final report

Project code: G.MFS.0295

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Date published: January 2014

PUBLISHED BY
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ESAM Analysis Reporting Service - Final Report

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government and contributions from the Australian Meat Processor Corporation to support the research and development detailed in this publication.

Abstract

The National Microbiological Database (NMD), also known as the ESAM (*Escherichia coli* and *Salmonella* monitoring) database, contains data on *E. coli* and *Salmonella* from each export slaughter establishment in Australia. SARDI Food Safety and Innovation provides regular monthly reports about NMD results to each participating red meat establishment as well as national reports to MLA and the Department of Agriculture. In addition, the reports have been modified to provide additional information to establishments regarding hot swabbed carcases and an anonymous comparison of establishments with each other. One recent change has been in the source of the ESAM data from the Department of Agriculture. SARDI Food Safety and Innovation has also worked with MLA to investigate trends in the data, provided input into MLA presentations and reports and provided additional help and feedback to QA managers on request.

Executive Summary

The National Microbiological Database (NMD), also known as the ESAM (*Escherichia coli* and *Salmonella* monitoring) database, contains data on *E. coli* and *Salmonella* from each export slaughter establishment in Australia. This database provides useful information for benchmarking Australia's performance and can be used in market access negotiations.

In 2009, SARDI Food Safety and Innovation began providing regular monthly reports about NMD results to each participating red meat export slaughter establishment. The aim of this project was to continue the provision of *E. coli* and *Salmonella* monitoring reports and *E. coli* O157 monitoring reports to establishments, to further develop the reports and to work with MLA to identify and investigate trends in the data.

Throughout the year, SARDI Food Safety and Innovation has worked with MLA to investigate trends in the national ESAM levels. Input has been provided into various process investigation workshops, presentations and projects run by MLA and data summaries have also been provided to processors upon request.

As part of the project, the reports were modified to provide additional information to establishments. The reports were extended to include an anonymous "league ladder" and separate hot swabbing reports for interested establishments. Changes to the wording of two table captions were also made to clarify the reported results.

The monthly ESAM reports allow establishments to identify errors in the database that might not be identified otherwise and to assess their performance against national averages. Through SARDI Food Safety and Innovation, establishments have better access to their own data and are better equipped to investigate and interpret it. Continued maintenance of the data, with the sourcing of data from both the NMD and the Product Hygiene Index databases, is vital to ensure that establishments are able to use the information contained in the reports to further improve their processing hygiene.

The ESAM reporting system is continuing to be developed according to the needs of the establishments. It is recommended that the ESAM reporting system be continued and that MLA and APL consider co-funding the reports.

Contents

Background

The *E. coli* and *Salmonella* monitoring program (ESAM) was established to help Australia meet market access requirements for the US. The program requires all export slaughter establishments to collect and analyse carcase samples from all slaughter species for *E. coli* and *Salmonella*. Data are entered into a national database which is maintained by the Department of Agriculture (formerly DAFF Biosecurity). This data, along with industry baseline data, have proven very useful in market access negotiations and in benchmarking the performance of Australian abattoirs.

In 2009, SARDI Food Safety and Innovation began providing regular monthly reports (*E. coli* and *Salmonella* monitoring reports) about NMD results to each participating red meat export slaughter establishment. This report describes the further development of the reporting system and additional work that has been done in conjunction with MLA.

Project Objectives

1. Continue the provision of the monthly report to establishments until December 2013.
2. Provide a monthly report to MLA and Department of Agriculture that contains national results.
3. Provide a monthly report to MLA which documents all user feedback (i.e. phone calls or emails) received over the project's duration to MLA.
4. Modify the report as required based on the outcome of the previous surveys and other feedback.
5. Modify the reports to include additional information on the Big 6 serotypes (O26, O45, O103, O111, O121 and O145).
6. Work with MLA to develop a system for identifying trends and obtaining processor feedback that will then be used to develop case studies on processing issues.

Success in Achieving Objectives

Monthly reports to establishments

E. coli and *Salmonella* monitoring reports have been sent to establishments monthly since June 2009. *E. coli* O157:H7 reports have been sent to establishments monthly since September 2010. The latest reports sent to establishments were those for the period ending December 2013.

Throughout the year, the mailing list of contact people and details was constantly updated to reflect any changes identified from the feedback to the monthly reports.

Monthly reports to MLA

SARDI Food Safety and Innovation has provided monthly national *E. coli* and *Salmonella* monitoring reports and national *E. coli* O157:H7 reports to Ian Jenson at MLA and Glen Edmunds at the Department of Agriculture.

Monthly reports to MLA documenting all feedback

Monthly reports documenting user feedback have not been provided to MLA since there has been limited feedback provided by QA staff on a monthly basis. However, each quarterly milestone report to MLA contains a collation of the feedback received

during the past three months. The questions and comments received from establishments in relation to the content of the reports are included in Appendix 1.

Report Modifications

The previous ESAM Analysis Reporting Service project (A.MFS.0246) proposed incorporating a ranking system for establishments in some form of a 'league ladder' which shows an anonymous ranking of TVC, *E. coli*, and coliform results. Box plots for the anonymous comparison of establishments' TVC, *E. coli* and coliform counts on a monthly basis were first included in the April ESAM reports, accompanied by an explanation of their interpretation. Establishments are now able to compare their results not only to the national averages, but also to other establishments for the given month. No comments were received regarding the box plots in subsequent reports.

Early in 2013, Food Safety and Innovation received feedback from an establishment requesting national averages calculated from hot boned operations since hot boned beef carcases have a different carcase microbiological profile compared to cold boned carcases. After investigation into how many establishments have a substantial proportion of hot swabs from carcases, MLA approved the proposal to send Hot Swabbing ESAM reports to five sheep establishments and to four establishments processing cows and bulls. These establishments will be reviewed on a quarterly basis. All feedback from a pilot study was positive and monthly Hot Swabbing ESAM establishment reports and national reports (sent to MLA) have been sent out since September (inclusive).

As a result of feedback and queries from two QA managers, the captions of Tables 2, 3 and 4 in the *E. coli* monitoring reports were changed to clarify that in the ESAM database, potential detections are of STECS (O157 and non O157) while confirmed detections are of only *E. coli* O157.

The report modifications of a 'league ladder' and caption changes are illustrated in sample ESAM reports for cows and bulls and sheep in Appendices B and C respectively. Appendix D contains a sample Hot Swabbing ESAM report.

Additional Information on the Big 6

Constant communication throughout the year was had with the Department of Agriculture (formerly known as DAFF Biosecurity) about accessing the data recorded for STEC testing. The Department of Agriculture now requires all STEC tests and detections to be entered by establishments into the Product Hygiene Index submission spreadsheet (Meat Notice 2013-01). Attempts by Food Safety and Innovation, SARDI to gain access to this data have been unsuccessful due to STEC testing being recorded in an inconsistent fashion. At present, there are still multiple databases which do not agree, but the expected result is a consistent collection of STEC data by the Department of Agriculture. In the instance of the extension of the ESAM Reporting Service contract, SARDI will continue to attempt to gain access to this data and then extend the reports accordingly.

Develop a system for identifying trends and obtaining processor feedback

A 10-year profile of national ESAM levels on beef and sheep carcases was produced in April 2013 for a book chapter written by Ian Jenson and John Sumner, with data from as early as 2003 provided by the Department of Agriculture.

Andreas Kiermeier (SARDI) also delivered process investigation workshops in collaboration with John Sumner which resulted in a series of case studies (part of A.MFS.0261). These case studies have been written up for publication and distribution to industry and further work on identifying trends has been undertaken under the principal investigation of Sam Rogers as part of MLA project G.MFS.0294.

The ESAM data was also used to investigate the trend in the detection of *Salmonella* serotypes, in particular *Salmonella* Typhimurium, in cows, bulls, steers, heifers, sheep and lambs.

As part of the introduction of hot swabbing reports, code was written to determine which plants are swabbing a high proportion of hot carcases on a regular basis. This code will be run quarterly to maintain the list of hot boning plants.

Results and Discussion

SARDI Food Safety and Innovation has worked to extract additional information from the ESAM data on request from MLA and individual processors, promptly providing the appropriate summaries and supporting information.

In response to the ESAM reports, SARDI Food Safety and Innovation received emails from QA managers regarding identified changes to their establishment's data in the ESAM database. In all cases, the Department of Agriculture was also notified of the required changes to the data. Follow-up checks were made by SARDI Food Safety and Innovation to ensure QA managers' requested changes were addressed.

It came to the attention of SARDI Food Safety and Innovation in late 2013 that not all data for some establishments were included and reported in the monthly data dumps received from the Department of Agriculture and hence, in the ESAM reports. Upon further and continued investigation, it was found that establishments are starting to enter ESAM results into the Product Hygiene Index (PHI) submission spreadsheet, whether completely or partially, to which SARDI Food Safety and Innovation does not currently have access. As with the issues regarding access to data on STECs in the PHI spreadsheet, SARDI Food Safety and Innovation have been communicating with the Department of Agriculture with the aim of gaining access to the ESAM data in the PHI spreadsheet.

The above point raises the issue of future data management and the need for additional time and resources to incorporate the amalgamation of the data from the PHI spreadsheet with the ESAM data for use in the generation of the ESAM reports and to maintain data compatibility.

Access to the ESAM and *E. coli* O157 data was granted to Sam Rogers to use and assist in the MLA project "Statistical process control – hygiene and hazards" (G.MFS.0294). The scope of his investigation is to provide the statistical capability to slaughter establishments and the industry to better understand and control microbial hazards during slaughter and dressing.

SARDI Food Safety and Innovation provided input and de-identified, exemplar data for presentations given by Andreas Kiermeier on statistical process control.

Impact on Meat and Livestock Industry – now and in 5 years' time

The regular feedback and comments from QA managers and on-site microbiologists after each monthly ESAM report is indicative of the value of the ESAM reports to the establishments and how they are actively using the reports for the management and improvement of their results. Appendix A contains the feedback and comments in response to the ESAM reports for the past year.

Establishments have also been able to access additional information on request through SARDI Food Safety and Innovation. The ESAM reports have given establishments greater access to their own data and brought transparency to the system. It can be expected that as the reports develop and become more relevant, with the inclusion of ESAM and STEC data from the PHI spreadsheet, that establishments will continue to use the results in client negotiation and process improvement.

With the initiative towards ESAM data being solely recorded in the PHI database, it is vital that the integrity, validity and consistency of the data be maintained during and after this transitional period. A few data discrepancy issues have been raised by establishments during this transitional period, but the expectation is that establishments will be able to receive reliable results once the Department of Agriculture has achieved a single, consistent database. This database could then provide the potential for additional information which could be incorporated into the ESAM reporting service.

The ESAM database continues to be a valuable resource in the wider scope of collection of data on meat hygiene and process control in the red meat industry.

Conclusions and Recommendations

With the amalgamation of the ESAM database into the PHI database, the source of data in the future will be from a single database. At present, however, the MLA and the Department of Agriculture reporting systems do not overlap and are maintained separately. A single, interactive, real-time reporting system could incorporate both current reporting systems and provide valuable information to establishments and the industry and integral to such a system would be the history of detailed, long-term results from the ESAM reports provided by SARDI Food Safety and Innovation.

To provide this service for the benefit of as many plants as possible, it is recommended that plants who are not currently receiving ESAM reports be contacted to enquire after their participation and inclusion in the ESAM reporting service.

Currently, there is discussion between SARDI, MLA and APL regarding the continued provision of the reports and the associated funding. It is recommended that MLA and APL co-fund the reports for 2014/15.

Appendix A: Feedback from Establishments

- A total of seven emails were received regarding changes to contact details on the ESAM distribution list.

- The following email was received in response to the January 2013 reports (15/02/2013):

> In case you are wondering why we have had no ESAM results since 2011; it is due to our plant being non-operational for the past 2 years. Hopefully we will recommence operations next month.

An email of acknowledgement was sent in response.

- One processor notified SARDI of the closing of a plant (15/02/2013):

> We have shut this plant now, so no longer will it contribute to the ESAM program.

The establishment number of the plant was removed from the list of participating establishments.

- One processor raised the issue of STEC reporting (15/02/2013):

> Your *E. coli* report has called all STEC's O157:H7. My suggestion is that O157:H7 is reported separately, since you will have Stats for this going back years, and the other 6 STEC's get reported together, since this has only been done since June last year, and then list serotypes like they do with Salmonella. I realise DAFF treats any positive the same, but the comparative stats will be mucked up.
> This report is factually incorrect as we have only had 1 O157:H7 since testing began 6 or so years ago.
>
> Can you please make the distinction clear as, I believe, there are customers (and therefore plants) who only want O157:H7 results and others who want them all, therefore if we are testing for 7 organisms, there is a higher probability of positives than for plants only testing for 1.

SARDI's response was that while the broader STEC testing has now been happening since June 2012, the recording of the STEC results (including O157) has not been quite standardised. For reporting purposes, SARDI has opted to retain only O157 detections, manually checks the data each month and where it is clear that a test has returned a non-O157 STEC, that detection is removed. The plan is to work with Department of Agriculture to include STECs in the future and develop the reports.

- An establishment sent through two lab certificates after noticing no outcome recorded in the confirmed section in their ESAM report for January 2013 (18/02/2013):

> On reviewing the *E. coli* O157 report forwarded by Jessica from SARDI Food Safety Research, we note that on page 2, table 2 that samples collected for January 15, 2013 and January 16, 2013 have no outcome recorded in the confirmed section.
>
> Both of these samples were sent for confirmation to Symbio Alliance Brisbane which returned a Not Detected "ND" result (refer attached Symbio Alliance Certificates).

The lab certificates and results were sent through to the Department of Agriculture to update the NMD. The QA manager was advised that the changes should be reflected in the February 2013 reports.

- One processor identified one incorrect species entry in the ESAM database (07/05/2013):

> Noticed Lamb in this report, we are a beef only plant. Obviously a typo somewhere in the data.

The species of this particular entry was corrected to Steer/Heifer in the ESAM database.

- The following comment was received in an email from a QA manager in response to the April 2013 reports (03/07/2013):

> There appears to be an omission in the Steers & Heifers report – March 2013 coliform data. There should be 22 tests performed and 3 positives? (I'm assuming that an *E. coli* positive should also be included in the coliform data).

After further discussion, the discrepancy was resolved and the Department of Agriculture was notified of the change, to be reflected in future reports.

- Official notice was received of the name change of T & R Establishments to Thomas Foods International (24/08/2013).

- An establishment commented as a result of the August 2013 reports (23/09/2013):

> Very interesting reading for *E. coli* 6% higher than the national results for our est.

This was in reference to the Steer/Heifer report and the comparison between the last three years and the national results. This email did not develop into further discussion.

- The following email was received by a QA manager after the August 2013 reports (23/09/2013):

> An anomaly exists with the reporting of O157 potential positives in the data supplied to SARDI and used for demonstrating possible prevalence.
>
> Our results for Aug 2013 show 6 potential positives for O157 with 2 confirmed positives; this is **incorrect**. The data that is entered in the PHI system details "STEC" testing results (O157 and non O157) whereas the data from SARDI only relates to O157.
>
> For Aug 2013 the following was the actual case.
> - 3 potential positives for O157 with 2 confirmed
> - In total there were 6 STEC potential positives (O157 and non O157) of which only 2 included O157.
> - One other test for the month was exclusively a potential positive for O157
>
> I request that the data be changed to reflect actual O157 data.

This issue is related to the reporting of STEC testing. The immediate, interim solution was the change to the captions of Tables 2, 3 and 4 in the *E. coli* O157 monitoring reports. The ultimate solution is to incorporate all the details of the STEC data.

> My response:
>
> Thank you for your call and email highlighting the differences in potential positives and whether they are O157 or non O157s.
>
> Yes, you are exactly right. SARDI only reports on O157 results at the present time and we ensure that all confirmed STEC positives are not reported as confirmed positives. However, your point of them being still given as "potential positives" whether they include O157 or not, does exist and gives an inaccurate representation of your establishment's O157 status.
>
> One of SARDI's objectives is to incorporate STEC reporting into the ESAM reports in the future which might help to clarify the reporting of positives.
>
> I'll talk with Paul Vanderlinde about addressing this issue.

- One establishment sent the following email (25/09/2013):

> From the report received it appears not all data has been entered into the database for August for all species. We will discuss at PMT meeting this week to rectify the issue.

A reply email was sent to highlight that any changes or additions sent to the Department of Agriculture will be updated and reflected in the following ESAM reports.

- The following comment was received in relation to the ESAM reports (24/09/2013):

> Do we have in place national averages for TVCs and coliforms on bovine and ovine carton trim samples yet? We would like to compare our monthly averages with the national averages.

