Random Selection for the Merit Performance Audit

2017/18

UPHOLDING FAIR HIRING IN THE
BC PUBLIC SERVICE

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Background

The Merit Commissioner is responsible for performing random audits of BC Public Service appointments to monitor the application of the merit principle under section 8 of the *Public Service Act* (the *Act*). The audits assess whether recruitment and selection practices have resulted in appointments based on merit, and whether individuals possessed the required qualifications for the position to which they were appointed. The results of the audits are reported to organization heads and the Deputy Minister of the BC Public Service Agency. The overall results and analysis of findings are summarized in a report titled *Merit Performance Audit 2017/18*, which is published on the Office of the Merit Commissioner's (the Office's) website and provided to the Legislative Assembly.

The purpose of this report is to elaborate on the population of appointments, sampling methodology, and method of extrapolation underpinning the *Merit Performance Audit 2017/18.*

Appointment Population

The 2017/18 audit timeframe was April 1, 2017, to March 31, 2018. The types of appointments audited included permanent appointments and temporary appointments of more than seven months. Based on these parameters, a total population of 6,683 appointments was identified.

Sample Selection

Objectives

The objective of the merit performance audit is to randomly sample permanent appointments and temporary appointments greater than seven months in order to ascertain the state of merit-based hiring in the BC Public Service. A simple random sample is considered a statistically representative sample of the population of appointments from which results can be generalized to the total population of appointments[1].

No stratification of the sample was implemented beyond the sampling interval, a necessary practicality as explained in the section titled "Random Selection of Cases". For an overview of how the sample compares to the population of appointments, see the section titled "Distribution of Audits".

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[1] See section titled "Estimates and Confidence Intervals" for more details about the precision of results from this audit.

Random Selection of Cases

Eligible BC Public Service appointments took place throughout the entire fiscal year. In order to run an efficient audit and provide timely feedback, the Office divided the year into four sampling intervals. An appointment population list of eligible appointments was derived from Corporate Human Resource Information and Payroll System (CHIPS) data provided by the BC Public Service Agency, and from the BC Liquor Distribution Branch (which retains appointment details independently) for each of the following sampling intervals:

- April 1 – June 30, 2017;
- July 1 – September 30, 2017;
- October 1 – December 31, 2017; and
- January 1 – March 31, 2018.

Prior to selecting each sample, the Office reviewed the appointment population list to identify duplicate appointments. These entries were investigated by the Office to determine whether they represented unique and eligible appointments for the audit. Any appointments deemed ineligible or duplicate entries were removed from the population list. For each sampling interval, the lists from the BC Public Service Agency and the Liquor Distribution Branch were combined to form a single appointment population list from which the sample could be drawn.

To ensure the desired precision would be met for the projected estimated findings, regardless of the size of the population of appointments, the sampling approach was changed in 2016/17 to a fixed sample size which also had the benefit of better meeting operational demands. The same approach was taken for the 2017/18 audit where the degree of precision for the confidence level and margin of error for the confidence interval were set to a maximum of 95 per cent and ±6 per cent, respectively, for the "merit not applied" finding.

When the desired confidence level is set at 95 per cent, the margin of error is set at 6 per cent, a single proportion is estimated at the conservative value of 50 per cent, and the maximum population of appointments is not expected to exceed 10,000, it can be determined that the largest sample size the Office would require to meet these criteria is 260. Given an increase in the rate of out-of-scope appointments from 2.4 per cent to 4.1 per cent in the 2016/17 audit, the Office selected a total sample size of 276, with a sample of 69 selected at each sampling interval, to provide a buffer to a potentially increasing rate of out-of-scope appointments of up to 5.8 per cent.

The Office drew all four samples using the methodology previously used by BC Stats. For each interval, the Office used a random number generator to randomize the appointments for selection of the sample. Since each sampling interval included a different number of appointments, this resulted in a different proportion of each interval being represented in the population (see Table 1). To ensure that any bias introduced by this variation was minimized in the final population estimates, a post-stratification weighting adjustment was applied, resulting in the creation of four unique weights to adjust for bias in the overall sample.

Table 1 summarizes the four independent samples drawn during the 2017/18 fiscal year period for auditing, as well as the proportion sampled in each interval.

Table 1: 2017/18 Population, Sample Size, and Proportion Sampled			
Sampling Interval	Population	Sample Size	Proportion Sampled
Apr 1 – Jun 30, 2017	1,724	69	4.0%
Jul 1 – Sep 30, 2017	1,619	69	4.3%
Oct 1 – Dec 31, 2017	1,506	69	4.6%
Jan 1 – Mar 31, 2018	1,834	69	3.8%
Total	6,683	276	4.1%

Of the 276 randomly-sampled appointments, the Office identified 17 appointments (6.2 per cent of the overall sample) as being out-of-scope, primarily due to coding errors in the source data. This represents another increase in the rate of out-of-scope appointments since 2015/16. These 17 appointments were removed from the sample, leaving 259 in-scope appointments which were subsequently audited. The Office used the strata information from the sampling intervals to estimate back into the original population how many appointments would likely be found to be out-of-scope if the entire population of appointments was audited. The statistics presented in the last two sections of this report are based on this adjusted in-scope population of 6,269.

Table 2 summarizes the in-scope populations and sample totals of appointments across audit years since 2011.

Table 2: Year-Over-Year Comparison of In-Scope Population and Sample Size			
Year	Number of Appointments	Number of Audits	Sampling Rate
2011	3,942	222	5.6%
2012	3,928	256	5.8%
Fiscal 2013/14[1]	2,010	150	7.5%
Fiscal 2014/15	3,915	243	6.2%
Fiscal 2015/16	5,343	321	6.0%
Fiscal 2016/17[2]	5,685	257	4.5%
Fiscal 2017/18[2]	6,269	259	4.1%

Notes:
1: In 2013/14, the audit period was changed to a fiscal year audit. This transition resulted in a seven month audit period of appointments from September 1, 2013 to March 31, 2014.
2: The sampling rates for the 2016/17 and 2017/18 audits represent the proportion of the population that was audited rather than a rate that was applied to the population to obtain a sample.

Distribution of Audits

The following tables show how the in-scope appointments selected for audit are distributed in the sample compared to the population of appointments by appointment type and organization size. The sample is also compared to the same population by job classification group, as this illustrates another way in which the sample is representative of the population of appointments from which it was drawn.

The small difference in values between the sample and population percentages indicates that even though the sample itself was not stratified, the 2017/18 sample is proportionately representative of the total population of appointments for the same period for the appointment types, organization sizes, and job classification groups shown below.

Tables 3, 4, and 5 below represent actual values found in the sample and population, without the 17 known out-of-scope appointments.[2]

Table 3: Audits by Appointment Type

Appointment Type	Total number of appointments	Per cent of all appointments	Number of audits	Per cent of all audits
Permanent	6,134	92.0%	237	91.5%
Temporary over 7 months	532	8.0%	22	8.5%

Table 4: Audits by Organization Size

Organization Size	Total number of appointments	Per cent of all appointments	Number of audits	Per cent of all audits
Large (> 1,000 employees)	5632	84.5%	211	81.5%
Small (≤ 1,000 employees)	1034	15.5%	48	18.5%

Table 5: Audits by Job Classification Group

Job Classification Group	Total number of appointments	Per cent of all appointments	Number of audits	Per cent of all audits
Administrative Support	1396	20.9%	52	20.1%
Enforcement & Corrections	477	7.2%	24	9.3%
Finance & Economics	304	4.6%	8	3.1%
Health, Education & Social Work	891	13.4%	33	12.7%
Information Technology	338	5.1%	18	6.9%
Legal Counsel	106	1.6%	3	1.2%
Management Band & Executive	1098	16.5%	50	19.3%
Science & Technical Officers	696	10.4%	28	10.8%
Senior Administration & Research	1296	19.4%	42	16.2%
Trades & Operations	64	1.0%	1	0.4%

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[2] It is not possible to obtain adjusted in-scope population estimates by these characteristics because the sample was not stratified by these characteristics.

Estimates and Confidence Intervals

As had been the practice of BC Stats since the 2010 audit, the Office applied confidence intervals to the estimates for the 2017/18 audit, basing them on a Poisson distribution appropriate for generating estimates for rare events. For the purposes of the 2017/18 Merit Performance Audit, a rare event would be interpreted as findings that occur infrequently, such as the "merit not applied" finding.

Even though the sampling variation across each sampling interval was small, the micro-data was weighted prior to generating the population estimates and confidence intervals in order to minimize sample bias and produce the best estimates.

A 95 per cent confidence interval can be interpreted as: with repeated sampling, the true population parameter would be found within the upper and lower limits of that interval 95 times out of 100. Therefore, in Table 6, the true population value for each of the "merit not applied", "merit with exception", and "merit" findings will lie within the lower and upper limits of the respective confidence intervals 95 times out of 100.

Table 6: Estimated Audit Findings and Confidence Intervals					
Audit	**Audit Finding**	**Sample Appointments Audited**	**Estimate (weighted)**	**95% Confidence Interval**	
				Lower	**Upper**
2017/18 Audit	Merit Not Applied	6.2%	6.3%	3.5%	9.6%
	Merit With Exception	51.0%	50.5%	42.1%	59.4%
	Merit Applied	42.9%	43.2%	35.4%	51.4%

In the 2017/18 audit, it is estimated that appointments with a "merit not applied" finding make up an estimated 6.3 per cent of all appointments; however, the true proportion of appointments with a "merit not applied" finding may lie as low as 3.5 per cent and as high as 9.6 per cent in the total population. The margin of error for this finding is smaller (i.e., more precise) than the set precision level of ±6 per cent, at approximately ±3 per cent. The true proportion of appointments with a "merit with exception" finding may lie as low as 42.1 per cent and as high as 59.4 per cent. The true proportion of appointments with a "merit" finding may lie as low as 35.4 per cent and as high as 51.4 per cent.

As in the 2016/17 audit, the weighted estimates for the audit findings in Table 6 are very similar to the sample findings, suggesting there was very little bias introduced into the sample as a result of the sampling methodology.

Uses and Limitations of Audit Results

There is always some error and uncertainty associated with sampling, as well as in any resulting statistics. This expectation of error is shown through the application of the confidence interval (here 95 per cent) around statistics of interest. This provides a level of precision associated with a sampling method as a percentage range both above and below the estimated statistic.

As a sample size increases, the likelihood of variance (or variability within a sample) decreases, and so does the error associated with the sampling. Samples should always aim to achieve the lowest possible ranges on those statistics and as such, the confidence in being able to say a sample represents the true population of appointments must be considered with the results of the confidence intervals in mind.

The appointments selected for audit are a random sample of all appointments occurring between April 1, 2017, and March 31, 2018. In terms of year-over-year comparisons, the number of audits conducted in the 2017/18 fiscal year (259) was similar to that in 2016/17 (257) due to the fixed sample size approach now used. Due to year-over-year changes in sampling approach, caution should be used when comparing results to previous years. This particularly applies when comparing 2016/17 and 2017/18 results to prior merit performance audits, as well as each other, due to the modifications that were introduced for the 2016/17 and 2017/18 audits. (Refer to the reports *Merit Performance Audit 2016/17* and *Merit Performance Audit 2017/18* for more details on the modifications.)

Table 7 summarizes changes made since 2011 to the sampling and audit approach.

