (0.191)
2008	-0.710 (0.090)	—	-1.847 (0.636)	—
2009	-0.142 (0.069)	—	-1.417 (0.369)	—
2010	0	—	0	—
2011	0.343 (0.120)	—	-0.157 (0.324)	—
coastal	0.156 (0.125)	0.156 (0.127)	—	—
permits	0.435 (0.135)	0.435 (0.137)	—	—
restaurant	-2.146 (0.122)	-2.146 (0.124)	—	—
road	-3.516 (0.187)	-3.516 (0.190)	—	—
sea	-4.574 (0.181)	-4.574 (0.184)	—	—
slipway	-0.063 (0.123)	-0.063 (0.125)	—	—
vehicles	0	0	—	—

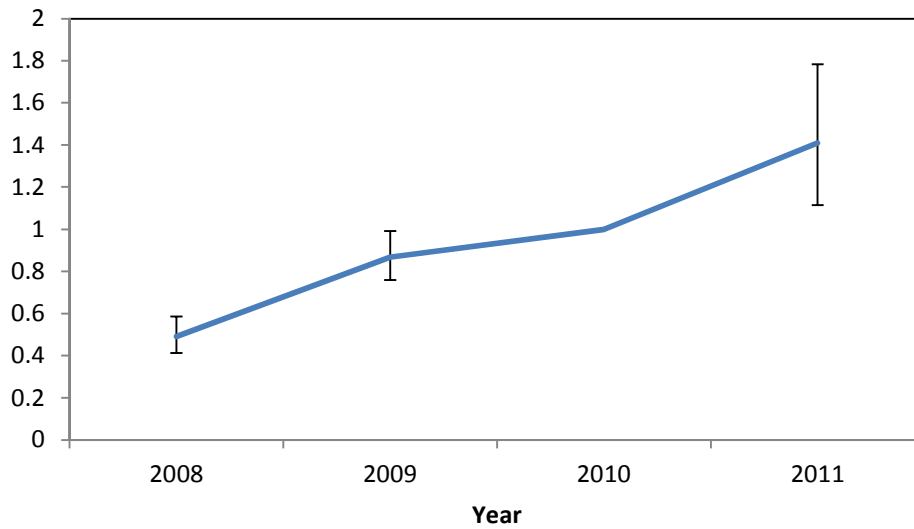


Figure 1. Year effect (together with 95% confidence limits) for policing effort.

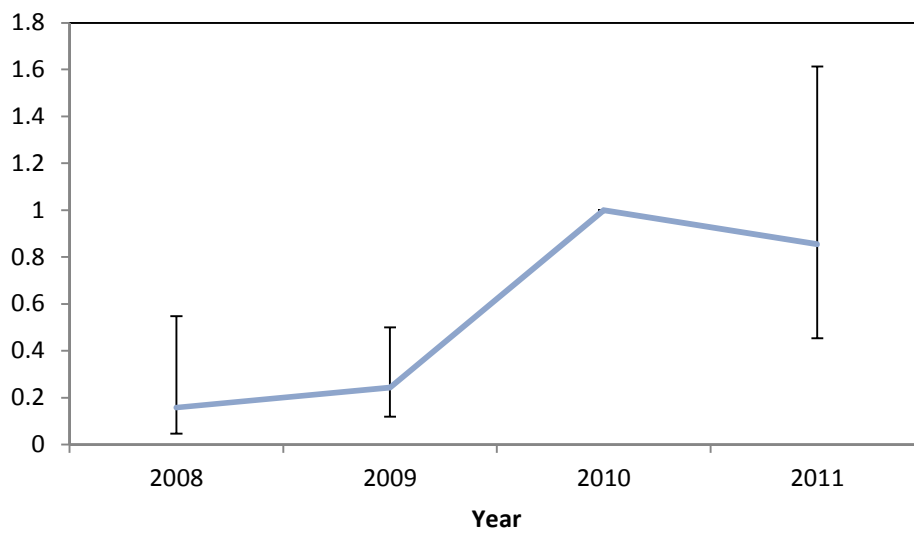


Figure 2. Year effect (together with 95% confidence limits) for the number of confiscations.