The sender of the email was notified that SARDI does not receive the data on the carton trim samples and so cannot calculate any national averages.

- The following email was received on 25/09/2013:

> Also, we do hot boned beef (steers/heifers/cows/bulls are all in one category). Are there any national median logs for this? Our hot boned beef averages should not have to be compared against national averages for cold boned steers/heifers and cold cows/bulls.

Hot swabbing ESAM reports were introduced the following month.

- A QA manger asked about the interpretation of potential and confirmed results (25/10/2013):

> One question *E. coli* O157 report page 3 table 4.
>
> Is this table just for *E. coli* O157 potential/confirmed results or does it also include the STEC (big 6)?

The reply explained the change to the table captions and the aim to include STEC reporting in the future.

- This response was received in relation to the Hot Swabbing reports (26/11/2013):

> I have received differing national log values for hot boned beef. Can you please confirm all the attached values are correct?

This question was resolved through a telephone conversation with the establishment contact and was simply found to be accidentally picking the incorrect values from the table.

- The following email was received from an OPV in response to the October 2013 reports (26/11/2013):

> The only discrepancy that I can pick up is in the *E. coli* O157 report, mainly because it relates to a DAFF Verification Test that I can remember, where there was a potential STEC (non O157) detection that was confirmed as Not Detected.
> The DAFF Verification Test was collected on 24/10/2012. The DAFF Verification Test reporting in ESAM at the time only had the O157 test entry, which would have been entered as Not Detected. Any included information comments on the potential STEC detection may not have been picked up in the screening process used for this reporting.
>
> The reported date of 03/04/2012 shown in the report at Table 3, relates to an O157 potential detection from a test submitted as part of the voluntary *E. coli* O157 Prevalence Survey, where the additional testing conducted was entered as DAFF Verification Test results.

Upon further discussion, no changes were required.

- The following series of emails were received from an establishment's microbiologist in response to the October 2013 reports (27/11/2013):

> Did we only receive 1 coliform test result for October?
>
> Strange, we did about 25 tests – our vet must have only entered 1 result out of the 25.
>
> Also, there is no way the national average for coliforms can have a more negative log result than *E. coli* as coliforms are comprised of *E. coli* + other organisms…
>
> Any luck with working out why the national log average for hot boned coliforms is better than for *E. coli* and not the other way round – this also appears to be the case for calves?

The explanation for the national averages is that there are generally less coliform tests than *E. coli* tests reported and this is because in some instances, data is entered only for *E. coli* and not duplicated for coliforms (coliforms are said to be "not tested"). Upon discussion, this question was resolved with the microbiologist.

- SARDI received the following comment after the October 2013 reports (26/11/2013):

> There is no data after June for Est xxx, is DAFF OPV still sending the data through?

This particular establishment's data had been entered into the PHI spreadsheet, not into the national ESAM database and so was not being included in the monthly ESAM reports.
This information is supported by other establishments.

- Several emails regarding data integrity, were received in response to the December 2013 reports.

Appendix B: Sample COW/BULL Report

(recent changes include box plots for comparison of establishments' monthly TVC, *E. coli* and coliform counts)

E. coli and *Salmonella* Monitoring Report

Establishment XXX

COW/BULL

Reporting Period:

01 Jan 2011 to 31 Dec 2013

Generated

March 11, 2014 at 09:34

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1 Total Viable Count Summary

Table 1: Total Viable Count prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**44**	**8**	**1015**	**16778**
Positives	**40**	**7**	**683**	**13675**
Percent +ve	**90.91**	**87.50**	**67.29**	**81.51**
Lower Bound	78.33	47.35	64.31	80.91
Upper Bound	97.47	99.68	70.17	82.09

Table 2: Total Viable Count summary for this establishment and nationally ($\log_{10}$ cfu/cm^2) for samples where TVC was greater than the limit of detection.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Minimum	-0.770	-0.301	-1.097	-1.301
Q1	**0.078**	**0.123**	**0.778**	**0.518**
Median	**0.405**	**0.230**	**1.079**	**1.000**
Mean (+ve)	0.394	0.375	1.079	1.128
Q3	**0.561**	**0.465**	**1.519**	**1.681**
90th Percentile	1.224	0.948	2.072	2.322
95th Percentile	1.398	1.233	2.394	2.763
99th Percentile	1.398	1.461	3.153	3.699
Maximum	1.398	1.519	4.544	6.470
SD	0.548	0.572	0.825	0.923

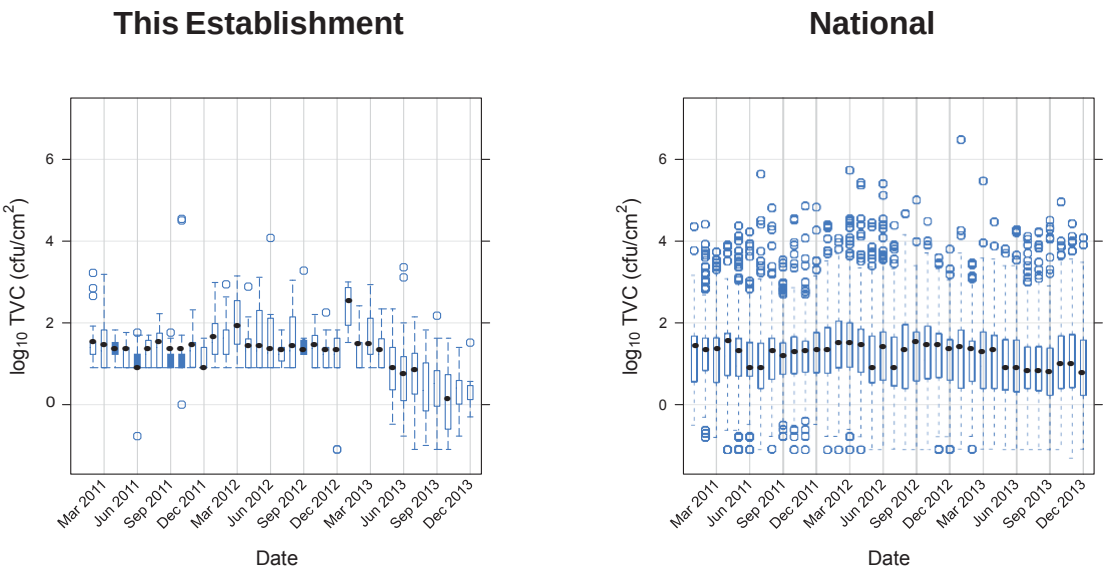


Figure 1: Box plot of monthly Total Viable Counts for Establishment XXX and all establishments **over the last 3 years**.

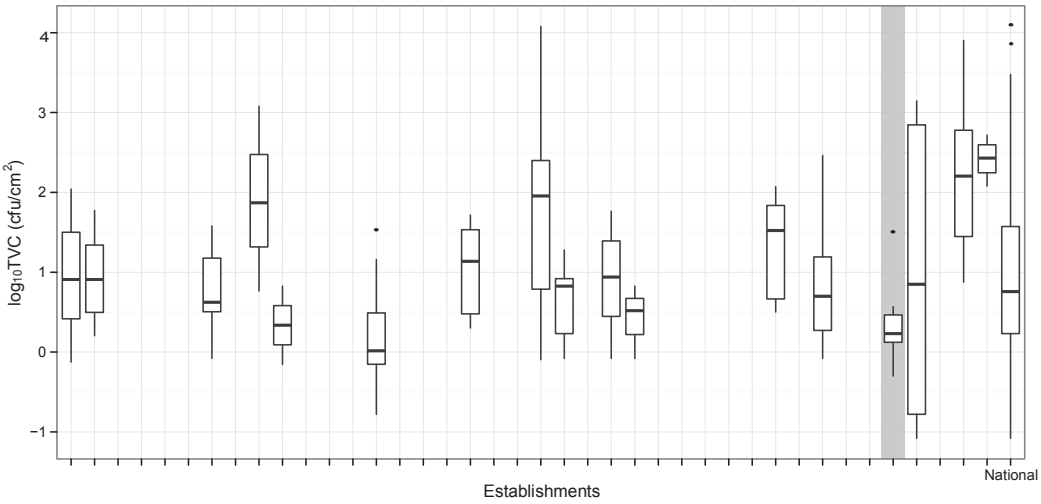


Figure 2: Box plots of this month's Total Viable Counts for all establishments individually and combined into a National box plot. The results for Establishment XXX are identified by the grey background.

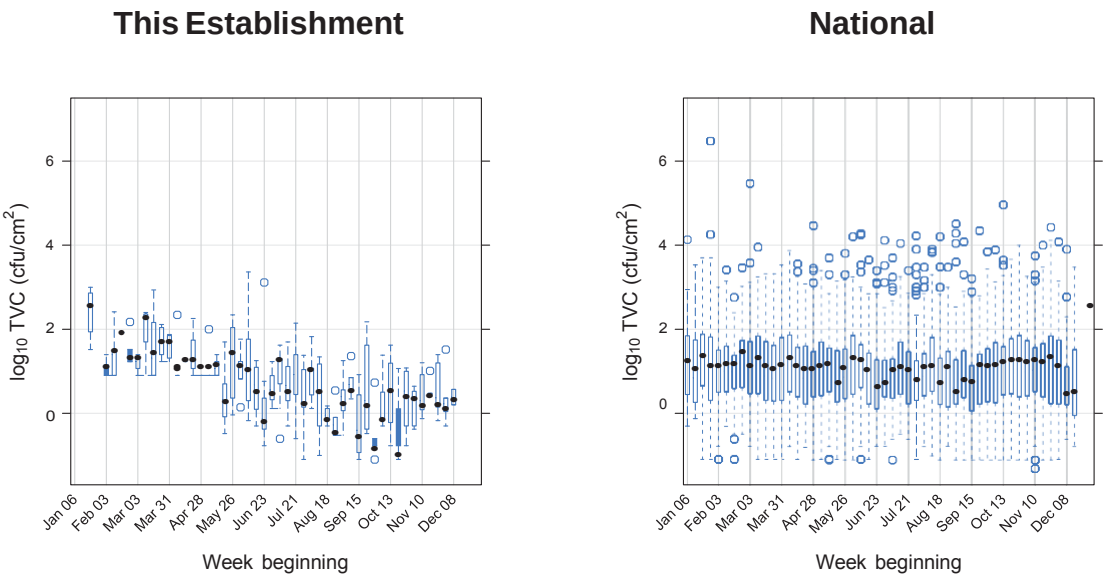


Figure 3: Box plot of weekly Total Viable Counts for Establishment XXX and all establishments **over the last year**.

2 *E. coli* Summary

Table 3: *E. coli* prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**44**	**8**	**997**	**17509**
Positives	**2**	**2**	**71**	**1079**
Percent +ve	**4.54**	**25.00**	**7.12**	**6.16**
Lower Bound	0.56	3.19	5.60	5.81
Upper Bound	15.47	65.09	8.90	6.53

Table 4: *E. coli* summary for this establishment and nationally ($\log_{10}$ cfu/cm^2) for samples where *E. coli* was detected.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Minimum	-0.770	-1.097	-1.770	-2.097
Q1	**-0.770**	**-1.015**	**-1.097**	**-1.097**
Median	**-0.770**	**-0.933**	**-0.770**	**-0.796**
Mean (+ve)	-0.770	-0.933	-0.708	-0.651
Q3	**-0.770**	**-0.851**	**-0.482**	**-0.398**
90th Percentile	-0.770	-0.802	-0.097	0.185
95th Percentile	-0.770	-0.786	0.176	0.628
99th Percentile	-0.770	-0.773	0.779	1.344
Maximum	-0.770	-0.770	1.279	2.995
SD	0.000	0.232	0.500	0.604

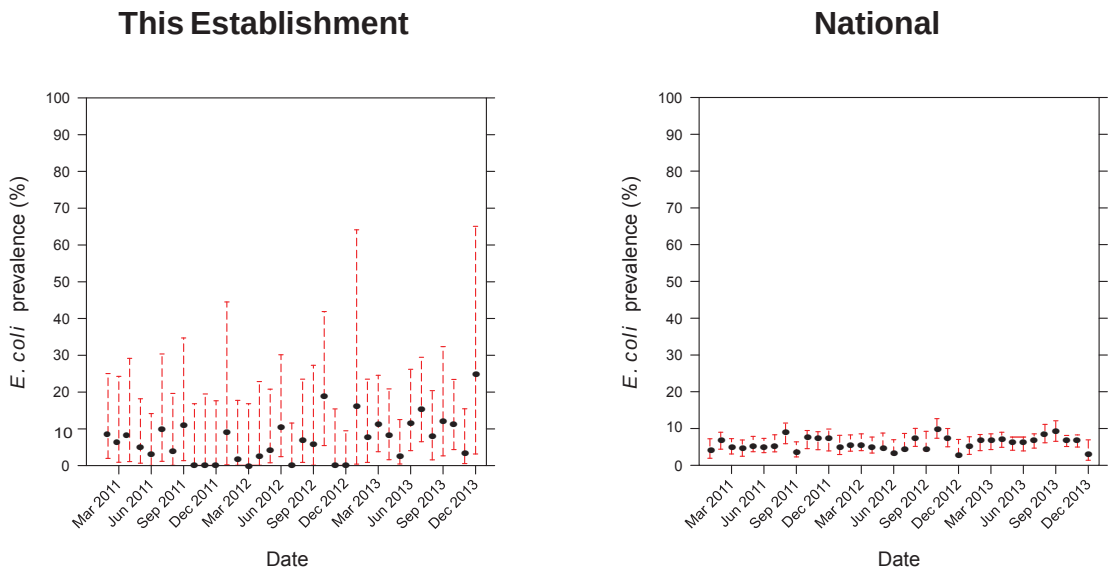


Figure 4: Time plot of monthly *E. coli* prevalence for Establishment XXX and all establishments **over the last 3 years** — the black dots indicate the estimated prevalence in each month (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

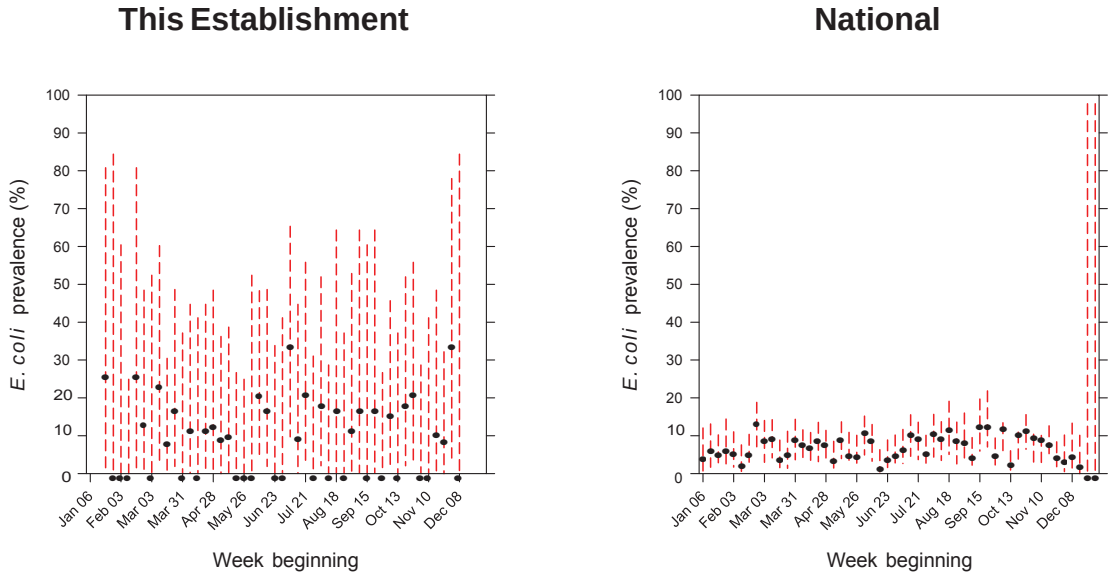


Figure 5: Time plot of weekly *E. coli* prevalences for Establishment XXX and all establishments **over the last year** — the black dots indicate the estimated prevalence in each week (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

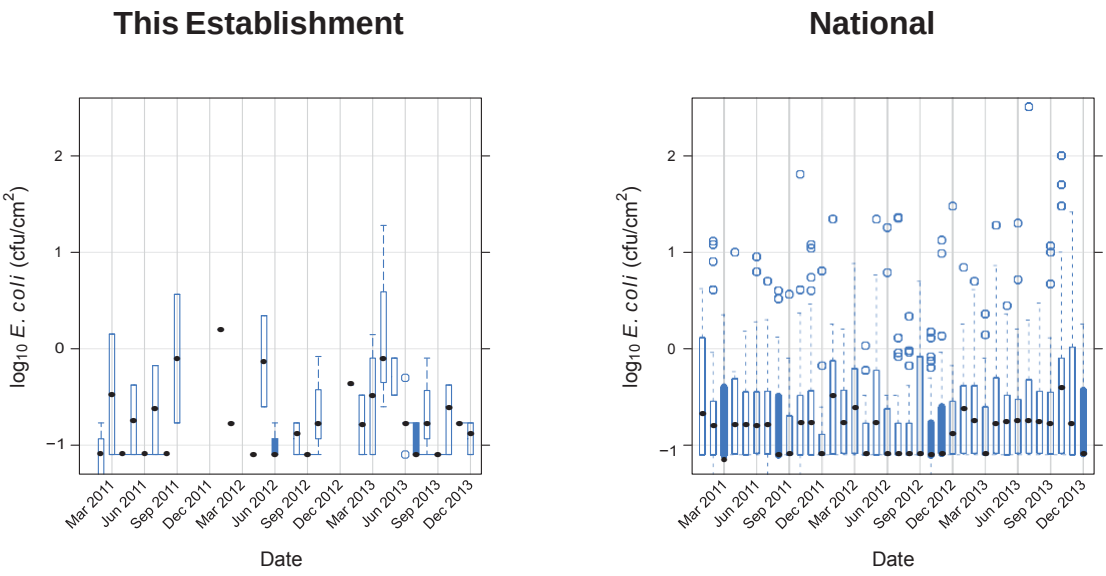


Figure 6: Box plot of monthly *E. coli* positive concentrations for Establishment XXX and all establishments **over the last 3 years**.

