

Overall poaching time series for west coast rock lobster, resulting from combining estimates of illegally exported and locally sold lobsters and compliance time series as at June 2021

Johnston, S.J. and Butterworth, D.S.

Summary

TRAFFIC and Compliance poaching indices are combined to provide an overall time series for poaching in absolute terms. This incorporates penalties on options that imply negative values for local sales of poached lobster, and large changes in the amount poached from year to year. The approach is applied to these indices separated by North and South areas. Two options for overall poaching time series, dependent on the value assumed for current local sales, are put forward, with the intent that they bound the range considered plausible.

Key words: West coast rock lobster, *Jasus lalandii*, poaching time series

Background

There are three sources of information on poaching which need to be combined.

- 1) The **TRAFFIC** time series of annual amounts of poached lobster exported, obtained by comparison of international import and export statistics. These values are absolute (in tons) and are underestimates of the total amount poached each year as they do not include illegal catches sold locally. These data extend from 2001 to 2021. A method of applying linear regressions to pre-2021 values was used to produce a more reliable estimate for 2021 of 95mt by adjusting for the downward bias in the most recent value reported that has been consistently indicated over previous years (see Appendix).
- 2) The **compliance** time series obtained from statistics collected by the DFFE compliance section from 2008 to 2021. These are relative indices (i.e. NOT in tons) and are taken to apply to all poaching (i.e. covering both international and local sales). Some assumption is needed to scale these values to absolute quantities in tons (mt).
- 3) Impressions of the likely size of the **locally sold illegal catch** in 2021. In 2021, the west coast rock lobster task team (TT) had different views on the appropriate value for this amount, but reached a compromise agreement to consider a range from 200 to 850 tons. The value assumed here is of importance for the process used to scale the compliance series to tons. The scaling factor is the ratio of the sum of the 2021 international illegal amount (from TRAFFIC) and the local illegal amount assumed, divided by the 2021 compliance series value.

The final composite series was constructed by:

- a) Using the historical poaching time series to 2008 (using historical trends described below).
- b) From 2009 to 2021 using the compliance series calibrated as described in 3) such that the total poaching (export plus local sales) in 2021 is either 295t or 945mt. (A lower value of 200mt rather than 400mt as assumed last year was used to provide a wider range, given views from some that the 400mt is unrealistically large.)

Previous TT proposals regarding poaching time series and quantities were developed through a number of steps. These are set out in detail below.

North: South split (North A3-7 : South A8+) (unchanged from previous years' assumptions)

North : South in 2008: 30 : 70

The relative splits of poaching in the North area amongst A3+4, A5+6 and A7 remain as previously, and are (as a % of poaching in the North):

A3+4: 37.5% (i.e. in 2008 11.25% of total)

A5+6: 37.5% (i.e. in 2008 11.25% of total)

A7: 25.0% (i.e. in 2008 7.5% of total)

Historical Trend (relative trend with a value of 1.0 in 2008)

Pre-1990 0.5 in 1990 decreasing linearly to zero in 1950

South 1990 – 2008 0.5 (in 1990) → 1.13 (in 2008)

North 1990 – 2008 0.5 (in 1990) → 1.00 (in 2008)

TRAFFIC absolute values

The TRAFFIC data provide absolute estimates of poaching for the 2001-2020 period. A value of 95t is taken to be a more reliable (bias corrected) estimate for 2020 (based on linear regression analyses (see Appendix)). Figure 1a shows the 3-pt smoothed estimates to be used as input into the combined poaching model.

The compliance time series

Figure 1a shows the final estimates of time series in poaching from the DFFE compliance data for both the North (A3-7) and South (A8+). The plots show the results from the application of the 3-pt smoothing method (Brandao and Butterworth 2022) to summarise those estimates. For the South, there is both a Reference Case time series as well as a sensitivity (which omits very large values in the 2021 database).

Final Poaching time series combining the TRAFFIC and Compliance data

The same method is used as in in 2021 (Johnston and Butterworth 2020, 2021).

Information available

C_y Annual compliance-based **index** of poaching for each of the North and South areas. This trend is assumed to apply to the combination of illegal local sales and exported lobsters [2009-2021].

T_y TRAFFIC-based estimates of illegally exported lobster [2001-2021]. The TRAFFIC estimates are split 0.30:0.70 between the North and South areas.

- L_y Annual locally sold poached lobster [2009-2021] [These values are to be **estimated**].
- P_y Total annually poached lobster (exported and locally sold added together) for each of the North and South areas [2008-2021].

Assumptions

- 1) P_y is roughly proportional to C_y , i.e. $P_y = k \cdot C_y + \text{error}$.

$$\text{Thus } k = \frac{\sum_{2009}^{2021} P_y}{\sum_{2009}^{2021} C_y}.$$

$$\text{Also } P_y = T_y + L_y$$

- 2) A fixed value of locally sold poached lobsters L_{2021} is used for input. Here we set $L_{2021} = 850$ mt and 200 mt. These relate to the Total local sales estimate, and these are again split 0.30:0.70 between the North and South areas.

Furthermore

- 3) L_y should not be negative.
- 4) P_y should not change too much from year to year.

Estimable parameters: $L_{2009}, L_{2010} \dots L_{2020}$ (12 estimable parameters). [L_{2021} is fixed]

The values of the estimable parameters are obtained by minimising the following function:

$$SS = SS1 + SS2 + SS3$$

$$SS = w1 * \sum_{2009}^{2021} (P_y - kC_y)^2 + w2 * \sum_{2009'}^{2021'} L_y^2 + w3 * \sum_{2009}^{2021} [P_y - P_{y-1}]^2$$

where $\sum_{2009'}^{2021'} L_y^2$ is summed only for those years for which L_y is negative.