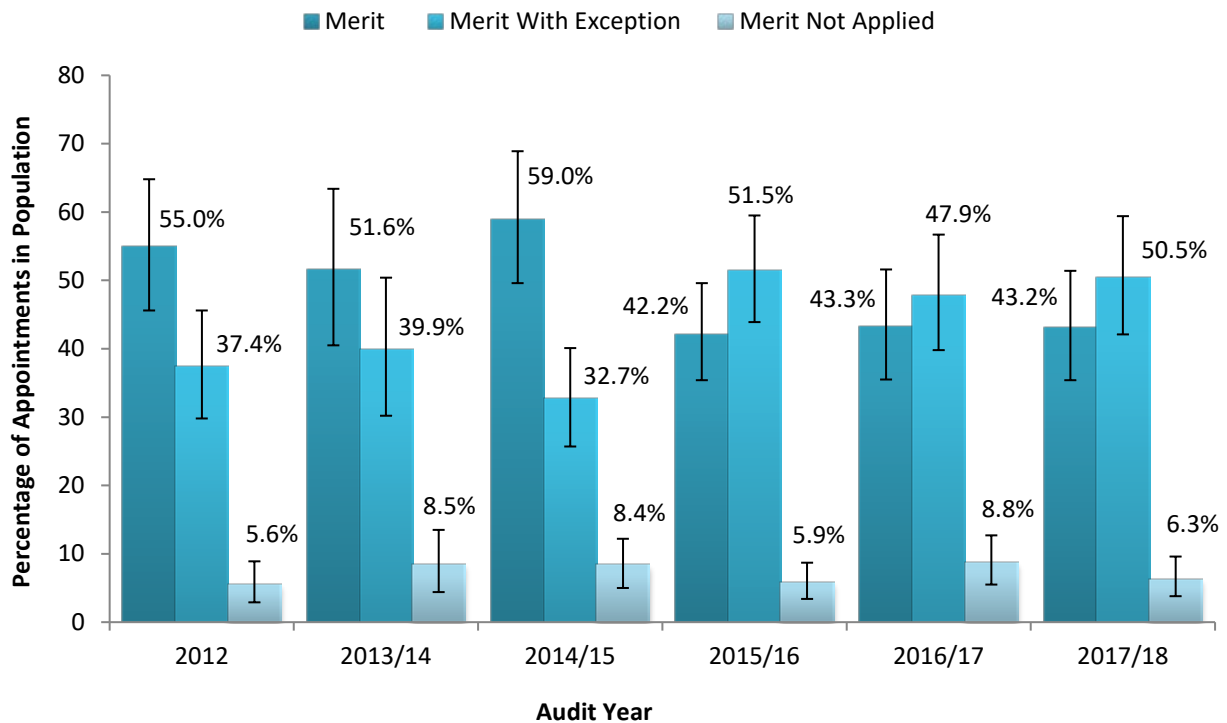| Table 7: Estimated Audit Findings and Confidence Intervals										
Year	Appointment Types Audited			Strata						Audit Finding Changes
	Permanent	Temporary over 7 months	Direct	Organization database[1]	Sampling interval	Administrative status	Organization size	Appointment Type	Bargaining Unit Status	
2011[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2012	✓	✓	✓	✓	✓	✓	✓	✓	✓	
2013/14[3]	✓	✓	✓	✓	✓		✓	✓		
2014/15[4]	✓	✓	✓	✓	✓		✓	✓		
2015/16[5]	✓	✓			✓			✓		
2016/17[6]	✓	✓			✓					✓
2017/18[7]	✓	✓			✓					✓

Notes:

1: Not all BC Public Service appointments are stored in the same database. Prior to 2015/16, samples were pulled from each separate database at a fixed sampling rate. From 2015/16 onwards, the appointments from separate databases were combined prior to sampling taking place.

2: Changes were made to the 2011 merit performance audit approach. See the Merit Commissioner's *2011/2012 Annual Report* for details.

3: First partial fiscal audit from September 1, 2013 to March 31, 2014. Organization database strata reduced from three to two; the Forensic Psychiatric & Riverview Hospitals no longer fall under the Merit Commissioner's oversight. Organization size strata reduced from four to two.

4: First complete fiscal audit.

5: Although two organization databases remain, population data is merged prior to drawing samples.

6: Changes were made to the 2016/17 merit performance audit approach. Refer to *Merit Performance Audit 2016/17* for more details on the modifications.

7: Refinements were made to the 2017/18 audit in error identification for inventories. Refer to Appendix B in *Merit Performance Audit 2017/18* for more details.

Chart 1 illustrates the estimated year-over-year merit performance audit results for the population of public service appointments, with confidence intervals shown as error bars.

Chart 1 – Population Estimates for the Recruitment and Selection Process Findings

Legend: ■ Merit ■ Merit With Exception ■ Merit Not Applied

Y-axis: Percentage of Appointments in Population (0 to 80)
X-axis: Audit Year

2012: 55.0%, 37.4%, 5.6%
2013/14: 51.6%, 39.9%, 8.5%
2014/15: 59.0%, 32.7%, 8.4%
2015/16: 42.2%, 51.5%, 5.9%
2016/17: 43.3%, 47.9%, 8.8%
2017/18: 43.2%, 50.5%, 6.3%

Notes:
- Error bars depict 95 per cent confidence intervals around each population estimate.
- Direct appointments were excluded from the population of appointments starting in 2015/16.
- The former "did not demonstrate" findings were consistently less than 2 per cent and are not represented in this chart. In 2016/17, this type of finding was redefined as "merit not applied".
- Caution should be applied when comparing 2016/17 and 2017/18 audit results to prior year-to-year results, as well as each other, due to audit changes made in 2016/17 and 2017/18.

Considering the sample sizes used and the consistently applied sampling methodology, the results from the 2017/18 Merit Performance Audit offer a good degree of comparability to 2016/17 Merit Performance Audit findings, and a reasonable degree of comparability to previous year's audit findings. Given the precision of the estimates, the samples and subsequent audit findings can be stated to be of reasonable statistical strength.