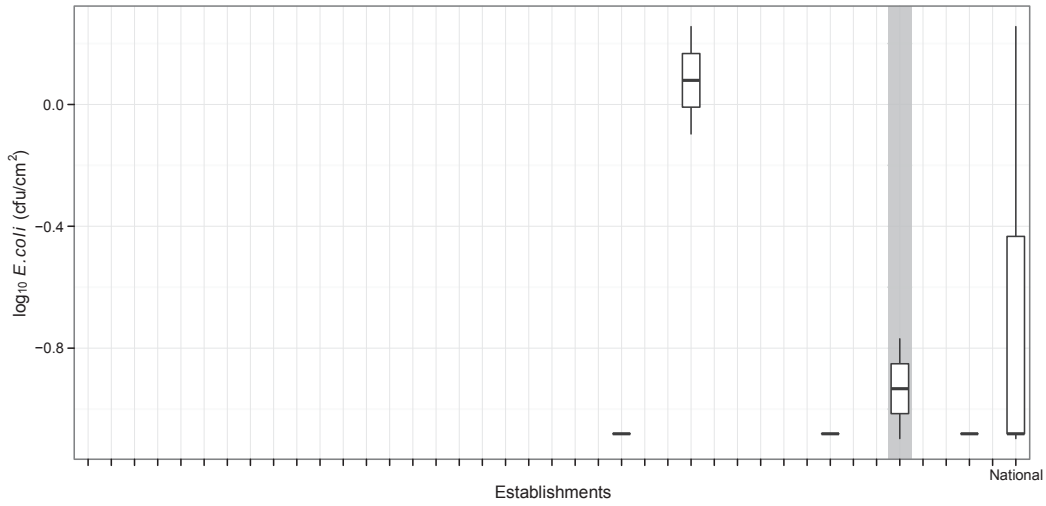


Figure 7: Box plots of this month's *E. coli* counts for all establishments individually and combined into a National box plot. The results for Establishment XXX are identified by the grey background.

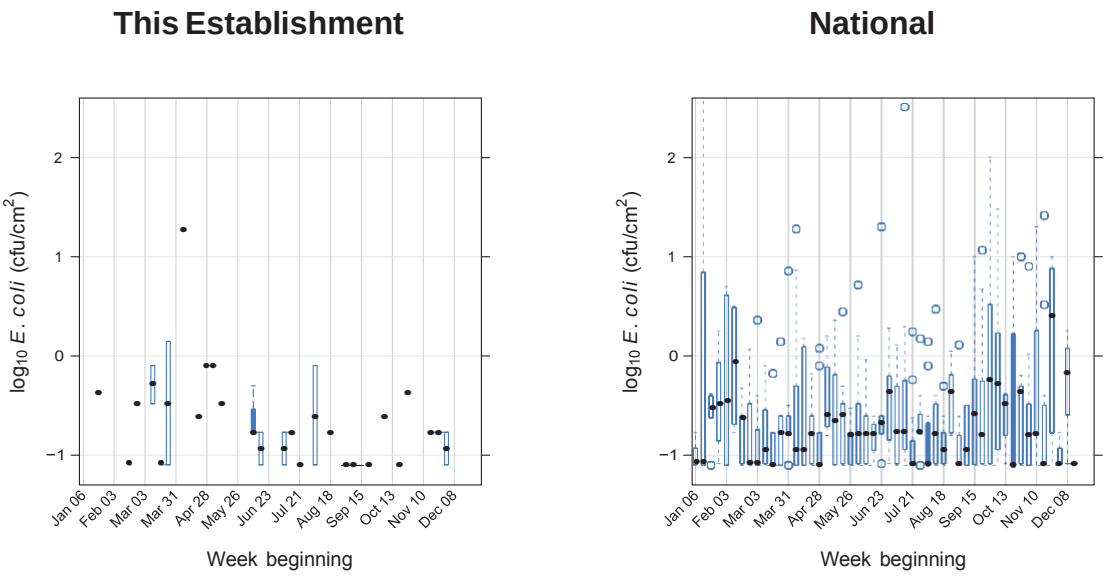


Figure 8: Box plot of weekly *E. coli* for Establishment XXX and all establishments **over the last year**.

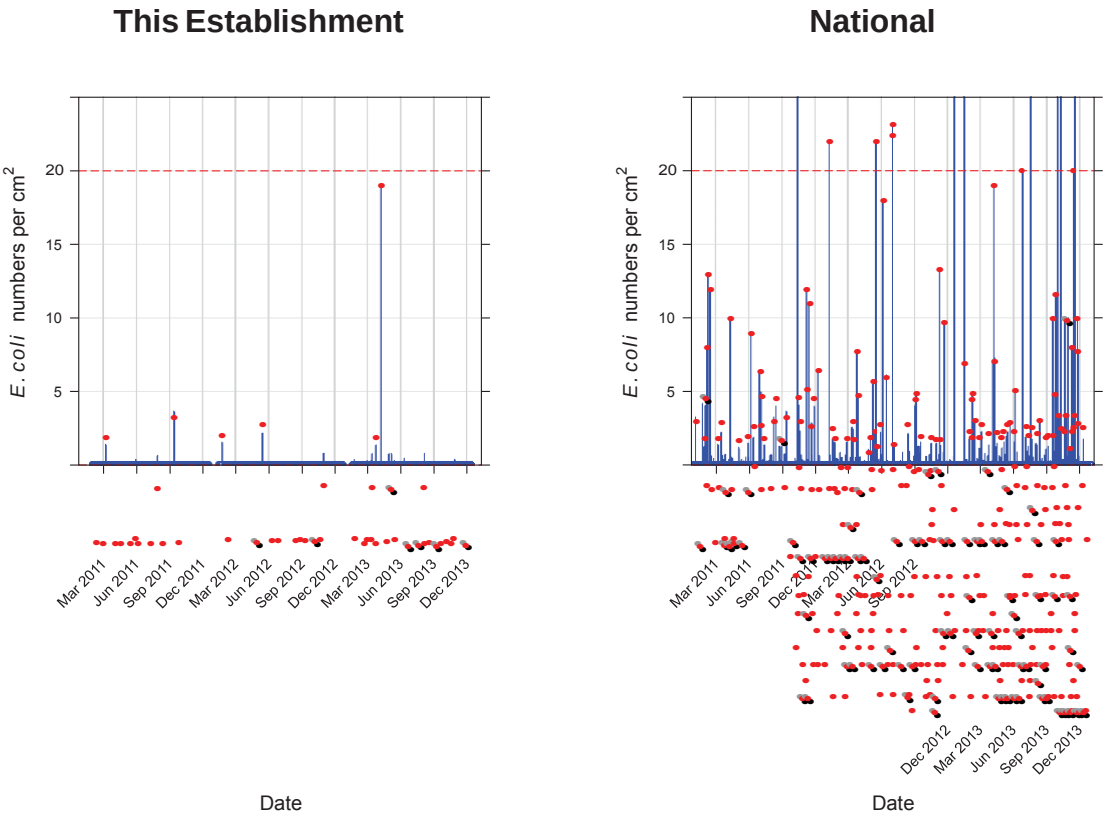


Figure 9: Time plot of *E. coli* tests for Establishment XXX and all establishments — positive tests are represented by red points; negative tests are represented by blue circles.

3 *Coliform* Summary

Table 5: Coliform prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**24**	**8**	**563**	**7990**
Positives	**2**	**3**	**84**	**1081**
Percent +ve	**8.33**	**37.50**	**14.92**	**13.53**
Lower Bound	1.03	8.52	12.08	12.79
Upper Bound	27.00	75.51	18.14	14.30

Table 6: Coliform summary for this establishment and nationally ($\log_{10}$ cfu/cm^2) for samples where *coliforms* were detected.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Minimum	-0.602	-1.097	-1.097	-1.301
Q1	**-0.602**	**-1.097**	**-0.770**	**-1.081**
Median	**-0.602**	**-1.097**	**-0.602**	**-0.495**
Mean (+ve)	-0.602	-0.932	-0.441	-0.235
Q3	**-0.602**	**-0.850**	**-0.097**	**0.279**
90th Percentile	-0.602	-0.701	0.264	1.000
95th Percentile	-0.602	-0.652	0.928	1.568
99th Percentile	-0.602	-0.612	1.403	2.273
Maximum	-0.602	-0.602	1.699	2.908
SD	0.000	0.286	0.607	0.915

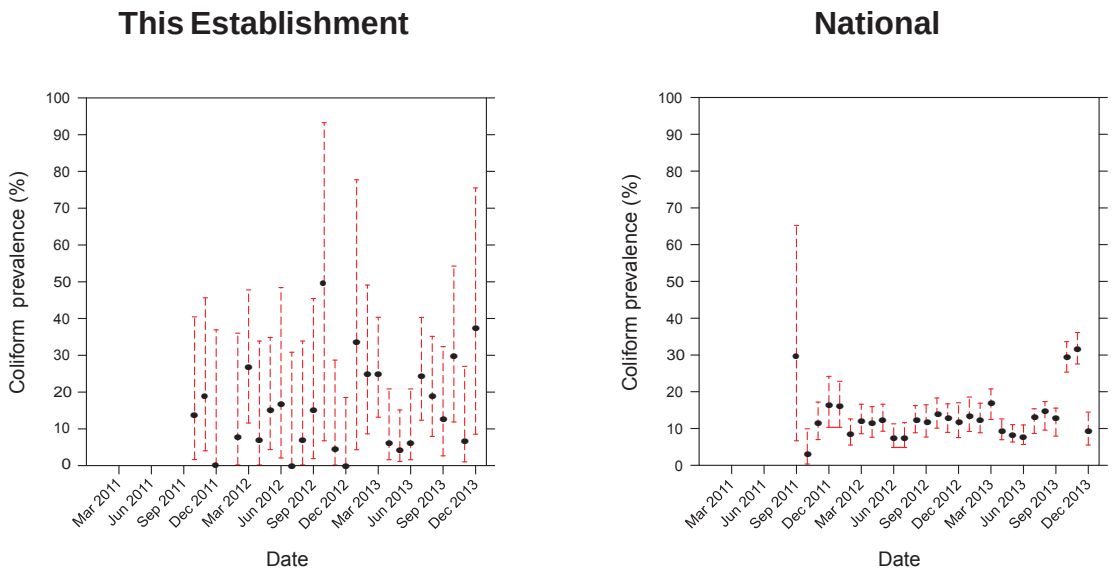


Figure 10: Time plot of monthly coliform prevalence for Establishment XXX and all establishments **over the last 3 years** — the black dots indicate the estimated prevalence in each month (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

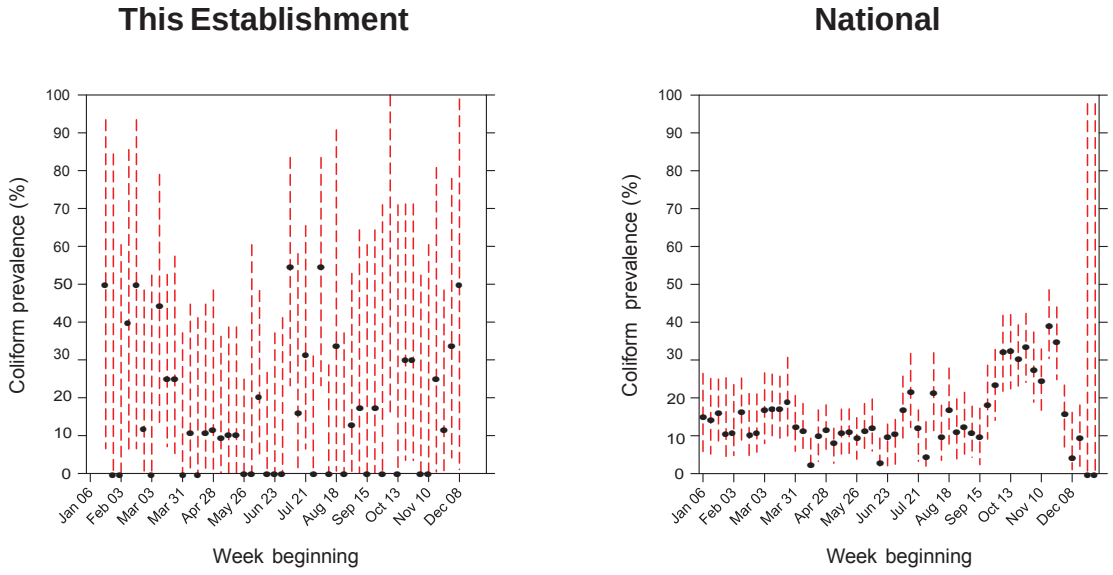


Figure 11: Time plot of weekly coliform prevalences for Establishment XXX and all establishments **over the last year** — the black dots indicate the estimated prevalence in each week (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

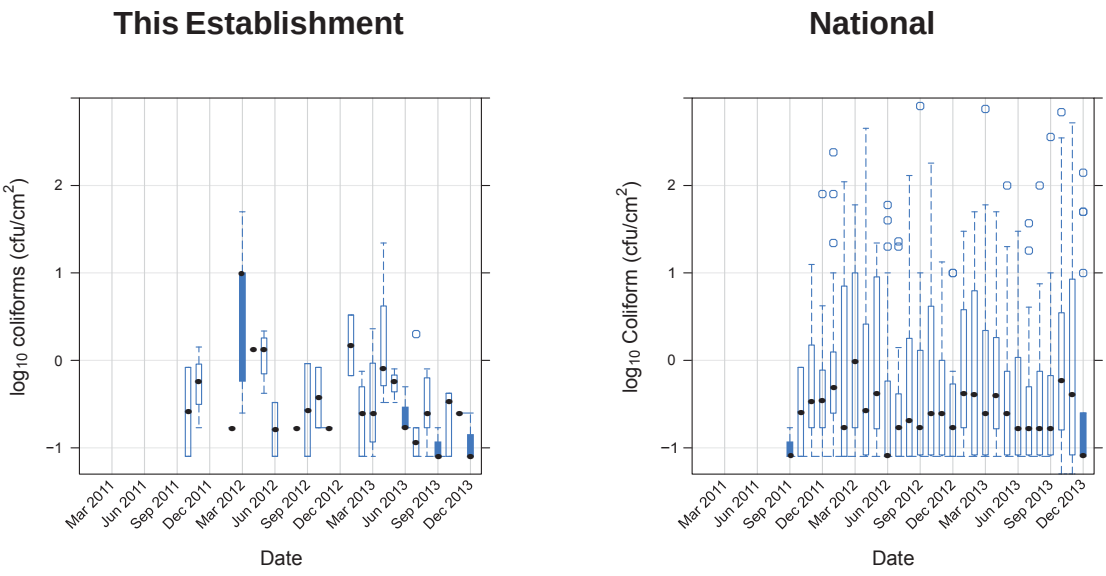


Figure 12: Box plot of monthly coliform positive concentrations for Establishment XXX and all establishments **over the last 3 years**.