The weights $w1$, $w2$ and $w3$ can be varied to see what form of P_y trajectories result. Here we use the same weights as in 2021, i.e. and $w1=1$, $w2=5$, and $w3=0.5$.

Note:

By increasing $w2$, the Local Sales trajectory is pushed higher, so that negative values are kept increasingly small.

By increasing $w3$, the overall poaching time series is “smoothed” over time.

Further statistics

Plots of the residuals (difference between P_y and $k.C_y$) are produced, along with the SS1 value of $w1 * \sum_{2009}^{2021} (P_y - k.C_y)^2$.

An AAV (annual average variation) statistic is calculated to represent the average fluctuation in the poaching estimates.

$$\text{where } AAV = \frac{\sum_{2009}^{2020} |P_{y+1} - P_y| / P_y}{11} * 100$$

Results

Last season (2021) it was agreed that for results should be presented for the weights of $w1=1$, $w2=5$, $w3=0.5$ as these seemed to reflect reasonable compromise weightings.

Two levels of total 2021 local sales are explored – these being 850mt and 200mt (see above for the reason this is used rather than 400mt as last year). Note that 850mt is split between North and South as 255mt and 595mt, and 200mt is split as 60mt and 140mt.

A recent document (FISHERIES/2022/JUN/SWG/WCRL09) provided results of residual analyses and a further sensitivity to “outlier” omission of the model to obtain Compliance poaching time series for West Coast rock lobster. As for last year the Base Case is used for both the North and the South, but the Sensitivity for the South for which outliers are omitted is also explored.

Table 1 and Table 2 reports results of the SS1 and AAV statistics respectively for North and South (and 850mt and 200mt values for L(2020)).

The final estimates of combined local and exported poached lobster (mt) for the North, South and Total (North+South) are shown in Figure 4a. The South has two different compliance time series (BC and SEN).

The final estimates of implied locally sold poached lobster (mt) ($P(y)-T(y)$) for the North, South and Total (North+South) are shown in Figure 4b. The South has two different compliance time series (BC and SEN).

Discussion

This approach is again attractive in being able to produce smoother series over time and reducing the extent of implied negative numbers of poaching lobsters sold locally in certain years.

References

Brandão, A. and Butterworth, D.S. 2022. Updated compliance poaching trends for West Coast rock lobster from modelling the “old” and “new” databases simultaneously. FISHERIES/2022/JUN/SWG/WCRL09.

Johnston, S.J. and Butterworth, D.S. 2021. Final poaching trends using the new approach to combine estimates of illegally exported and locally sold west coast rock lobster. FISHERIES/2021/JUL/SWGTT/WCRL19.

Louw, S., Okes, N and Burgener, M. (TRAFFIC Southern Africa). 2021. Estimating the number of poached lobsters exported from South Africa to international market destinations (2000-2021). Fisheries/2022/JUN/SWG/WCRL10/

Table 1: The SS1 statistic (which measures the goodness of fit to the compliance time series).

	L(2021)	Compliance Time Series	w1=1, w2=5, w3=0.5
NORTH	850	BC	5.2×10^4
	200	BC	6.6×10^4
SOUTH	850	BC	224×10^4
	200	BC	305×10^4
	850	SEN	120×10^4
	200	SEN	190×10^4

Table 2: The AAV statistic (which measures the smoothness of the poaching trajectory).

	L(2021)	Compliance Time Series	w1=1, w2=5, w3=0.5
NORTH	850	BC	26.11
	200	BC	21.94
SOUTH	850	BC	18.26
	200	BC	14.74
	850	SEN	12.55
	200	SEN	13.39

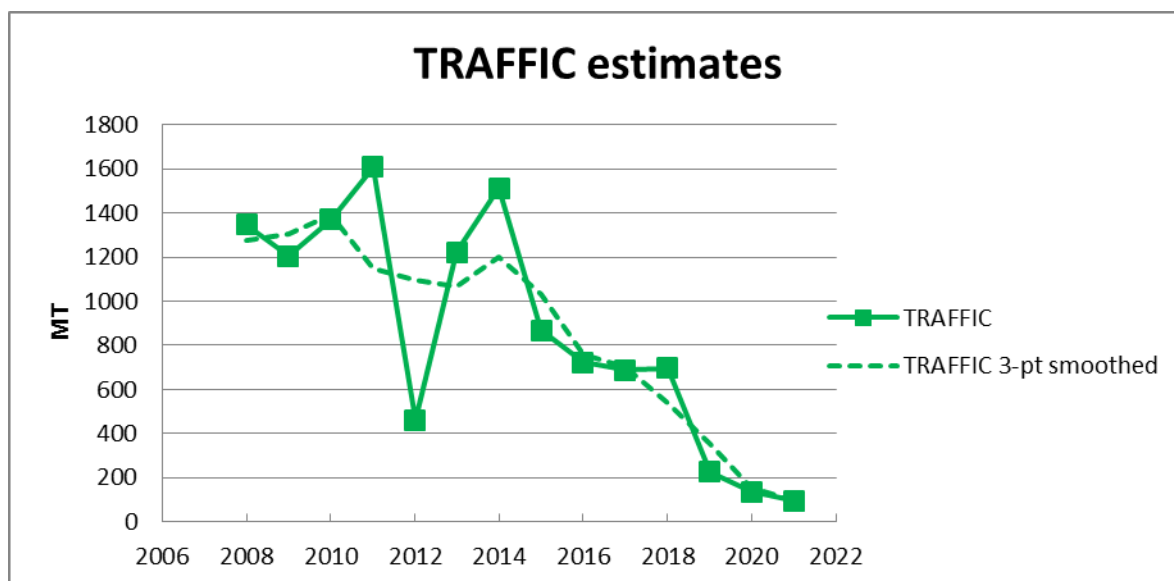


Figure 1a: Updated TRAFFIC estimates and their 3-pt smoothed time series [Note the 2021 value for both is 95mt].

