Force Mix Analysis in the Context of the Canadian Armed Forces

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Abstract

The Vice Chief of the Defence Staff and the Chief of Military Personnel are sponsors for the Canadian Armed Forces (CAF) Establishment Study reviewing the size and composition of the CAF establishment to ensure that it is affordable, sustainable and positioned to meet its operational requirements. A significant component of this study is a force mix analysis quantifying the ability of the CAF establishment to meet the requirements of six high priority missions outlined in the Canada First Defence Strategy (CFDS). This paper presents the methodology and some illustrative results of this force mix analysis. Two techniques are used to estimate the demand on the CAF establishment based on a set of the most likely concurrent CFDS missions. First, a constrained demand is obtained by using an approach based on historical missions. Then, a complementary unconstrained demand is estimated through an approach associating a set of desired force elements to each CFDS mission. By contrasting these demands to the CAF establishment, key shortfalls in personnel occupation groups can be identified.

Keywords: Force Mix Analysis, Occupation Groups, Military Establishment

1. Introduction

The Vice Chief of the Defence Staff and the Chief of Military Personnel are sponsors for the Canadian Armed Forces (CAF) Establishment Study reviewing the size and composition of the CAF establishment to ensure that it is affordable, sustainable and positioned to meet its operational requirements. A significant component of this study, conducted by Defence Research and Development Canada (DRDC), is a force mix analysis quantifying the ability of the CAF establishment to meet the requirements of six high priority missions outlined in the Canada First Defence Strategy (CFDS) [1]. Through this analysis, the CAF establishment is broken down into occupation groups and key personnel shortfalls are identified by comparing the available personnel supply to the personnel demands generated by various combinations of the CFDS missions.

Such a force mix analysis problem is similar to previous work related to workforce planning where the objective is to close any gaps between the resources an organization needs to carry out its mission (demand) and the resources it has (supply) [2]. Several papers discuss various types of approaches and their applications to organizations in the United Kingdom [3], the United States (US) public sector [4], