Random Selection for the Fiscal 2013/14 Merit Performance Audit

BRITISH COLUMBIA | BCStats

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Background

The Office of the Merit Commissioner was established by legislation in August 2001. Under this legislation, the Merit Commissioner is responsible for performing audits of public service appointments, as part of a program of monitoring the application of the merit principle under section 8 of the *Public Service Act*. The results of the audits are reported to the Executive of ministries and other organizations. The aggregate results are also communicated to the Legislative Assembly.

The Office of the Merit Commissioner is legislated to perform random audits of public service appointments.

The audits are designed to assess whether recruitment and selection practices have resulted in appointments based on merit, and whether individuals possess the required qualifications for the position to which they were appointed. This requires a close study of the details of each appointment audited by an expert in staffing processes. In 2011, the Office of the Merit Commissioner identified the need for refinements to the audit program and adjustments were introduced.

To support the audit process, BC Stats developed a sampling solution to ensure that the cases selected for the audit were both random and representative.

In 2013, the Office of the Merit Commissioner moved from a calendar year (January through December) to that of a fiscal year (April through March). Therefore, this report describes the appointments that occurred within most of the fiscal 2013/14 year, and explains the method that was used to make an audit selection from these appointments.

Between 2001 and 2005, the resources available for auditing were limited and the number of appointments audited were constrained accordingly. With the 2006 appointment of the first Merit Commissioner as an independent Officer of the Legislature, the annual audit increased in size. The sample rate was then increased each year such that it was robust enough to generalize the audit results to the population of appointments for a hiring year with greater certainty – at roughly 12% by 2009. The 2010 audit was an anomalous partial year audit which included oversampling of the administrative category, covering appointments from September 1, 2010 to December 31, 2010. To allow for the most effective use of available auditing resources in 2011, that year's audit saw a decrease in sampling rate to 5.6%, while allowing for continued generalization of the audit findings to the larger appointment population. The 2012 audit results were based on a slight increase in sampling rate to 5.8%. In the fiscal 2013/14 audit, a slight increase in the sampling rate to 7.5% or 150 appointments were

audited from an adjusted population of 2,010 appointments[1], which allowed for continued, but also improved generalization of the partial year audit results to allow generalization to the full population of appointments for the fiscal 2013/14 year[1].

Table 1(A) summarizes the in-scope population and sample counts across audit years *prior to* the establishment of the Office of the Merit Commissioner as an independent office.

TABLE 1(A): YEAR-OVER-YEAR COMPARISON OF IN-SCOPE POPULATION AND SAMPLE COUNTS

Year	Number of Appointments	Number of Audits	Sampling Rate
2001	1,481	39	2.6%
2002	1,835	30	1.6%
2002	2,772	40	1.4%
2003	2,904	39	1.3%
2004	2,871	70	2.4%
2005	1,481	39	2.6%

Table 1(B) summarizes the in-scope population and sample counts across audit years *following* the establishment of the Office of the Merit Commissioner as an independent office.

TABLE 1(B): YEAR –OVER-YEAR COMPARISON OF IN-SCOPE POPULATION AND SAMPLE COUNTS

Year	Number of Appointments	Number of Audits	Sampling Rate
2006	3,754	308	8.2%
2007	5,508	531	9.6%
2008[1]	n/a	n/a	n/a
2009	2,429	302	12.4%
2010[2]	942	183	19.4%
2011	3,942	222	5.6%
2012	3,928	256	5.8%
2013 Jan - Aug[3]	n/a	n/a	n/a
Fiscal 2013/14[4]	2010	150	7.5%

Note 1: An audit was not conducted in 2008 and, as a result, a count of appointments occurring within the 2008 calendar year was not obtained for this study.
Note 2: The 2010 audit was a partial year audit, covering appointments from September 1, 2010 to December 31, 2010.
Note 3: The Fiscal 2013/14 audit was a partial year audit, covering appointments from September 1, fiscal 2013 to March 31, 2014 to synchronize with the 2013/14 year.

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[1]See "Random Selection of Cases" for a full discussion of the number of appointments originally put forward for audit. A certain proportion, upon review, was deemed out of scope and this proportion was then estimated back into the original population.