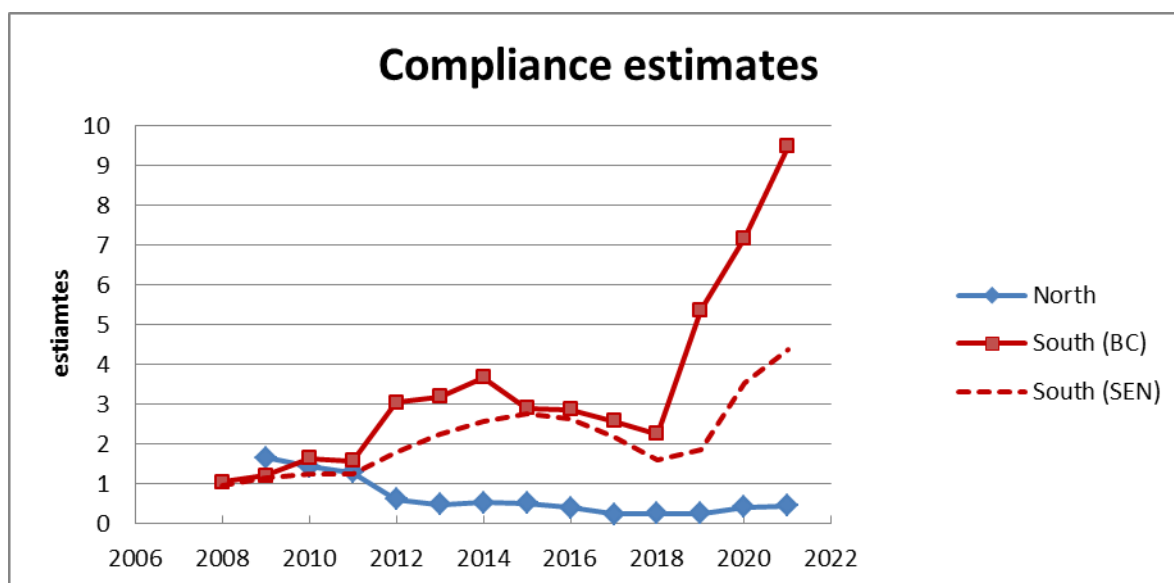


Figure 1b: Compliance time series for the North and South (3-pt smoothed time series are shown).