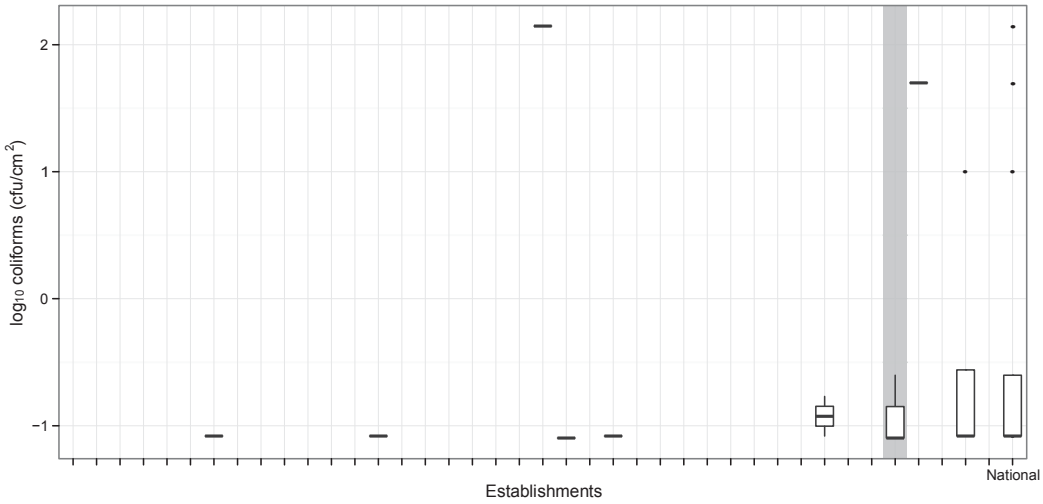


Figure 13: Box plots of this month's coliform counts for all establishments individually and combined into a National box plot. The results for Establishment XXX are identified by the grey background.

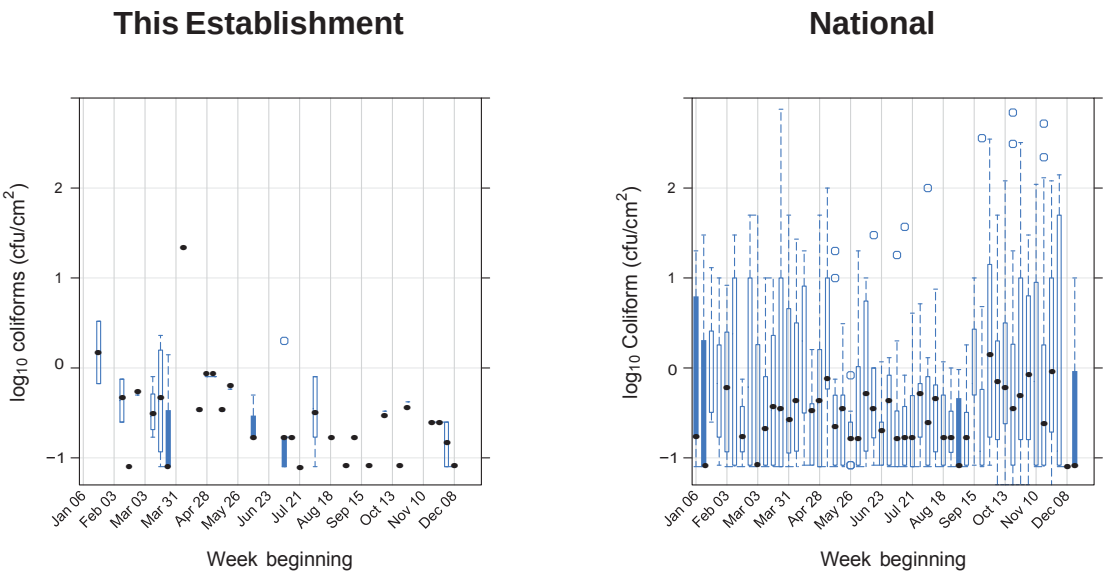


Figure 14: Box plot of weekly coliform concentrations for Establishment XXX and all establishments **over the last year**.

4 *Salmonella* Summary

Table 7: *Salmonella* prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**9**	**1**	**221**	**4919**
Positives	**0**	**0**	**1**	**33**
Percent +ve	**0.000**	**0.000**	**0.452**	**0.671**
Lower Bound	0.000	0.000	0.011	0.462
Upper Bound	33.627	97.500	2.495	0.941

Table 8: *Salmonella* serovars for this establishment.

TestDate	Serotype
2013-03-21	Salmonella Anatum

5 Glossary of Terms

5.1 Prevalence summary

Tests: The total number of samples (TVC, *E. coli* or *Salmonella*) in the ESAM database during the reporting period.

Positives: The number of samples with positive concentrations (ie. concentrations > 0).

Percent +ve: 100 × Positives/Tests.

Lower Bound & Upper Bound: Lower and Upper 95% Confidence Bounds. The "true" prevalence is expected to be in this range.

5.2 TVC and *E. coli* concentration summary

All concentration data are converted into logarithms with base 10, given by $\log_{10}$ cfu/cm^2.

Minimum: Minimum concentration.

Q1 or 1st Quartile: 25% of the data are less than this value, 75% are more.

Q3 or 3rd Quartile: 75% of the data are less than this value, 25% are more.

Median: 50% of the data are less than this concentration, 50% are more,

90th Percentile: 90% of the data are less than this value, 10% are more.

95th Percentile: 95% of the data are less than this value, 5% are more.

99th Percentile: 99% of the data are less than this value, 1% are more.

Maximum: Maximum concentration.

Mean: The average.

Standard Deviation (SD): A measure of spread (or variability) about the mean.

5.3 Box plot

A graphical tool to assess the data.

- The solid dot is the median.
- The box contains half the data.
- The lower and upper bounds of the box are the 1st and 3rd quartile.
- The inter-quartile range (IQR) = Q3 - Q1
- The length of the whiskers is calculated by ±1.5× IQR. The end of the whiskers corresponds to the observation in the dataset that is closest to this defined value.
- Observations falling outside the extent of the whiskers are indicated separately. Values falling far outside the whiskers indicate unusual or extreme values.

5.4 Time plot of *E. coli* concentrations over time

This plot is useful to compare the level of *E. coli* at individual plants over time compared to that found nationally over the same sampling period.

- Positive tests are represented as red dots; negative tests as blue open circles.
- Red (dashed) horizontal lines show the ‘m’ and ‘M’ values for that species.
  - The value of ‘m’ and ‘M’ for each species is defined in Appendix 1 of AQIS Meat Notice 2003/6.
  - Observations **below** the defined value ‘m’ are considered to have Acceptable levels of *E. coli*.
  - Observations **above** the defined value ‘M’ are considered to have Unacceptable levels of *E. coli*.
  - The observations between ‘m’ and ‘M’ are considered to have Marginal levels of *E. coli*.

Appendix C: Sample SHEEP Report

(recent changes include box plots for comparison of establishments' monthly TVC, *E. coli* and coliform counts)

E. coli and *Salmonella* Monitoring Report

Establishment XXX

SHEEP

Reporting Period:

01 Jan 2011 to 31 Dec 2013

Generated

March 11, 2014 at 09:43

Prepared by
SARDI Food Safety Research
GPO Box 397
ADELAIDE, SA 5001, Australia
Ph: +61 8 8303 9771
Fax: +61 8 8303 9424

Government of South Australia

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

1 Total Viable Count Summary

Table 1: Total Viable Count prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**209**	**63**	**1715**	**19355**
Positives	**177**	**57**	**1546**	**18064**
Percent +ve	**84.69**	**90.48**	**90.15**	**93.33**
Lower Bound	79.08	80.41	88.64	92.97
Upper Bound	89.28	96.42	91.52	93.68

Table 2: Total Viable Count summary for this establishment and nationally ($\log_{10}$ cfu/cm^2) for samples where TVC was greater than the limit of detection.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Minimum	0.518	0.518	-0.174	-1.222
Q1	**1.519**	**1.431**	**1.301**	**0.981**
Median	**2.322**	**2.079**	**1.826**	**1.447**
Mean (+ve)	2.177	2.061	1.921	1.479
Q3	**2.771**	**2.690**	**2.477**	**1.919**
90th Percentile	3.319	3.106	3.079	2.531
95th Percentile	3.813	3.468	3.491	2.851
99th Percentile	4.776	4.276	4.192	3.618
Maximum	4.914	4.968	5.114	6.000
SD	0.971	0.924	0.863	0.799

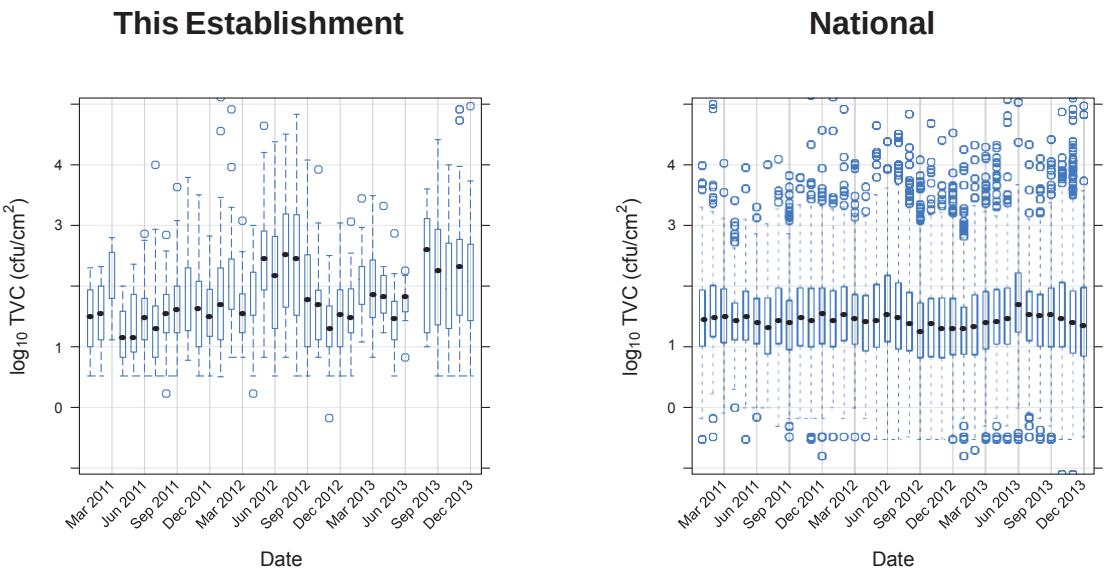


Figure 1: Box plot of monthly Total Viable Counts for Establishment XXX and all establishments **over the last 3 years**.

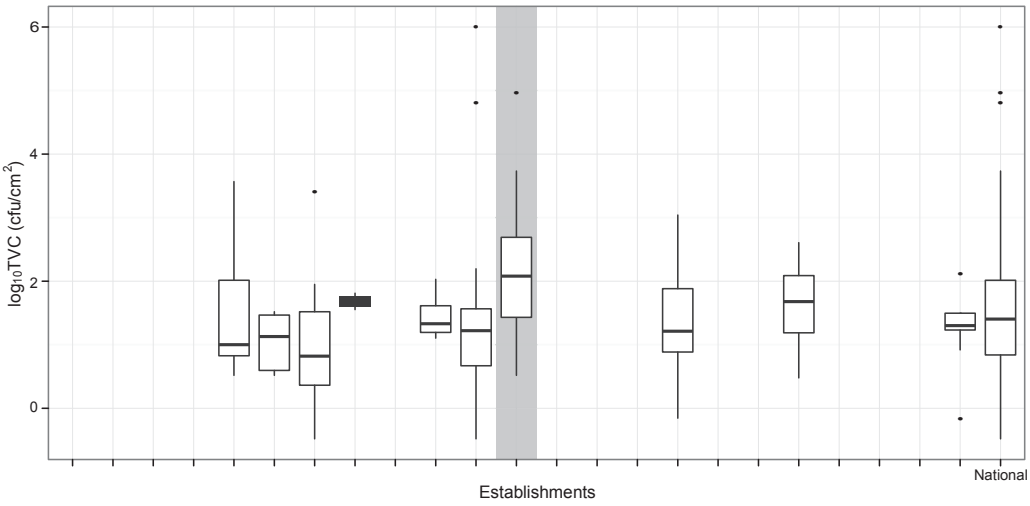


Figure 2: Box plots of this month's Total Viable Counts for all establishments individually and combined into a National box plot. The results for Establishment XXX are identified by the grey background.

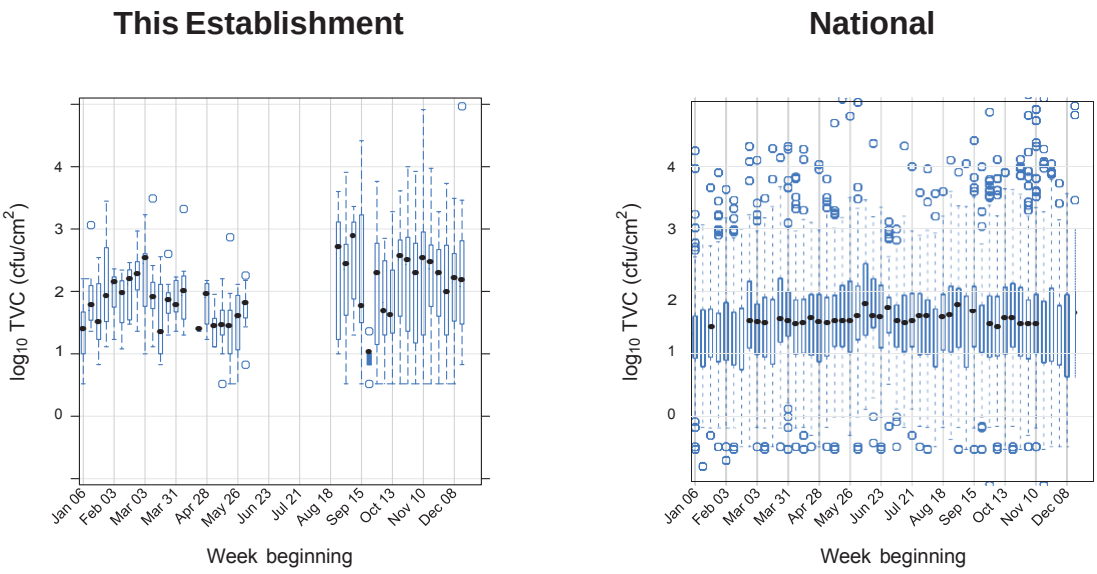


Figure 3: Box plot of weekly Total Viable Counts for Establishment XXX and all establishments **over the last year**.