2013/14 Appointment Demographics

The Office of the Merit Commissioner defined the population of appointments for the fiscal 2013/14 audit according to two key factors: the type of appointment and the timeframe in which the appointment occurred. The fiscal 2013/14 audit timeframe was September 1, 2013 to March 31, 2014. The types of appointments to be audited included direct appointments, permanent appointments and temporary appointments of more than seven months. The remaining appointments within the Merit Commissioner's jurisdiction of appointments made under section 8 of the *Public Service Act* (i.e., auxiliary appointments and temporary appointments of seven months or less), were excluded from the audit population. Based on these query parameters, a final population of 2,161 appointments was identified.

Random Selection of Cases

The objective of the Office of the Merit Commissioner's merit performance audit is to randomly sample all permanent new hires, promotions, direct appointments and temporary appointments greater than seven months in order to obtain an unbiased picture of the application of the merit principle under the *Public Service Act*. However, while a random sample offers a generally unbiased representation of an overall population, the sample's representativeness for specific groups within the population may be limited due to constraints imposed by the size of the population and the sample. For this reason, the population was stratified prior to sample selection to ensure adequate representation in the final sample. The data stratification process is described later in this report.

The samples for the fiscal 2013/14 audit were selected at three intervals across the 2013/14 fiscal year.

Eligible B.C. Public Service (BCPS) appointments took place between three intervals: September 1 - October 31, 2013, November 1 - December 31, 2013 and January 1 - March 31, 2014. Eligible appointments within the Liquor Distribution Branch (LDB) were sampled twice from their own source data for appointments that took place between September 1 - December 31, 2013 and January 1 - March 31, 2014.

For the 2013/14 audit which began in September 2013, the sampling rates were slightly increased to improve the robustness of the merit findings on all metrics of interest in the appointment populations within the available resources of the Office of the Merit Commissioner. The resulting adjusted sampling rate culminated in a 7% overall sample rate for the 2013/14 fiscal year and a 15% overall sample rate for LDB appointments. Once the population was known for the first portion of the 2013/14 fiscal year, the same

overall sampling rate was applied to the samples of appointments from January 1 to March 31, 2014.

For each sampling window, a cumulative list of appointments made from the first date of the sampling window to the date of the sample draw, was provided to BC Stats. The list was filtered to distinguish appointments that had already appeared in any previous sampling window. In addition to identifying new appointments, the filtering process was also used to identify unique appointments for employees with multiple entries in the cumulative list. This filtering process provided a final population of appointments from which independent samples could be drawn.

In total, five samples were drawn for the fiscal 2013/14 audit. A summary of the five sampling windows and their associated sampling rates are provided in Table 2.

As none of the population sizes were evenly divisible by their respective systematic sample rate, in addition to the influence of random start counts, the actual sampling rates slightly differed from the systematic rates.

TABLE 2: 2013/14 SAMPLING AND POPULATION CHARACTERISTICS

Organizations	Sampling Window	Population	Sample Size	Systematic Sampling Rate	Actual Sampling Rate
BC Public Service	Sept 1 – Oct 31, 2013	643	46	7.0%	7.2%
	Nov 1 – Dec 31, 2013	564	41	7.0%	7.3%
	Jan 1 – Mar 31, 2014	869	61	7.0%	7.0%
Liquor Distribution Branch	Sept 1 – Dec 31, 2013	41	6	15%	14.6%
	Jan 1 – Mar 31, 2014	44	7	15%	15.9%
TOTAL		**2,161**	**161**	**-**	**-**

Note: The systematic sampling rate represents the initial rate at which sample points were drawn from a sample window as none of the population sizes were evenly divisible by their respective samples. Based on the sampling plan summarized in Table 2, a final sample size of 161 appointments was drawn from

the total population of 2,161 appointments with 11 identified as out-of-scope, leaving a total of 150
audited appointments out of an estimated total in-scope population of 2,007.

In previous years, three key categories were selected to stratify the data, based on their
relative importance. Using a set of category definitions similar to those used in previous
annual audits, the fiscal 2013/14 appointments were stratified by their size and
appointment type. Based on BC Stats' recommendation[2] for simplifying the complex
sampling methodology, the bargaining unit status category was eliminated from the
sampling stratification and the ministry/organization size category was reduced from a
four to a two category stratum for the 2013/14 audit. The two categories chosen for
fiscal 2013/14 were defined as follows:

Sampled public service appointments entered into the complex sampling draw, were stratified on two levels: by organization size and appointment type.