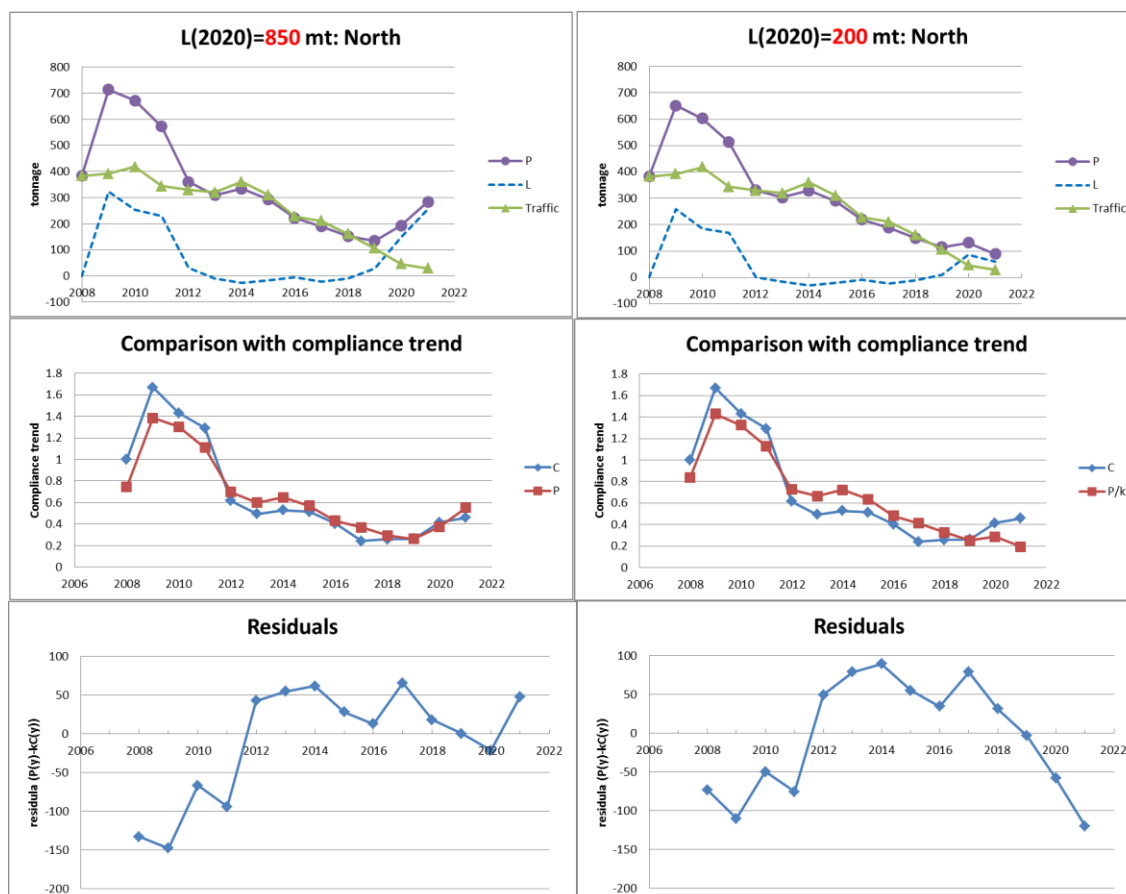


Figure 2: Poaching trajectories for the **North** for a total (i.e. North and South combined) L(2021) of either 850mt or 200mt. The top plots show the final poaching time series (P) for the North, along with the proportions of the TRAFFIC estimates (TRAFFIC) assumed to apply to the North and the estimated local sales for the North (L). The middle plots show the comparisons of the poaching time series (P/k) with the compliance time series (C), and the bottom plots show the residuals for those comparisons.

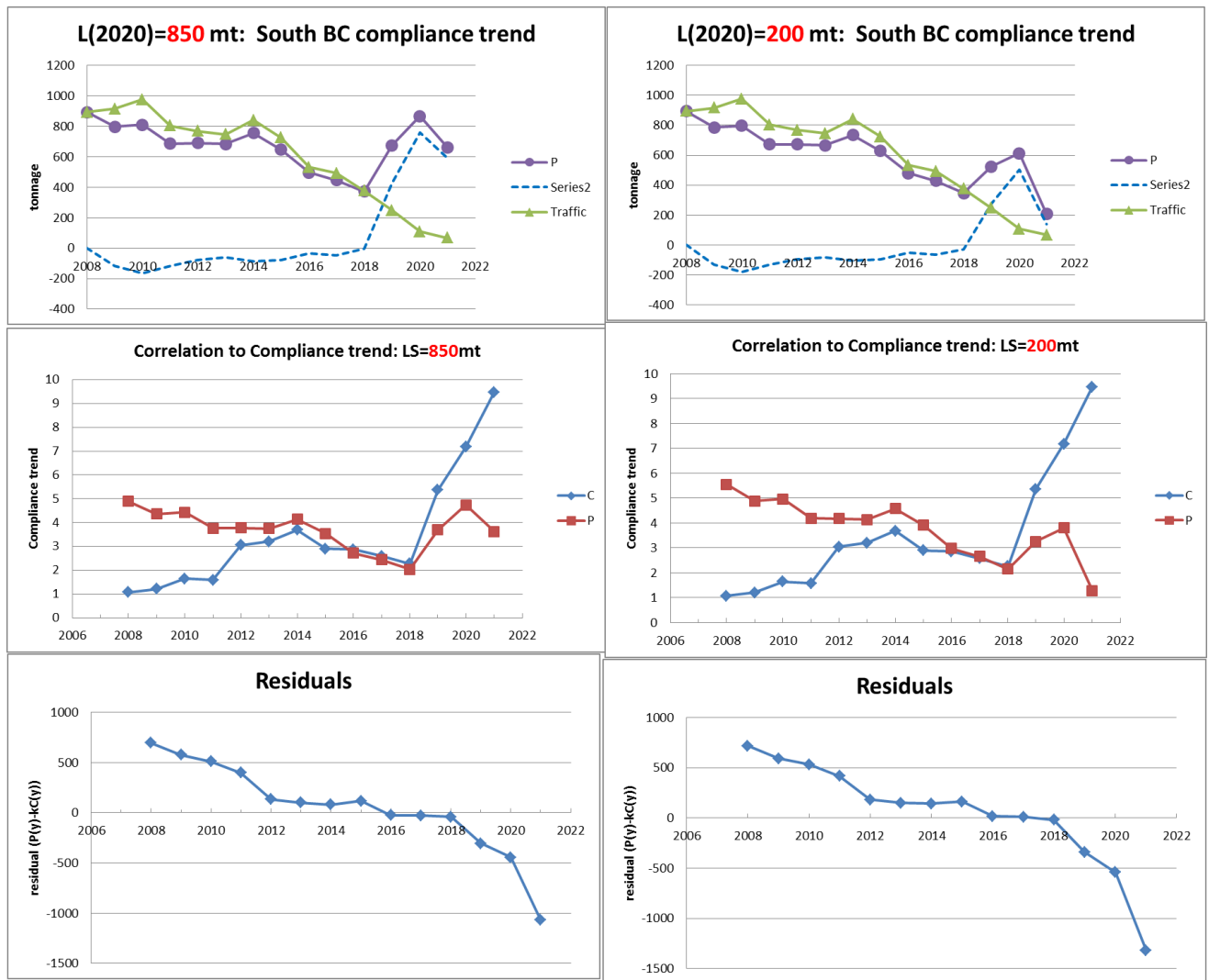


Figure 3a: Poaching trajectories for the **SOUTH** for a total (i.e. North and South combined) L(2021) value of either 850mt or 200mt. Results are presented assuming the **BC compliance** time series. The top plots show the final poaching time series (P) for the South, along with the proportions of the TRAFFIC estimates (TRAFFIC) assumed to apply to the South and the estimated local sales for the South (L). The middle plots show the comparisons of the poaching time series (P) with the compliance time series (C), and the bottom plots show the residuals for those comparisons.