2 *E. coli* Summary

Table 3: *E. coli* prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**104**	**32**	**1298**	**18120**
Positives	**12**	**8**	**325**	**4414**
Percent +ve	**11.54**	**25.00**	**25.04**	**24.36**
Lower Bound	6.11	11.46	22.70	23.74
Upper Bound	19.29	43.41	27.49	24.99

Table 4: *E. coli* summary for this establishment and nationally ($\log_{10}$ cfu/cm^2) for samples where *E. coli* was detected.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Minimum	-0.482	-0.482	-0.482	-1.523
Q1	**-0.180**	**-0.251**	**-0.482**	**-0.482**
Median	**0.057**	**-0.087**	**0.000**	**-0.155**
Mean (+ve)	0.028	0.342	0.082	0.047
Q3	**0.114**	**1.030**	**0.431**	**0.330**
90th Percentile	0.553	1.453	0.940	0.845
95th Percentile	0.602	1.629	1.176	1.186
99th Percentile	0.602	1.771	1.805	1.785
Maximum	0.602	1.806	2.204	3.431
SD	0.343	0.880	0.578	0.565

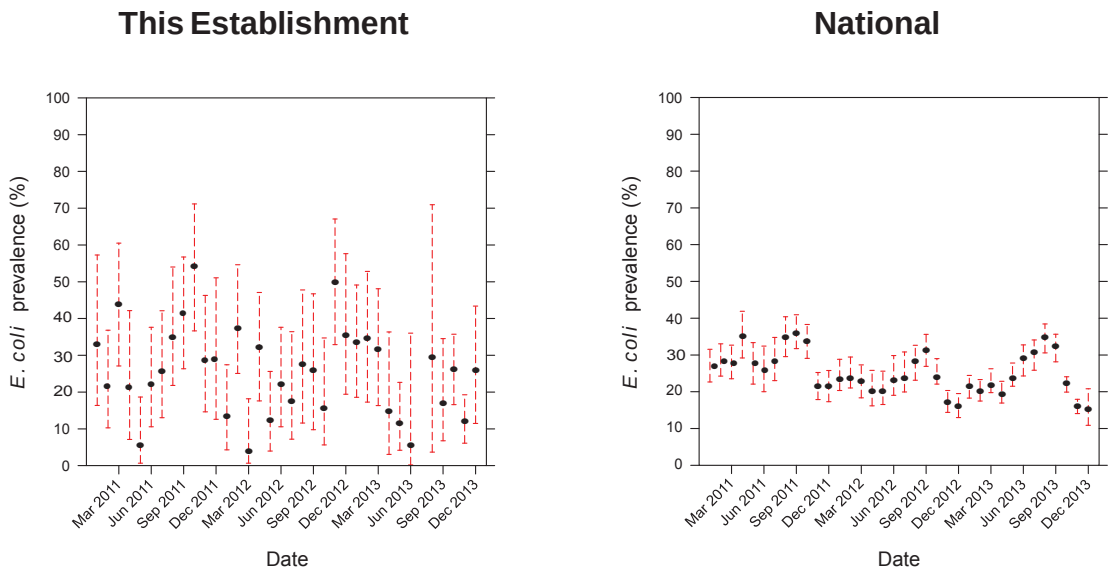


Figure 4: Time plot of monthly *E. coli* prevalence for Establishment XXX and all establishments **over the last 3 years** — the black dots indicate the estimated prevalence in each month (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

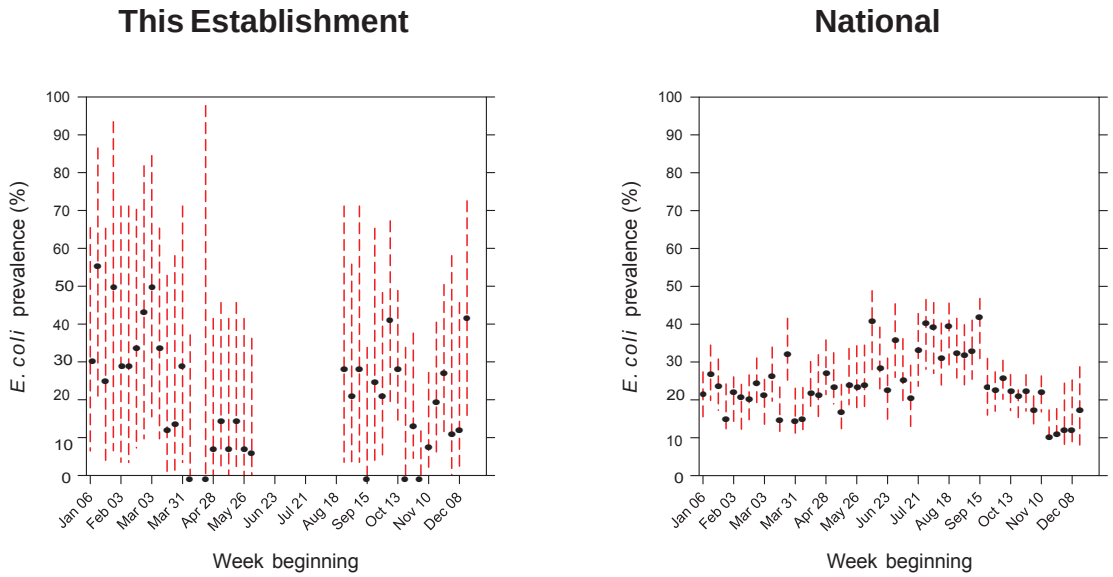


Figure 5: Time plot of weekly *E. coli* prevalences for Establishment XXX and all establishments **over the last year** — the black dots indicate the estimated prevalence in each week (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

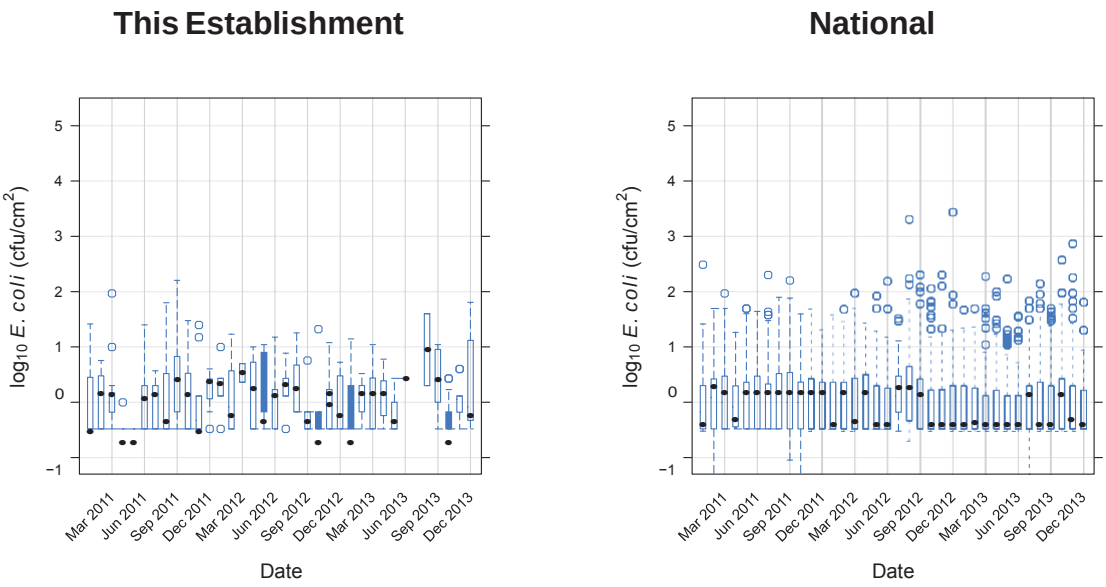


Figure 6: Box plot of monthly *E. coli* positive concentrations for Establishment XXX and all establishments **over the last 3 years**.

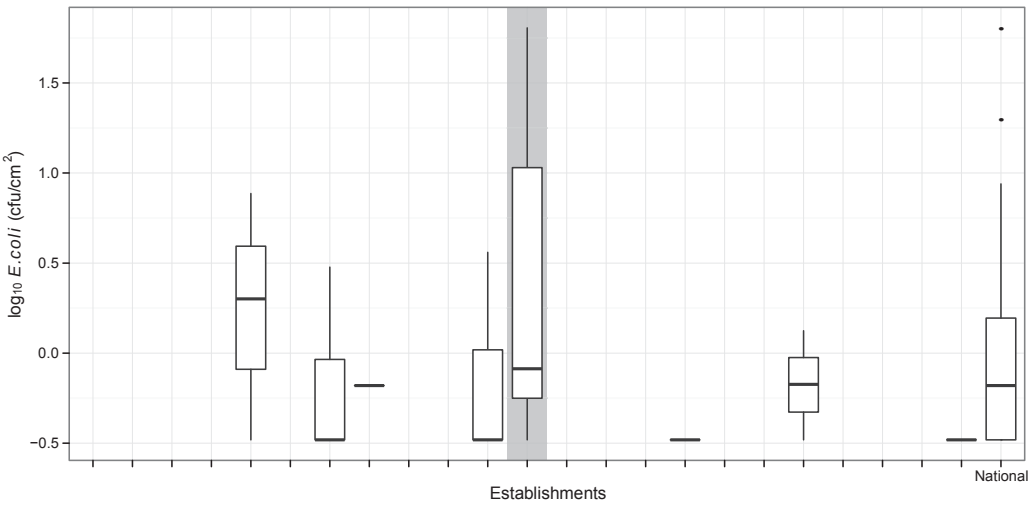


Figure 7: Box plots of this month's *E. coli* counts for all establishments individually and combined into a National box plot. The results for Establishment XXX are identified by the grey background.

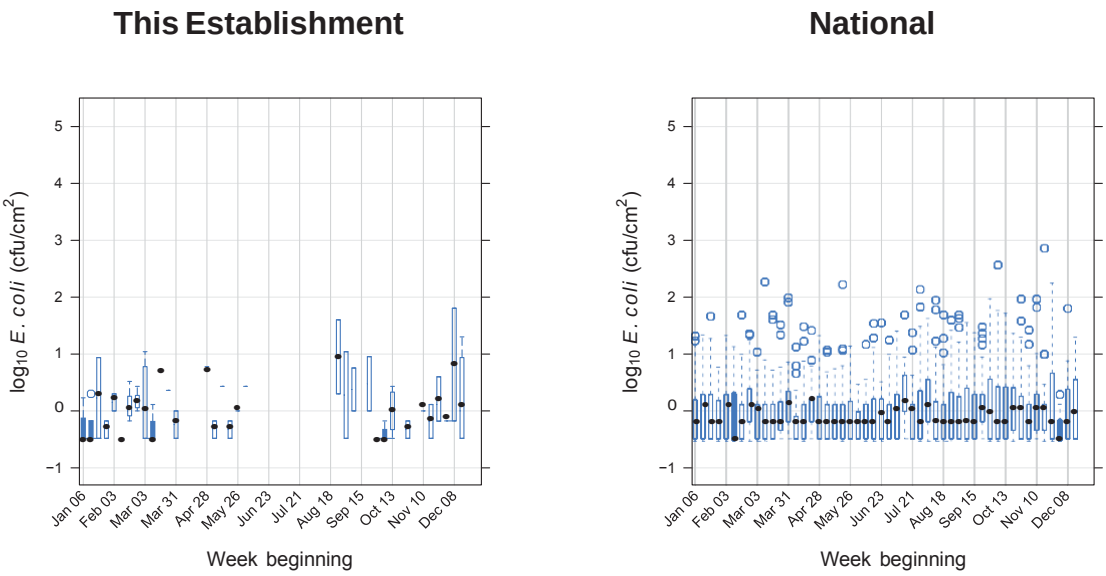
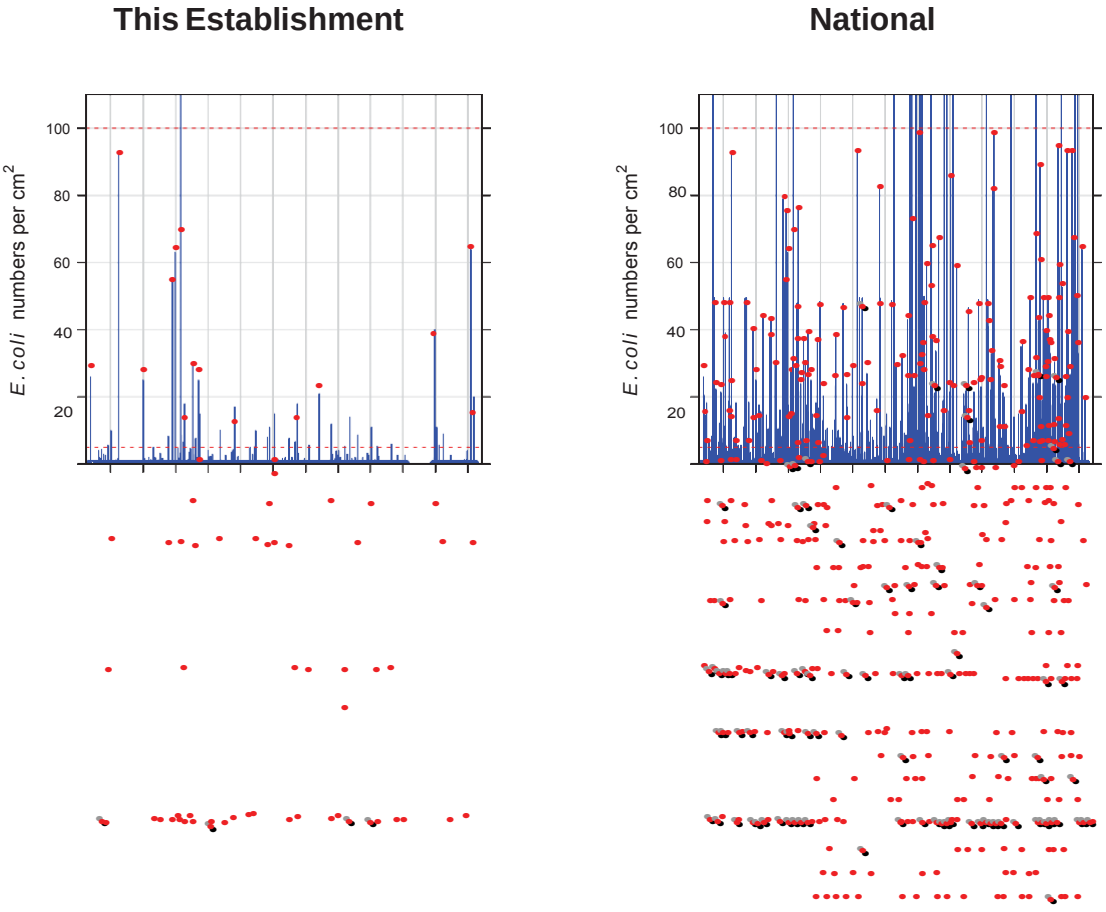


Figure 8: Box plot of weekly *E. coli* for Establishment XXX and all establishments **over the last year**.



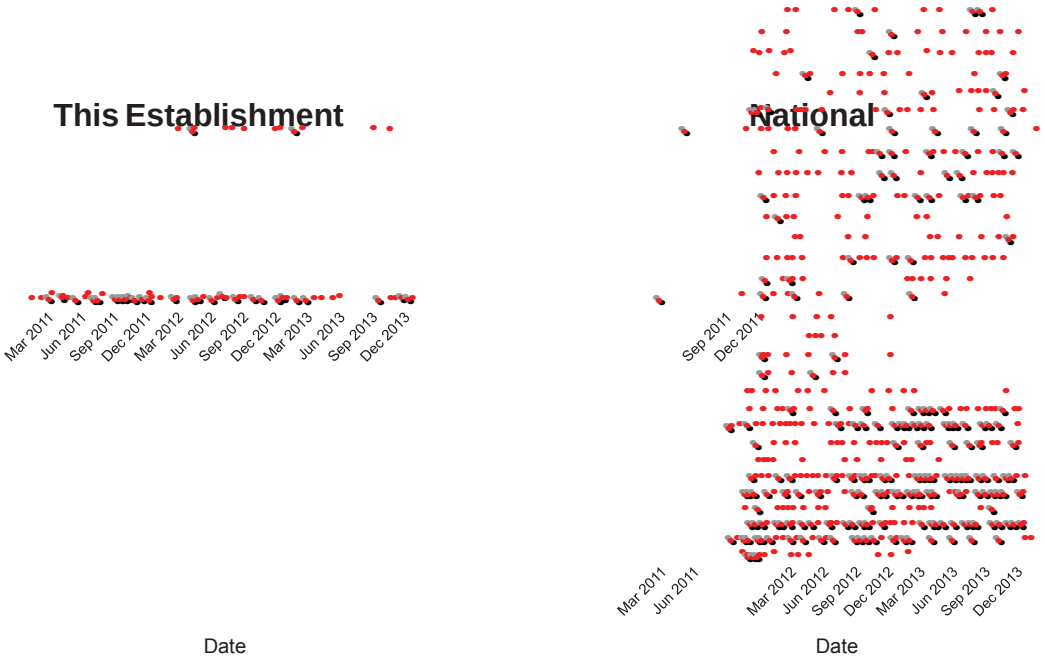


Figure 9: Time plot of *E. coli* tests for Establishment XXX and all establishments — positive tests are represented by red points; negative tests are represented by blue circles.