- Ministry/organization size: Up to 1000 employees, larger than 1000 employees;
  and

- Appointment type: Permanent appointment, temporary appointment of more
  than seven months, direct appointment.

In fiscal 2013/14, as in previous audits, certain portions of the population were under-
sampled so as to better optimize the distribution of the full sample. A post stratification
weighting adjustment ensured that any bias introduced by disproportionate sampling
was largely minimized in the final population estimates.

Of the 161 randomly-sampled appointments, the Office of the Merit Commissioner
identified 11 cases as being out-of-scope, primarily due to coding errors in the source
data. These 11 cases were removed from the sample, leaving 150 appointments that were
audited.

However, since 11 records represented a sizeable proportion of the sample size
(i.e., 7%), BC Stats used the strata information to estimate back into the original
population how many cases would likely be deemed out-of-scope if the entire population
of cases had been audited. The statistics presented in the rest of the report are based on
this reduced population (150/2,010). In summary, random sampling was used to ensure
broad-based auditing of all appointments. Sampling independently in the above-
mentioned categories ensured correct proportional coverage of:

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[2] In June/July 2013, the Office of the Merit Commissioner and BC Stats decided to test whether the three
strata differ significantly in merit findings, to determine whether any variables could be dropped or
combined to reduce the instance of over-sampling. Based on the results, the Office of the Merit
Commissioner chose to instate BC Stats' recommendation to combine the three smallest organization size
strata into one stratum: up to 1000 employees as well as delete the bargaining unit category. See Appendix
B.

- a range of differently-sized organizations/ministries; and

- permanent, temporary and direct appointments.

As a final note regarding the stratification plan, the calculation of sample weights was not limited to the sample strata. In total, a set of 16 unique weights were created to adjust for bias in the overall sample.

Distribution of Audits

The following two tables show how the audits are distributed according to various characteristics of appointments. The tables (appointment type and ministry/organization size) represent the categories that were used in sample stratifications. In all cases, percentages were rounded to the first decimal place, and sum to 100%.

The relatively close correspondence between the sample percentages and percentages within all appointments on the majority of strata indicates that they are reasonably representative of the whole. As discussed above, unique weights were created to adjust for bias in the overall sample.

The 2013/14 partial-year audit samples are reasonably representative of the fiscal year's population of public service appointments as a whole.

TABLE 3: AUDITS BY APPOINTMENT TYPE

Appointment Type	Adjusted Number of Appointments	Percent of All Appointments	Number of Audits	Percent of All Audits
Direct Appointment	71	3.5%	5	3.3%
Temporary > 7 Months	97	4.8%	7	4.7%
Permanent Hire	1841	91.6%	138	92.0%

TABLE 4: AUDITS BY ORGANIZATION SIZE

Organization Size	Adjusted Number of Appointments	Percent of All Appointments	Number of Audits	Percent of All Audits
Large	1,596	73.9%	102	68.7%
Small	565	26.1%	48	32.0%

Note: Organization size was based on total regular employment at the start of the study period. In this table, organizations with more than 1,000 employees were deemed large, and organizations with 1,000 employees or less were deemed small.

Uses and Limitations of Audit Results

BC Stats assists the Office of the Merit Commissioner to draw representative sample populations to mimic and predict merit principle application trends for the whole population of appointments in a given time period. A certain degree of error and uncertainty is normally expected in sampling as well as in the statistics of interest and the ranges of their probabilities. This expectation of error is captured through the application of the confidence interval. The confidence interval level (here 95%) describes the uncertainty associated with a sampling method given a range of possibilities both above and below the found statistic (± a percentage range).

Given the stringency of the audit sampling methodology, confidence can be placed in the statistical accuracy of the audit finding proportions as representative of the corresponding population of total BC Public Service appointments from the audit time period.

With small sample sizes, such as those which occur with the 7% overall sampling rates in the BCPS appointment samples, the likelihood of variance (or difference within the samples when compared to one another) increases, and therefore, so does the error associated with the sampling. This in turn, increases the range of error (or variance) on the audit results of interest. Sampling rates should strive to achieve the lowest possible ranges on those statistics and as such, the confidence in being able to say that the samples represent the real world must be tempered with these errors and ranges in mind.

The appointments selected for auditing provided random and representative samples of all appointments that occurred between September 1, 2013 and March 31, 2014 and represent fiscal 2013/14. As a result, the audit selections were biased towards the later part of the year in 2013 and the first quarter of 2014 in regards to the sampling framework.