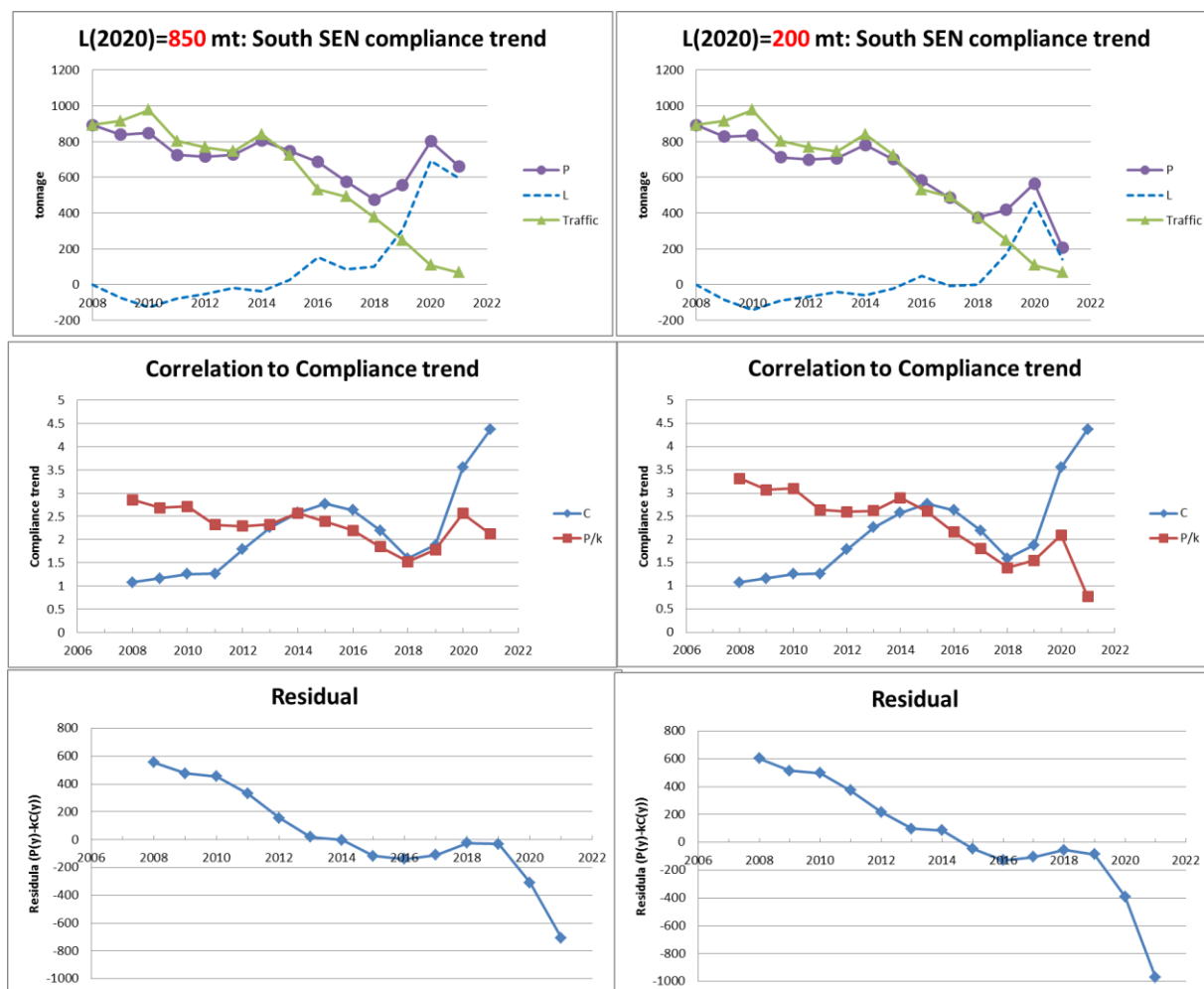


Figure 3a: Poaching trajectories for the **SOUTH** for a total (i.e. North and South combined) L(2021) value of either 850mt or 200mt. Results are presented assuming the **SEN compliance** time series. The top plots show the final poaching time series (P) for the South, along with the proportions of the TRAFFIC estimates (TRAFFIC) assumed to apply to the South and the estimated local sales for the South (L). The middle plots show the comparisons of the poaching time series (P) with the compliance time series (C), and the bottom plots show the residuals for those comparisons.