3 *Coliform* Summary

Table 5: Coliform prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**124**	**63**	**1396**	**8312**
Positives	**37**	**19**	**464**	**2155**
Percent +ve	**29.84**	**30.16**	**33.24**	**25.93**
Lower Bound	21.96	19.23	30.77	24.99
Upper Bound	38.71	43.02	35.78	26.88

Table 6: Coliform summary for this establishment and nationally ($\log_{10}$ cfu/cm^2) for samples where *coliforms* were detected.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Minimum	-0.482	-0.482	-0.523	-0.523
Q1	**0.114**	**-0.087**	**-0.176**	**-0.482**
Median	**1.000**	**1.000**	**0.431**	**0.121**
Mean (+ve)	0.994	0.730	0.497	0.257
Q3	**1.602**	**1.331**	**1.000**	**0.695**
90th Percentile	1.778	1.647	1.602	1.286
95th Percentile	2.498	1.834	1.903	1.602
99th Percentile	2.580	1.889	2.584	2.293
Maximum	2.580	1.903	3.176	3.431
SD	0.835	0.782	0.838	0.697

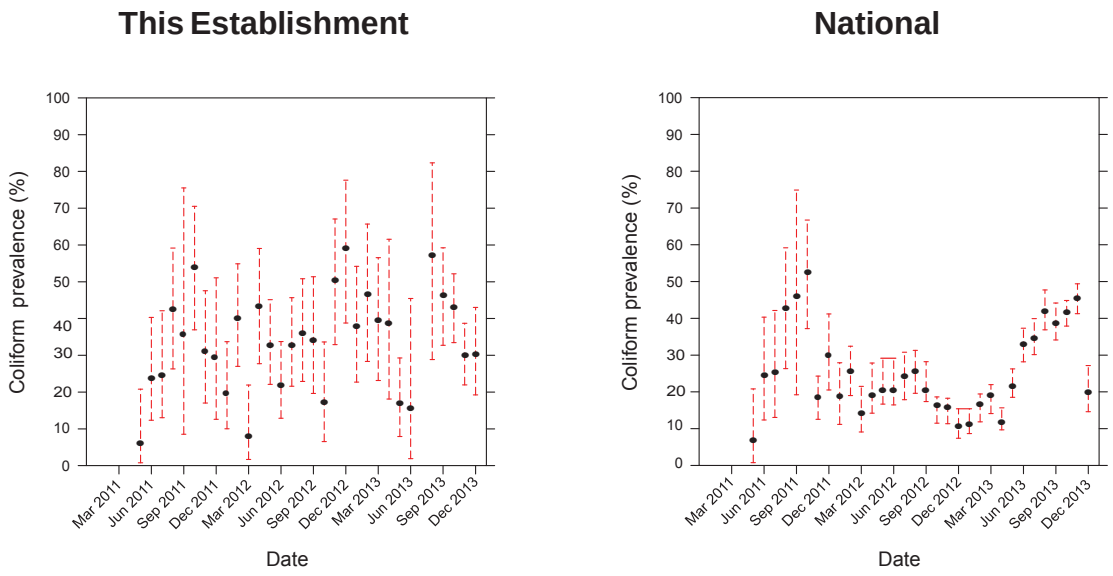


Figure 10: Time plot of monthly coliform prevalence for Establishment XXX and all establishments **over the last 3 years** — the black dots indicate the estimated prevalence in each month (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

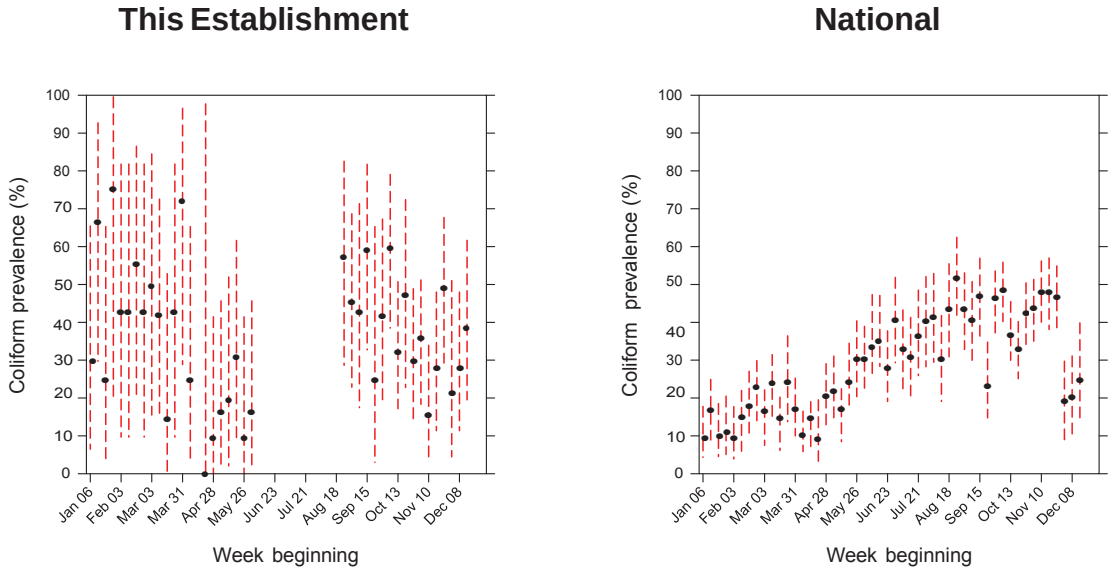


Figure 11: Time plot of weekly coliform prevalences for Establishment XXX and all establishments **over the last year** — the black dots indicate the estimated prevalence in each week (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

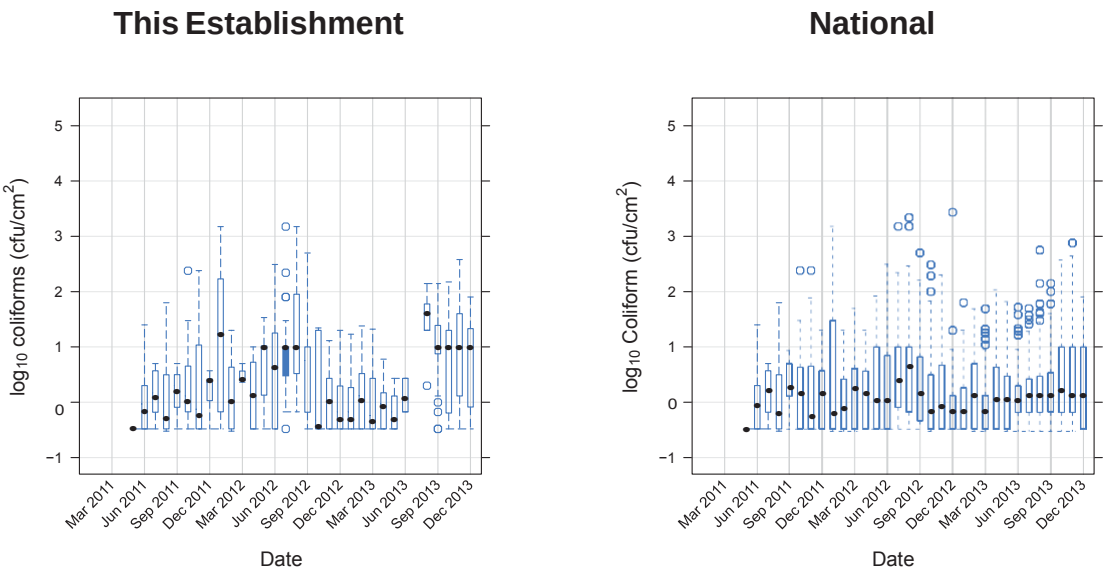


Figure 12: Box plot of monthly coliform positive concentrations for Establishment XXX and all establishments **over the last 3 years**.

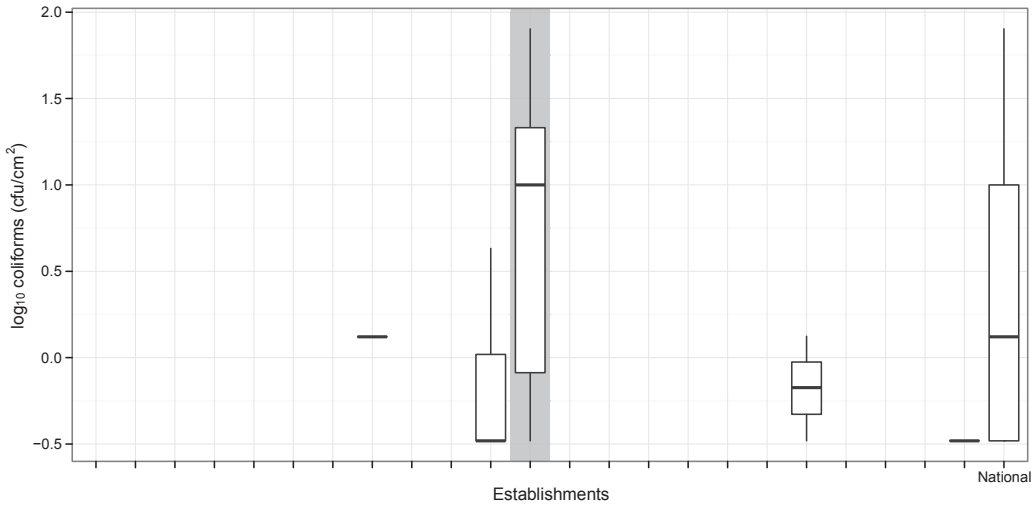


Figure 13: Box plots of this month's coliform counts for all establishments individually and combined into a National box plot. The results for Establishment XXX are identified by the grey background.

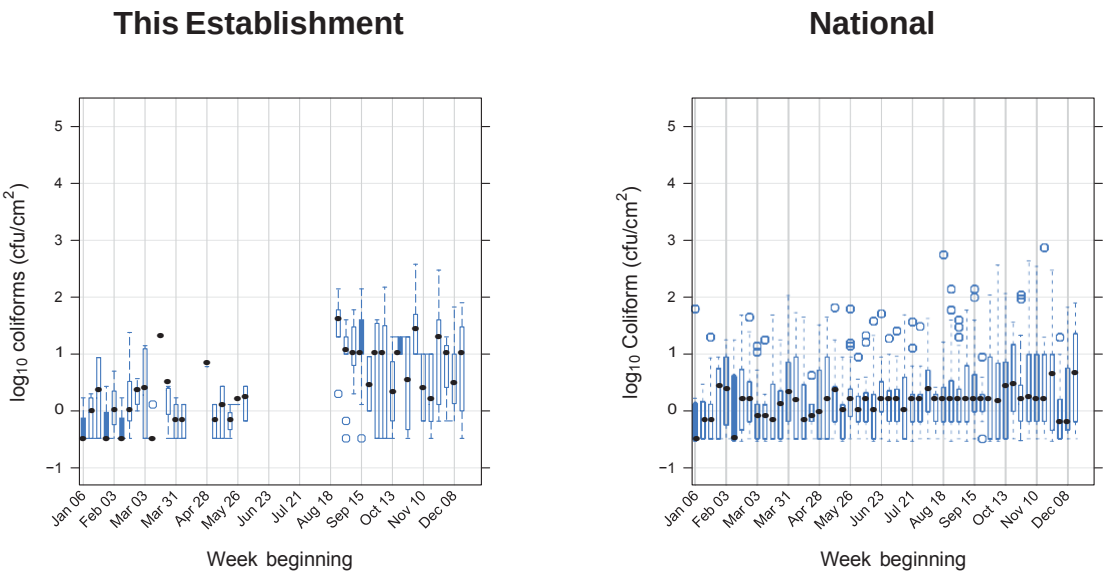


Figure 14: Box plot of weekly coliform concentrations for Establishment XXX and all establishments **over the last year**.

4 *Salmonella* Summary

Table 7: *Salmonella* prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**20**	**7**	**288**	**4328**
Positives	**0**	**0**	**1**	**23**
Percent +ve	**0.000**	**0.000**	**0.347**	**0.531**
Lower Bound	0.000	0.000	0.009	0.337
Upper Bound	16.843	40.962	1.919	0.796

Table 8: *Salmonella* serovars for this establishment.

TestDate	Serotype
2011-06-06	Adelaide

5 Glossary of Terms

5.1 Prevalence summary

Tests: The total number of samples (TVC, *E. coli* or *Salmonella*) in the ESAM database during the reporting period.

Positives: The number of samples with positive concentrations (ie. concentrations > 0).

Percent +ve: 100 × Positives/Tests.

Lower Bound & Upper Bound: Lower and Upper 95% Confidence Bounds. The "true" prevalence is expected to be in this range.

5.2 TVC and *E. coli* concentration summary

All concentration data are converted into logarithms with base 10, given by $\log_{10}$ cfu/cm^2.

Minimum: Minimum concentration.

Q1 or 1st Quartile: 25% of the data are less than this value, 75% are more.

Q3 or 3rd Quartile: 75% of the data are less than this value, 25% are more.

Median: 50% of the data are less than this concentration, 50% are more,

90th Percentile: 90% of the data are less than this value, 10% are more.

95th Percentile: 95% of the data are less than this value, 5% are more.

99th Percentile: 99% of the data are less than this value, 1% are more.

Maximum: Maximum concentration.

Mean: The average.

Standard Deviation (SD): A measure of spread (or variability) about the mean.

5.3 Box plot

A graphical tool to assess the data.

- The solid dot is the median.
- The box contains half the data.
- The lower and upper bounds of the box are the 1st and 3rd quartile.
- The inter-quartile range (IQR) = Q3 - Q1
- The length of the whiskers is calculated by ±1.5× IQR. The end of the whiskers corresponds to the observation in the dataset that is closest to this defined value.
- Observations falling outside the extent of the whiskers are indicated separately. Values falling far outside the whiskers indicate unusual or extreme values.

5.4 Time plot of *E. coli* concentrations over time

This plot is useful to compare the level of *E. coli* at individual plants over time compared to that found nationally over the same sampling period.

- Positive tests are represented as red dots; negative tests as blue open circles.
- Red (dashed) horizontal lines show the ‘m’ and ‘M’ values for that species.
  - The value of ‘m’ and ‘M’ for each species is defined in Appendix 1 of AQIS Meat Notice 2003/6.
  - Observations **below** the defined value ‘m’ are considered to have Acceptable levels of *E. coli*.
  - Observations **above** the defined value ‘M’ are considered to have Unacceptable levels of *E. coli*.
  - The observations between ‘m’ and ‘M’ are considered to have Marginal levels of *E. coli*.

Appendix D: Sample Hot Swabbing Report

E. coli and *Salmonella* Monitoring Report

Establishment XXX

COW/BULL - Hot Swabbed

Reporting Period:

01 Jan 2011 to 31 Dec 2013

Generated

March 11, 2014 at 09:51

Prepared by
SARDI Food Safety Research
GPO Box 397
ADELAIDE, SA 5001, Australia
Ph: +61 8 8303 9771
Fax: +61 8 8303 9424

Government of South Australia

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

1 Total Viable Count Summary

Table 1: Total Viable Count prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**48**	**18**	**452**	**3286**
Positives	**48**	**17**	**424**	**3048**
Percent +ve	**100.00**	**94.44**	**93.81**	**92.76**
Lower Bound	92.60	72.71	91.17	91.82
Upper Bound	100.00	99.86	95.84	93.62

Table 2: Total Viable Count summary for this establishment and nationally ($\log_{10}$ cfu/cm^2) for samples where TVC was greater than the limit of detection.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Minimum	1.079	0.875	-0.770	-1.301
Q1	**1.402**	**1.447**	**0.903**	**0.422**
Median	**2.130**	**2.204**	**1.371**	**0.940**
Mean (+ve)	2.091	2.213	1.445	0.949
Q3	**2.480**	**2.778**	**1.919**	**1.492**
90th Percentile	3.114	3.419	2.492	1.964
95th Percentile	3.176	3.562	3.079	2.258
99th Percentile	3.204	3.835	3.835	3.083
Maximum	3.204	3.903	3.903	4.534
SD	0.684	0.931	0.826	0.828

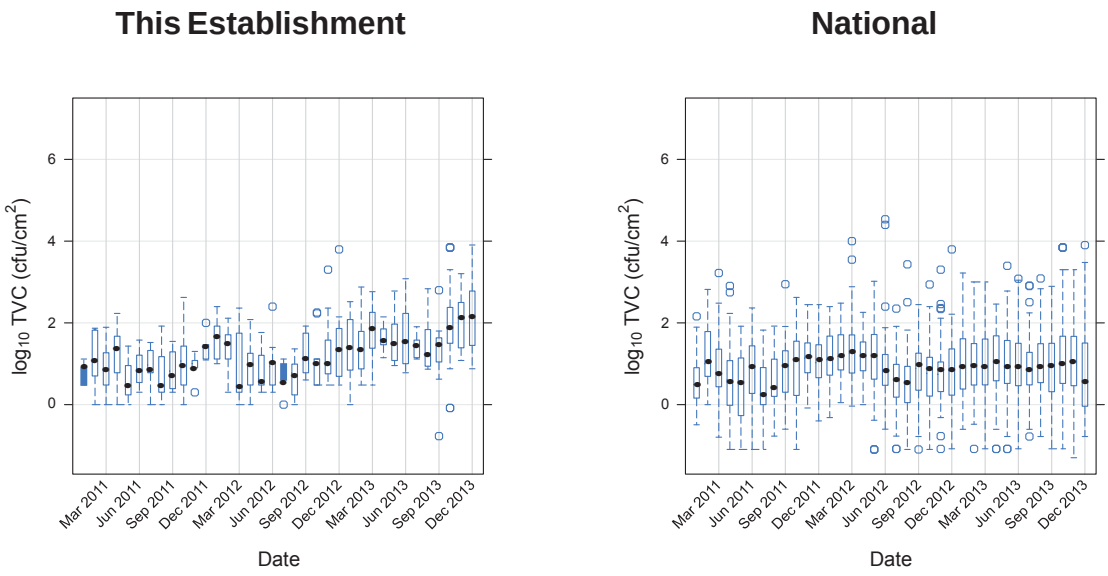


Figure 1: Box plot of monthly Total Viable Counts for Establishment XXX and all establishments with at least one hot swabbed test **over the last 3 years**.