In terms of year-over-year comparisons, while the number of audits conducted in fiscal 2013/14 (150) was less than in 2012 (228), the number was also a result of a shorter time frame - seven months versus a full calendar year. The number of audits conducted in fiscal 2013/14 was based on available audit resources, and the ongoing hiring constraints reduced the number of overall appointments in the 2013/14 fiscal year. By combining the realities of audit resource constraints with the continuation of reduced rates but consistently applied, randomized, stratified complex sampling strategies, the samples and subsequent audit findings can be stated to be of reasonable statistical strength.

Appendix A: Estimates and Confidence Intervals for Fiscal 2013/14 Appointment Audit Data

In order to apply confidence intervals to the estimates for the fiscal 2013/14 Merit Performance Audit, BC Stats employed a methodology that was similar to what was used in the 2010,2011 and 2012 audits. As with those previous audits, the confidence intervals in fiscal 2013/14 were based on a Poisson distribution, whereas the intervals from years prior to 2010 employed an F-distribution. While both methods provided accurate estimates, the Poisson offered a greater degree of flexibility, particularly for generating estimates for 'rare events'. For the purposes of the merit findings and the performance audit report, a 'rare event' would include findings of Merit Not Applied or 'Unable to Determine'.

A 95% confidence level means that 95% of the intervals from repeated sampling from the same total population of appointments would include the number of appointment findings indicated in the samples.

- In order to minimize sample bias and produce the best estimates, the micro data was weighted prior to generating the estimates.

- As the sample size (150) relative to the rate of 'Merit Not Applied' findings was so low, a normal approximation to the binomial could not be used. As a result, a more exact calculation was made through a Poisson distribution. This in turn produced asymmetric confidence intervals around the estimates.

- Due to year-over-year changes in sampling rates and adjustments to the audit program, parsimony should be employed when interpreting the cumulative audit results especially when considering pre-2011 findings.

- The interpretation of the 95% interval is that with repeated sampling, the true statistic (in this case, the 'Merit Not Applied' statistic) lies within 95% of the distribution. Stated another way, 95 times out of 100, the statistic would be found within the upper and lower bounds for that interval.

TABLE 5: ESTIMATED AUDIT FINDINGS AND CONFIDENCE INTERVALS

Audit	Audit Finding	Estimate (weighted)	95% Confidence Interval	
			Lower	Upper
All Audits (2001-2013/14)	Merit Not Applied	4.2%	3.2%	5.0%
	Unable to Determine	1.5%	1.0%	2.1%
Fiscal 2013/14 Audit	Merit Not Applied	8.0%	4.1%	13.1%
	Unable to Determine	-	-	-
	Merit With Exception	40.0%	30.5%	50.7%
	Total	**43.0%**	**32.9%**	**53.7%**

Note: As appointments for the 2010 audit were only drawn from a four month review, rather than the full 2010 calendar year, the 2010 merit results were not incorporated into the cumulative year-over-year results. Also, in Fiscal 2013/14 audit findings, there were zero 'unable to determine' and as such, this line is blank in the table above.

Appendix B: Strata Analyses

Background

BC Stats has historically conducted population stratification by multiple variables to pull random but representative samples for the Office of the Merit Commissioner's appointment audits of merit findings. Specifically, samples pulled from the 2011 and 2012 appointment populations were stratified by:[3]

- Appointment type (permanent, direct, temporary > 7 months)

- Bargaining unit status (included or excluded)

- Organization size (< 200, 200-499, 500-1000, > 1000 employees)

This resulted in a stratification plan of up to 24 possible cells (3x2x4) into which an appointment could be sorted. Certain portions of the population were under-sampled so as to better optimize the distribution of the full sample. A post stratification weighting adjustment ensured that any bias introduced by disproportionate sampling was largely minimized in the final population estimates.

Each year, a sampling plan was set to balance a certain and minimum level of accuracy with workload demands on Office the Merit Commissioner's auditors. However, with the possible 24 cells into which appointments could be categorized, BC Stats needed to over-sample various groups to ensure minimum 1 sample per type of cell when such categories existed.[4]

The goal of this strata analysis is to determine whether the three strata have significant differences in merit findings. It is hypothesized that in fact there are no significant differences in merit findings of appointments based on differing strata. Based on the findings, BC Stats will advise the Office of the Merit Commissioner on how future stratifications could be refined.