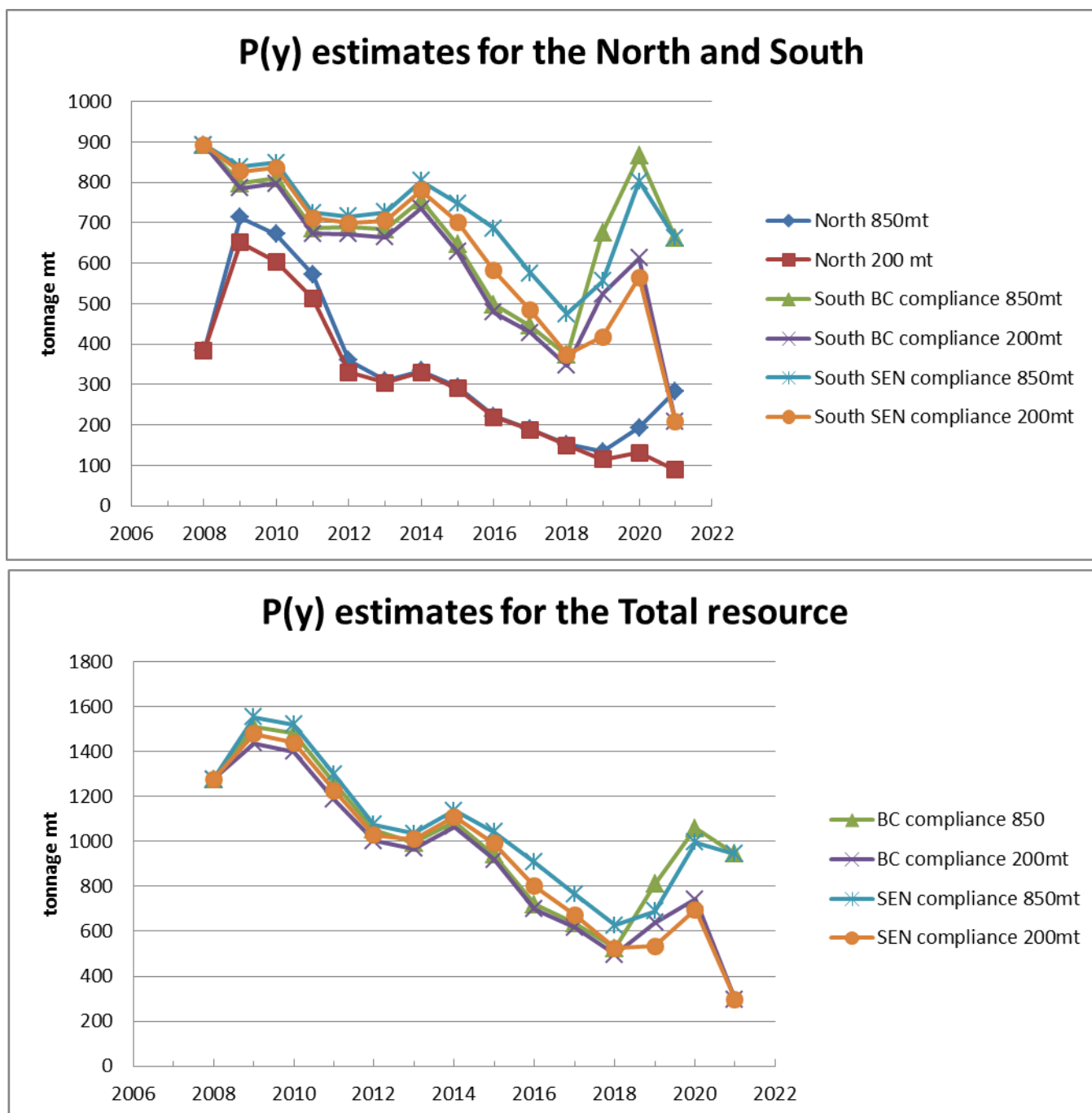


Figure 4a: Poaching $P(y)$ estimates for the North and South (top plot) and the total resource (bottom plot). Results are for 850mt or 200mt for $L(2021)$, and two compliance trends applicable to the South.