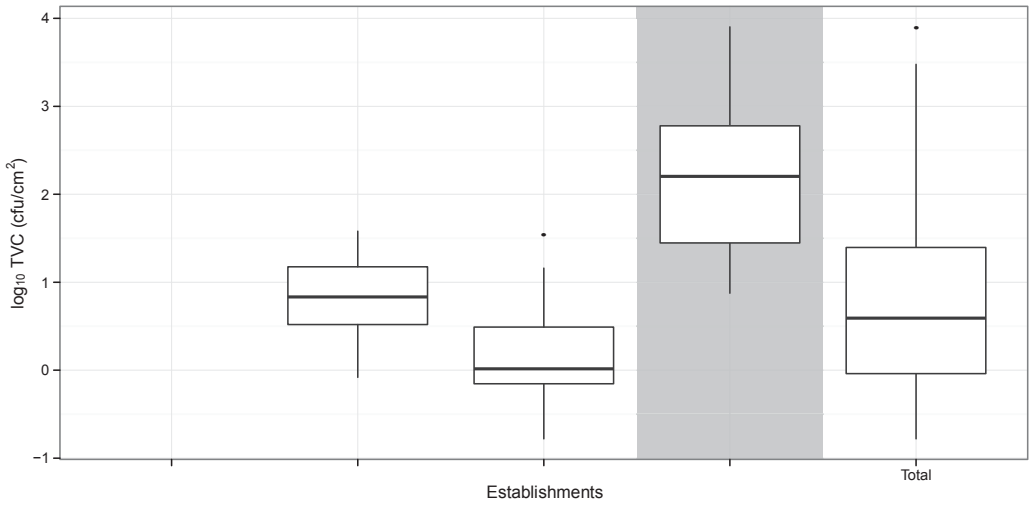


Figure 2: Box plots of this month's Total Viable Counts for all hot swabbing establishments individually and combined (Total) box plot. The results for Establishment XXX are identified by the grey background. (Establishments included here swab a substantial proportion from hot carcases.)

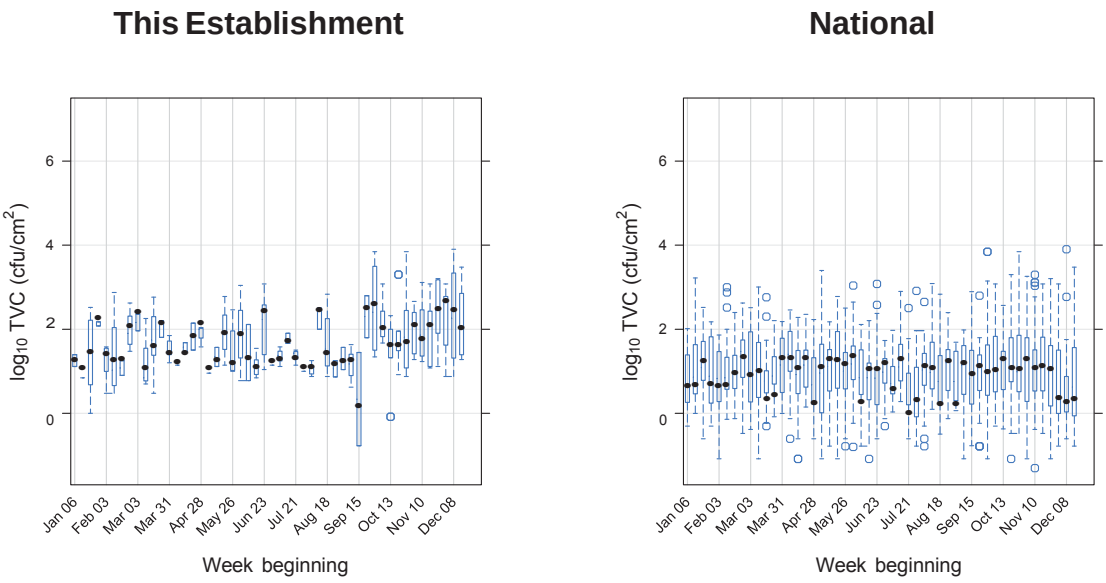


Figure 3: Box plot of weekly Total Viable Counts for Establishment XXX and all establishments **over the last year**.

2 *E. coli* Summary

Table 3: *E. coli* prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**47**	**18**	**452**	**4637**
Positives	**6**	**1**	**47**	**463**
Percent +ve	**12.77**	**5.56**	**10.40**	**9.98**
Lower Bound	4.83	0.14	7.74	9.14
Upper Bound	25.74	27.29	13.59	10.88

Table 4: *E. coli* summary for this establishment and nationally ($\log_{10}$ cfu/cm^2) for samples where *E. coli* was detected.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Minimum	-1.081	-1.081	-1.081	-2.097
Q1	**-0.561**	**-1.081**	**-1.000**	**-1.089**
Median	**1.000**	**-1.081**	**-0.523**	**-0.796**
Mean (+ve)	0.407	-1.081	-0.169	-0.598
Q3	**1.226**	**-1.081**	**0.483**	**-0.319**
90th Percentile	1.301	-1.081	1.120	0.225
95th Percentile	1.301	-1.081	1.330	0.666
99th Percentile	1.301	-1.081	1.477	1.477
Maximum	1.301	-1.081	1.477	2.995
SD	1.160	NA	0.864	0.629

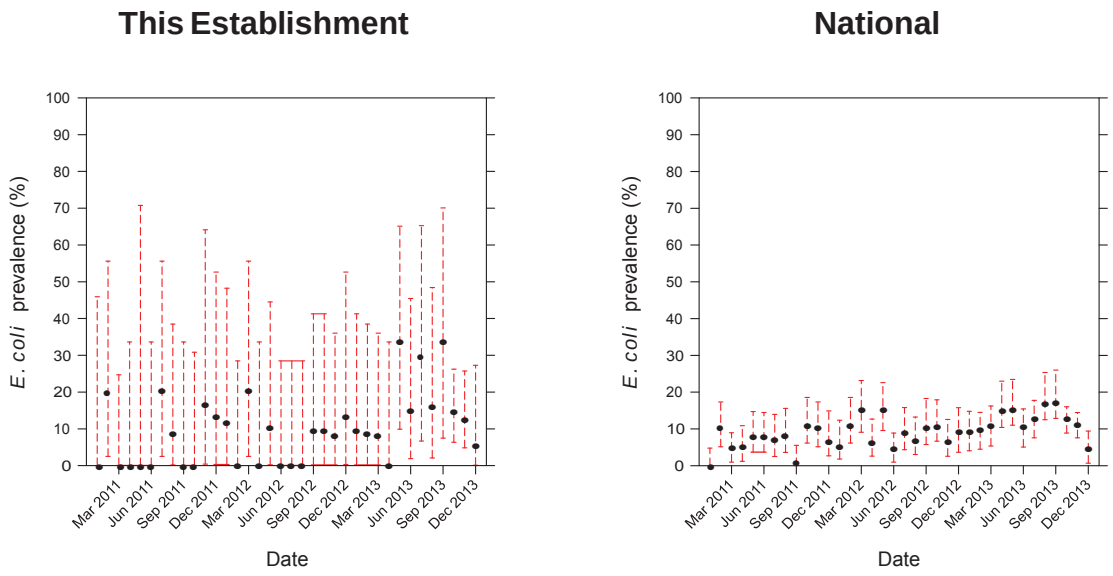


Figure 4: Time plot of monthly *E. coli* prevalence for Establishment XXX and all establishments **over the last 3 years** — the black dots indicate the estimated prevalence in each month (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

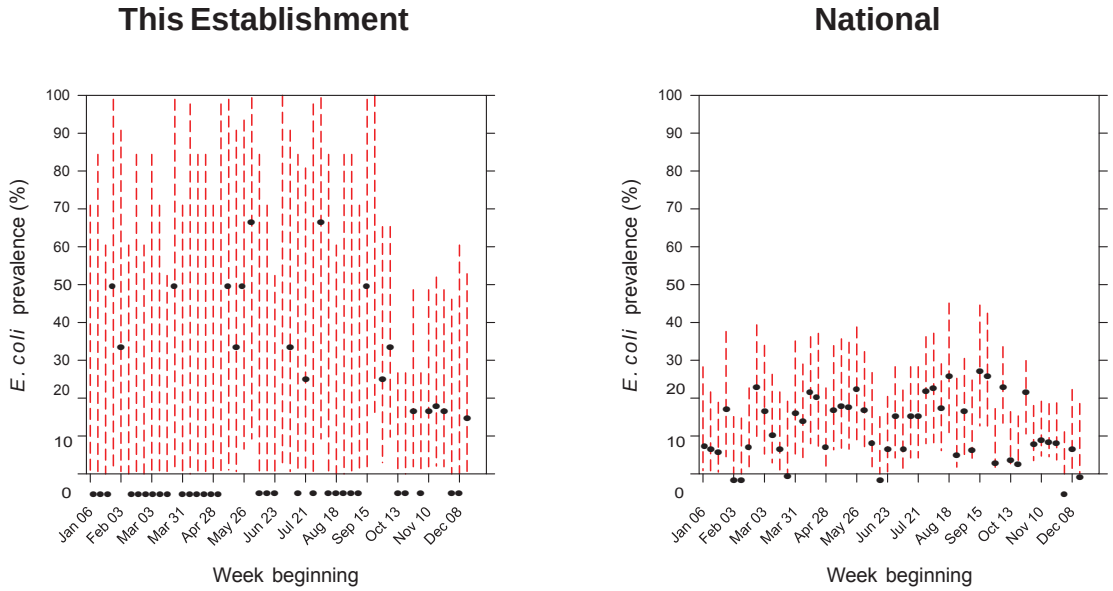


Figure 5: Time plot of weekly *E. coli* prevalences for Establishment XXX and all establishments **over the last year** — the black dots indicate the estimated prevalence in each week (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

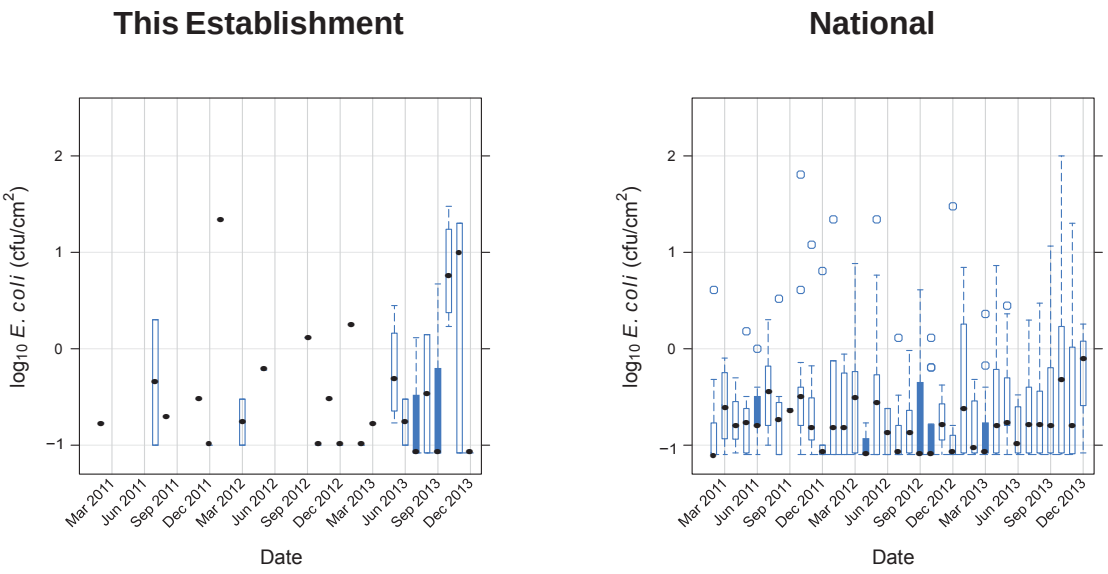


Figure 6: Box plot of monthly *E. coli* positive concentrations for Establishment XXX and all establishments with at least one hot swabbed test **over the last 3 years**.

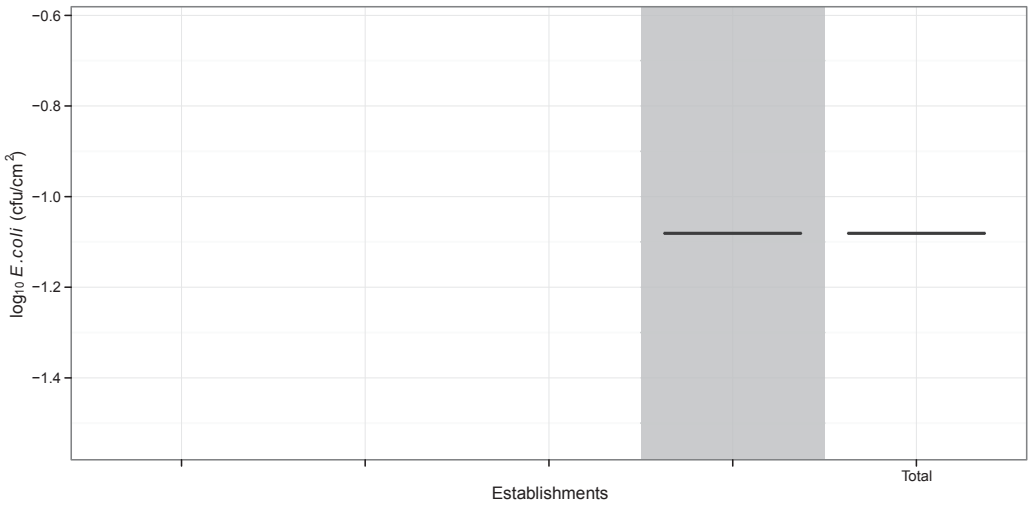


Figure 7: Box plots of this month's *E. coli* counts for all hot swabbing establishments individually and combined (Total) box plot. The results for Establishment XXX are identified by the grey background. (Establishments included here swab a substantial proportion from hot carcases.)

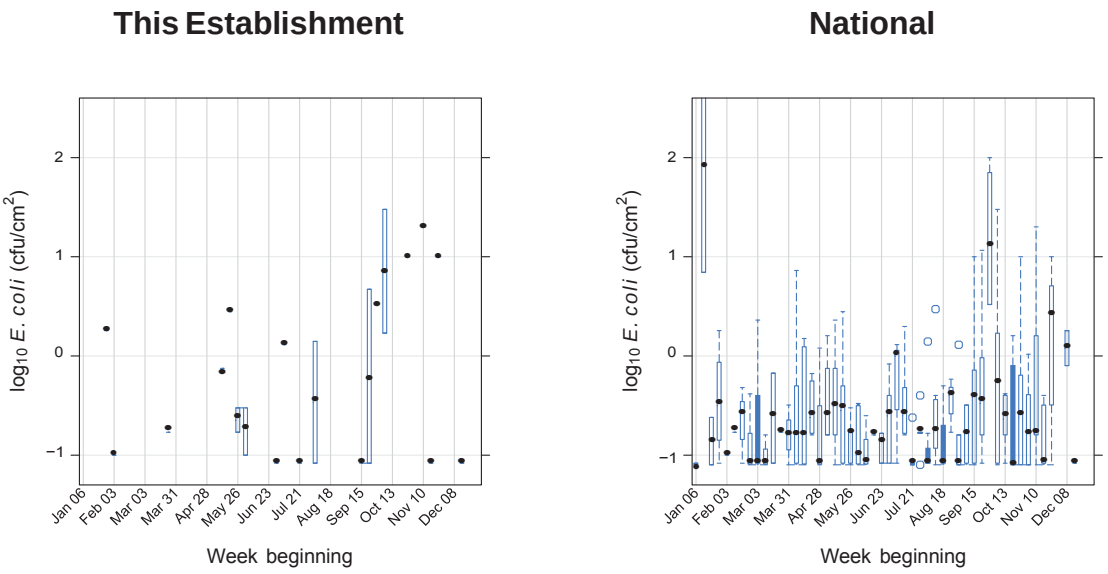


Figure 8: Box plot of weekly *E. coli* for Establishment XXX and all establishments **over the last year**.