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[3] In previous years, whether the appointment was to an administrative or non-administrative position was also included in the stratification.

[4] For example, MHAS and LDB appointments are much smaller populations than appointments of the BC Public Sevice. When either of these smaller populations were stratified, the sampling rtate applied (e.g., 4.7% in 2012) led to samples of less than one appointment per strata. As it is not possible to audit part of an appointment, such samples were rounded up to n=1, which resulted in a larger sample.

Analysis

Two main analyses were conducted by BC Stats on the combined appointment lists from 2011 and 2012.

First, BC Stats ran simple frequency counts by the three strata in question to calculate the strata proportions (see Table 1). Then three test random samples were pulled (with both years combined), and the proportions of the resulting "sample" by the three strata were calculated. For each test, all strata sampled proportions were within ±3.3 percentage points of the strata population proportions.

TABLE 4: COMPARISON OF IN-SCOPE POPULATION AND TEST RANDOM SAMPLE PROPORTIONS

Strata	Population Proportion	Test Random Samples Proportions	Maximum Difference
Permanent appointment	89%	87% - 92%	2.7%
Temporary > 7 months	11%	8% - 12%	2.9%
Direct appointment	0.4%	0.0% - 0.6%	0.4%
Excluded bargaining unit	26%	24% - 26%	1.5%
Included bargaining unit	74%	74% - 76%	1.5%
Small (up to 1000 employees)	24%	21% - 25%	3.3%
Large (> 1000 employees)	76%	75% - 79%	3.3%

Second, BC Stats conducted Fisher's Exact Tests on the three strata as dichotomous variables.[5] The tests looked at whether the 'Merit Not Applied' rate differed between the two dichotomies for the three strata. The 'Merit Not Applied' rate differed significantly only by appointment type.

TABLE 5: IS THERE A DIFFERENCE BETWEEN THE 'MERIT NOT APPLIED' RATE FOR APPOINTMENTS OF DIFFERENT STRATA?

Strata Dichotomies	Finding	Fisher's Exact Test	
		P Value (1-tailed)	P Value (2-tailed)
Appointment Type: Permanent vs. Other	MNA rate is different	0.003	0.004
Bargaining Unit Status: Included vs. Excluded	No difference	0.11	0.17
Organization Size: Small vs. Large	No difference	0.31	0.57

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[5] Appointment type was tested as Permanent appointments compared to Other appointments (direct and temporary > 7 months combined). Bargaining unit status was tested as Included status compared to Excluded status. Organization Size was tested as Large organizations (those with over 1000 employees) compared to Small organizations (those with 1000 or fewer employees).

Recommendations

Continue to stratify by appointment type because there are so few non-permanent appointments, and in two of the random samples, no DAP appointments were randomly sampled. As well, this was the only strata that did find a difference in the 'Merit Not Applied' rate.

Modify organization size strata. There was more variation between sample proportions and population proportions of organization size in the three test random samples, although the variation was not considered large (less than ±5.0 percentage points differences). However, no difference was found in the 'Merit Not Applied' rate. It is recommended to reduce organization size stratification from four stratum to two (small – up to 1,000 employees versus large – over 1,000 employees), and to consider discontinuing stratification by organization size entirely.

Discontinue stratifying by bargaining unit status. There was minimal variation between sample proportions and population proportions in the three test random samples. As well, no difference was found in the 'Merit Not Applied' rate.

If these three recommendations are accepted, the stratification plan would reduce from a possible 24 cells (3x2x4) into which an appointment could be sorted to a much simpler plan of a possible 6 cells (3x2), or even just 3 cells. This would result in less over-sampling[6] of appointments for the Office of the Merit Commissioner to audit, while maintaining representation of the population.

It is also recommended that BC Stats continues checking that proportions of strata within samples are representative of population proportions each year. If at any point in time, sample proportions by bargaining unit status or some other variable start to differ from proportions in the population, the stratification plan would need to be revised to account for these differences.

It should be noted that making the changes recommended will not negatively impact year-over-year comparisons.

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[6] With possible 24 cells into which appointments could be categorized, BC Stats has had to over-sample various groups to ensure minimum 1 sample per type of cell when such categories existed. The amount of over-sampling would decrease if there was only a possible 6 (or even 3) cells into which appointments could be placed.

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