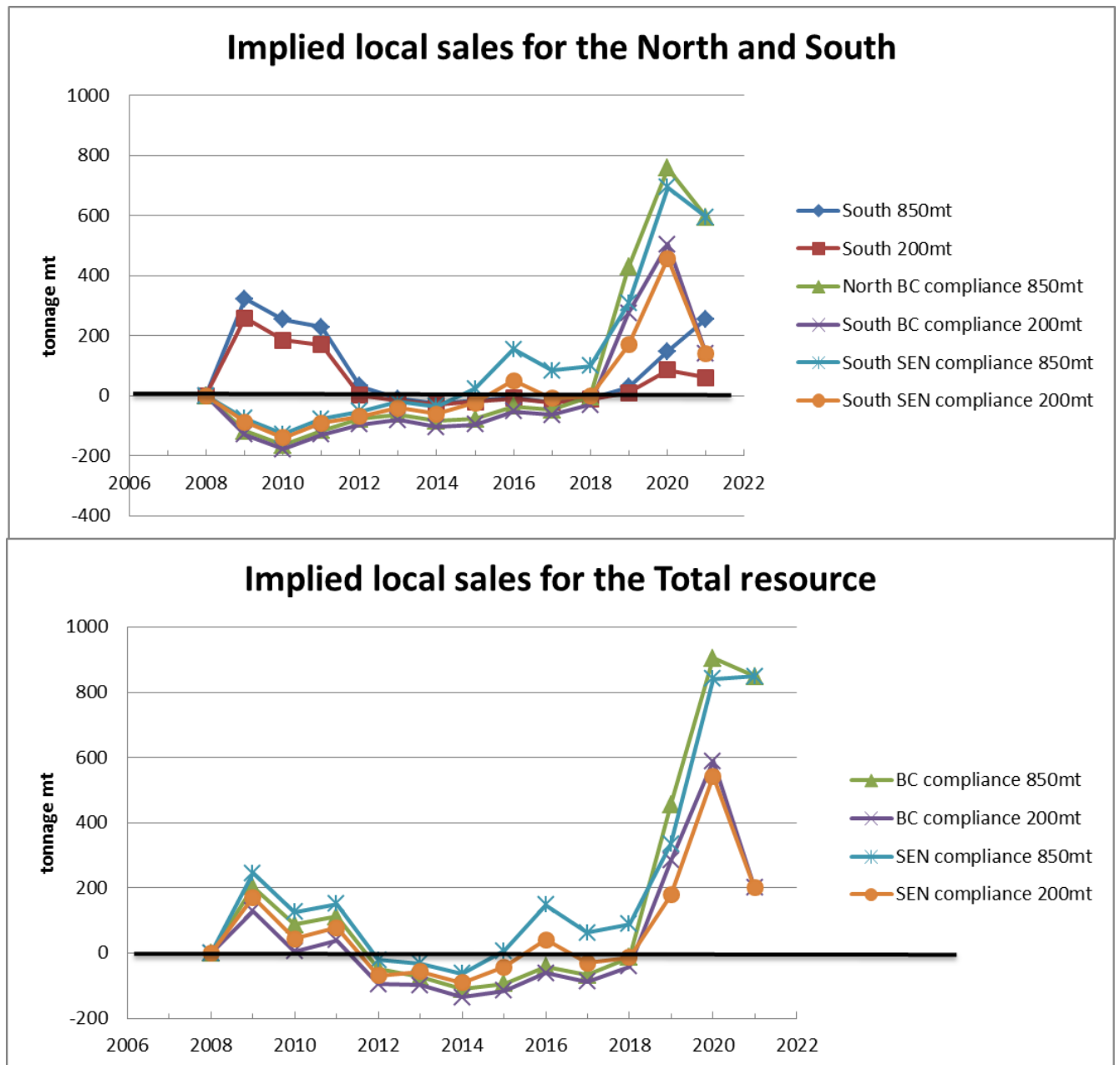


Figure 4b: Implied local sales estimates ($P(y)-T(y)$) for the North and South (top plot) and the total resource (bottom plot). Results are for 850mt or 200mt for the 2020 local sales $L(2020)$, and two compliance time series applicable to the South.

Appendix

Projected TRAFFIC estimates for 2021 assuming different starting years for linear regressions

Updated TRAFFIC estimates (FISHERIES/2022/JUNE/SWG/WCRL/10) were provided recently. The initial estimate of 50 mt for 2021 is again low. These recent low estimates have been shown in the past to increase over time as more data become available, so some adjustment for this bias is required, as explained below.

Linear regressions were applied to these estimates for different starting years up to and including the 2020 estimate. Each regression was then used to predict the value for 2021. This is the same approach as used in the previous two years (FISHERIES/2020/AUG/WCRL/WP4 and FISHERIES/2021/JUN/SWG/03)), when again low estimates for the current year (then 2019 and 2020) were provided.

Table A1 and Figure A1 report these values. The regressions themselves are shown in Figure A2.

Starting year	Projected 2021 estimate (95% CI)
2007	76
2008	258
2009	226
2010	171
2011	153
2012	228
2013	-14
2014	-92
2015	44
2016	15
2017	-15
2018	[-200]
Ave 2007-2017	95

The 2018-2020 regression estimate for 2021 appears to be an outlier as it is so much larger (negatively) than any previous estimate and implies a negative take whereas the existence of a 50 t estimate is already known. This changed behaviour is perhaps not surprising, given the recent impact of COVID. Consequently, it has been excluded from the averaging.

From inspection of Figure A1 it would seem reasonable to assume a bias-corrected figure of 95mt should be assumed for the 2021 TRAFFIC estimate.

Note that last year, following this approach, the 2020 bias-corrected TRAFFIC estimate was assumed to be 350mt. This estimate is now updated to 138mt.