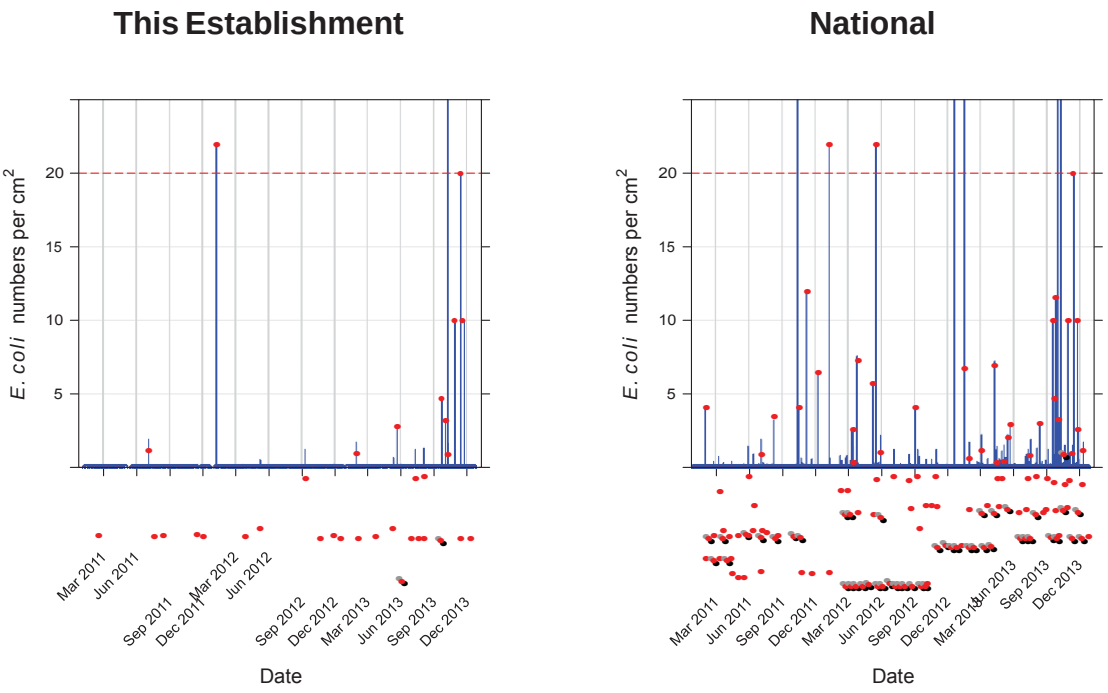


Figure 9: Time plot of *E. coli* tests for Establishment XXX and all establishments — positive tests are represented by red points; negative tests are represented by blue circles.

3 *Coliform* Summary

Table 5: Coliform prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**30**	**18**	**320**	**1349**
Positives	**12**	**4**	**70**	**315**
Percent +ve	**40.00**	**22.22**	**21.88**	**23.35**
Lower Bound	22.66	6.41	17.47	21.12
Upper Bound	59.40	47.64	26.81	25.70

Table 6: Coliform summary for this establishment and nationally ($\log_{10}$ cfu/cm^2) for samples where *coliforms* were detected.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Minimum	-1.081	-1.081	-1.097	-1.301
Q1	**-0.770**	**-1.081**	**-1.081**	**-1.081**
Median	**1.000**	**-1.081**	**-0.482**	**-0.602**
Mean (+ve)	0.459	-0.561	-0.182	-0.421
Q3	**1.000**	**-0.561**	**0.531**	**0.000**
90th Percentile	1.542	0.376	1.000	0.658
95th Percentile	1.602	0.688	1.485	1.000
99th Percentile	1.602	0.938	1.699	1.602
Maximum	1.602	1.000	1.699	2.000
SD	1.050	1.040	0.885	0.708

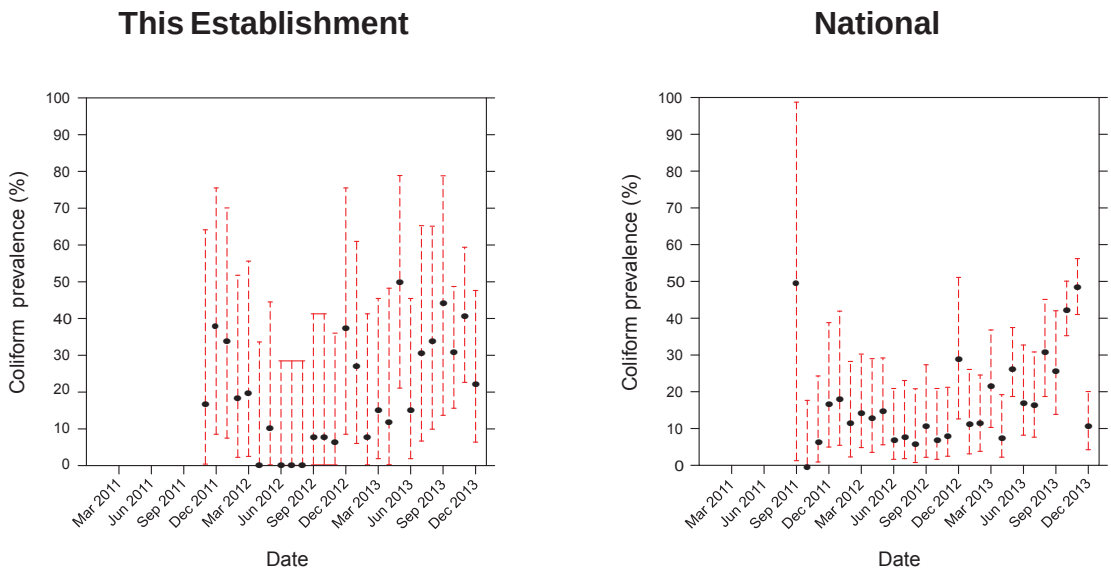


Figure 10: Time plot of monthly coliform prevalence for Establishment XXX and all establishments **over the last 3 years** — the black dots indicate the estimated prevalence in each month (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

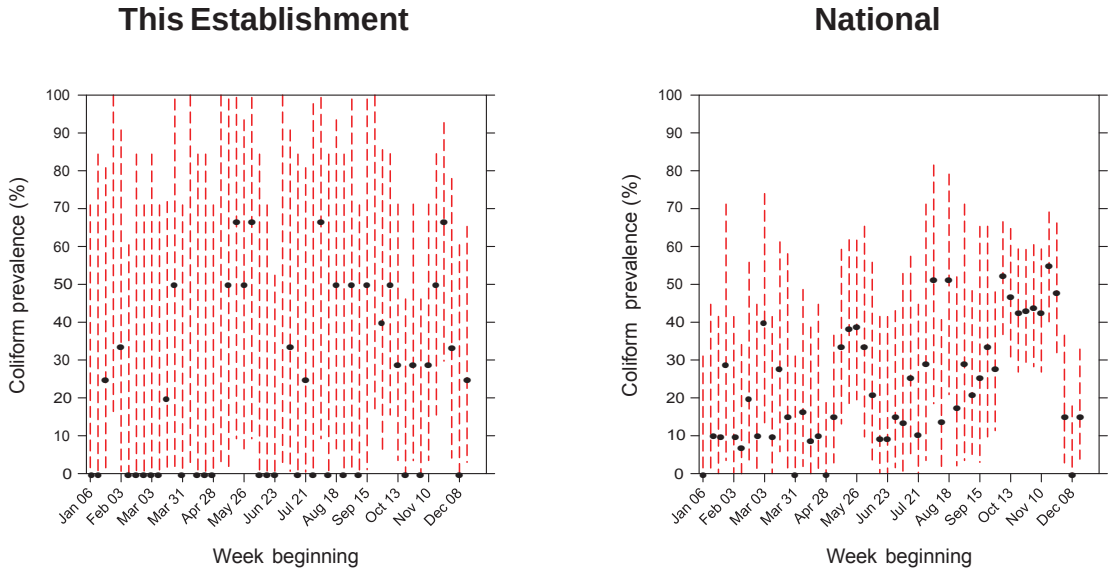


Figure 11: Time plot of weekly coliform prevalences for Establishment XXX and all establishments **over the last year** — the black dots indicate the estimated prevalence in each week (as a percentage) and the red lines indicate 95% confidence intervals for each estimate.

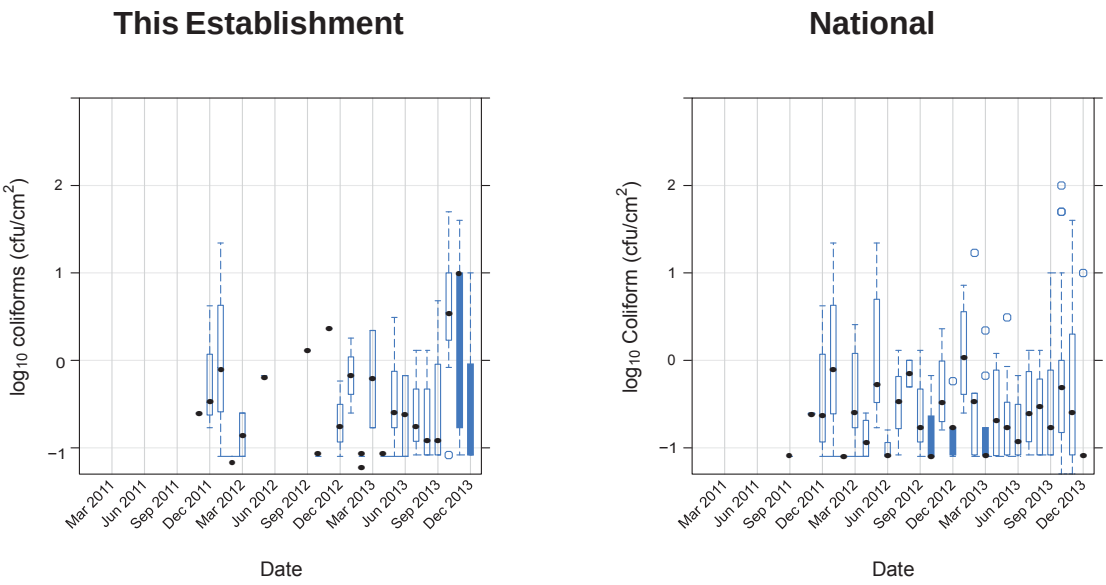


Figure 12: Box plot of monthly coliform positive concentrations for Establishment XXX and all establishments with at least one hot swabbed test **over the last 3 years**.

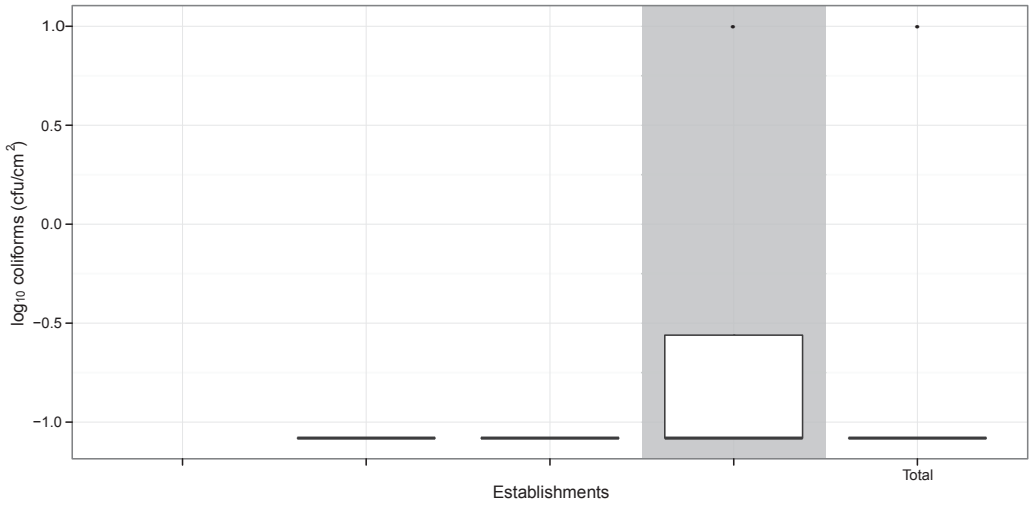


Figure 13: Box plots of this month's coliform counts for all hot swabbing establishments individually and combined (Total) box plot. The results for Establishment XXX are identified by the grey background. (Establishments included here swab a substantial proportion from hot carcases.)

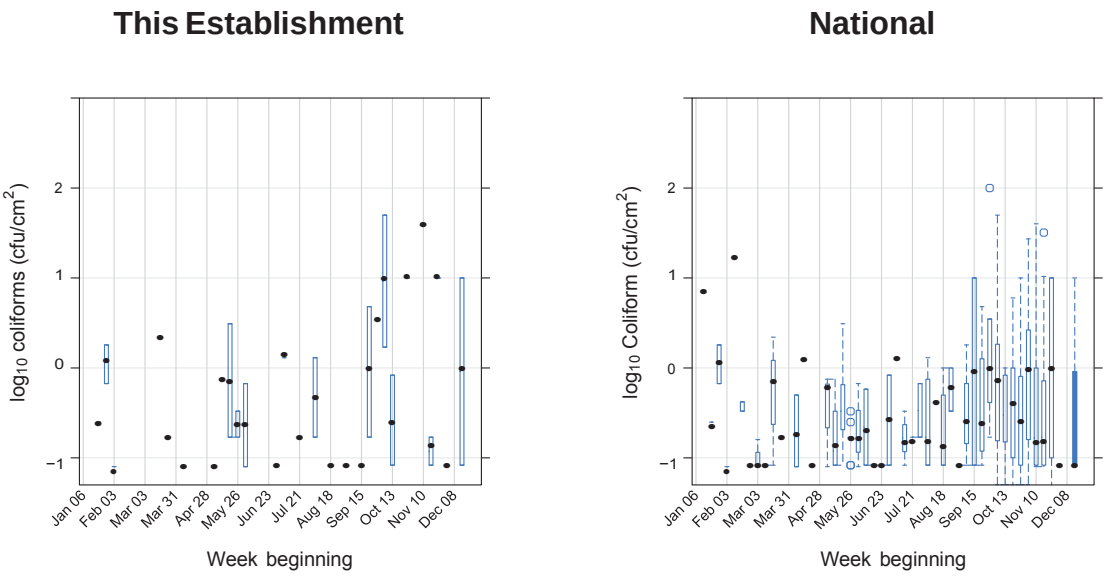


Figure 14: Box plot of weekly coliform concentrations for Establishment XXX and all establishments **over the last year**.

4 *Salmonella* Summary

Table 7: *Salmonella* prevalence summary for this establishment and nationally.

	This Establishment			National
	Nov 2013	Dec 2013	Last 3 Years	Last 3 Years
Tests	**6**	**2**	**127**	**1476**
Positives	**0**	**0**	**0**	**24**
Percent +ve	**0.000**	**0.000**	**0.000**	**1.626**
Lower Bound	0.000	0.000	0.000	1.045
Upper Bound	45.926	84.189	2.863	2.410

There were no *Salmonella* detections at this establishment over the reporting period and consequently no serovar information is provided.

5 Glossary of Terms

5.1 Prevalence summary

Tests: The total number of samples (TVC, *E. coli* or *Salmonella*) in the ESAM database during the reporting period.

Positives: The number of samples with positive concentrations (ie. concentrations > 0).

Percent +ve: 100 × Positives/Tests.

Lower Bound & Upper Bound: Lower and Upper 95% Confidence Bounds. The "true" prevalence is expected to be in this range.

5.2 TVC and *E. coli* concentration summary

All concentration data are converted into logarithms with base 10, given by $\log_{10}$ cfu/cm^2.

Minimum: Minimum concentration.

Q1 or 1st Quartile: 25% of the data are less than this value, 75% are more.

Q3 or 3rd Quartile: 75% of the data are less than this value, 25% are more.

Median: 50% of the data are less than this concentration, 50% are more,

90th Percentile: 90% of the data are less than this value, 10% are more.

95th Percentile: 95% of the data are less than this value, 5% are more.

99th Percentile: 99% of the data are less than this value, 1% are more.

Maximum: Maximum concentration.

Mean: The average.

Standard Deviation (SD): A measure of spread (or variability) about the mean.

5.3 Box plot

A graphical tool to assess the data.

- The solid dot is the median.
- The box contains half the data.
- The lower and upper bounds of the box are the 1st and 3rd quartile.
- The inter-quartile range (IQR) = Q3 - Q1
- The length of the whiskers is calculated by ±1.5× IQR. The end of the whiskers corresponds to the observation in the dataset that is closest to this defined value.
- Observations falling outside the extent of the whiskers are indicated separately. Values falling far outside the whiskers indicate unusual or extreme values.

5.4 Time plot of *E. coli* concentrations over time

This plot is useful to compare the level of *E. coli* at individual plants over time compared to that found nationally over the same sampling period.

- Positive tests are represented as red dots; negative tests as blue open circles.
- Red (dashed) horizontal lines show the ‘m’ and ‘M’ values for that species.
  - The value of ‘m’ and ‘M’ for each species is defined in Appendix 1 of AQIS Meat Notice 2003/6.
  - Observations **below** the defined value ‘m’ are considered to have Acceptable levels of *E. coli*.
  - Observations **above** the defined value ‘M’ are considered to have Unacceptable levels of *E. coli*.
  - The observations between ‘m’ and ‘M’ are considered to have Marginal levels of *E. coli*.