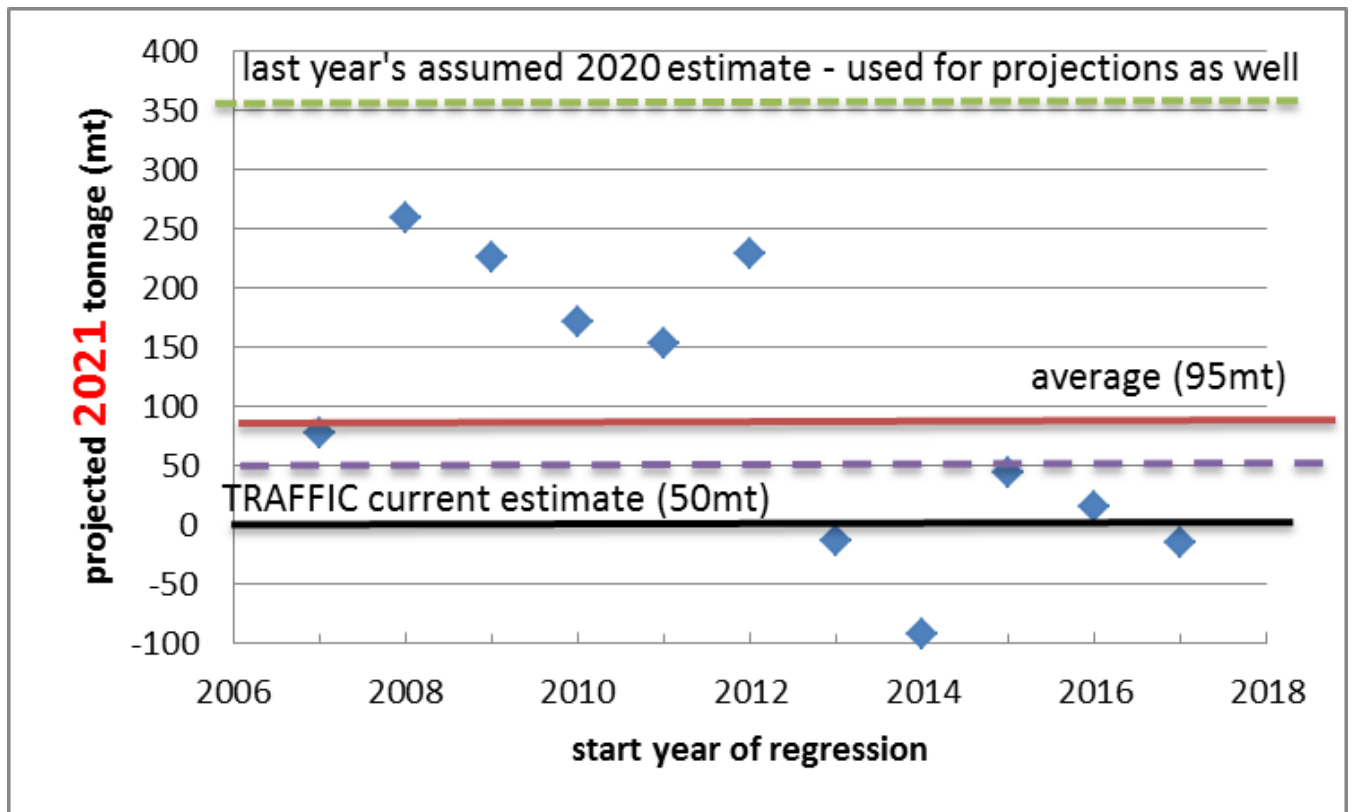


Figure A1: Plots of values in Table 1. The horizontal dashed purple line indicates the updated original TRAFFIC 2021 estimate of 50 mt. The green dashed line indicates the value assumed for projections last year (350mt – this excludes the local sales estimate). The red line is the average of the projected 2021 estimates reported in Table A1 (95mt).

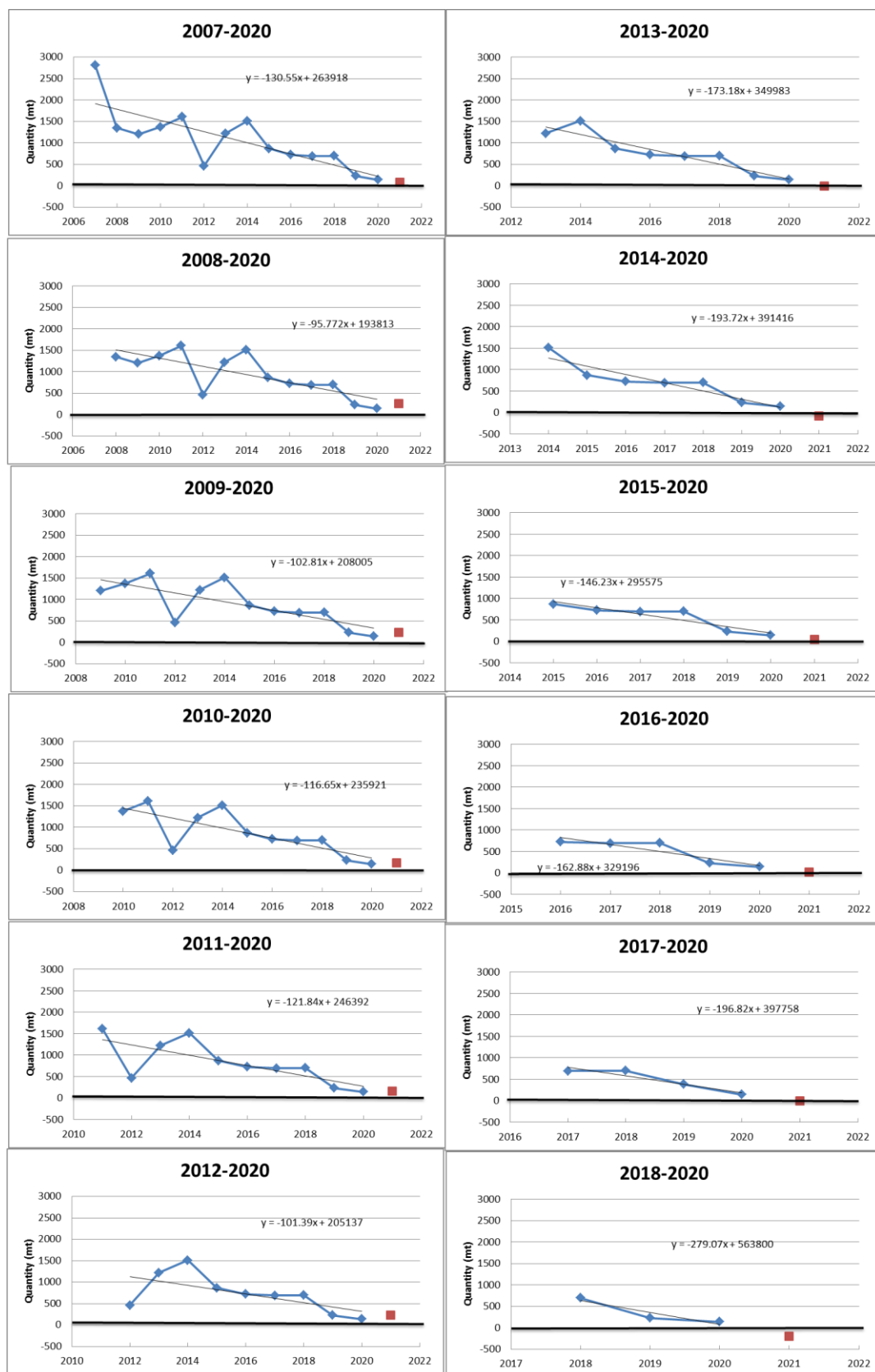


Figure A2: Details of each regression. In each plot the predicted value for 2021 is shown as a red square.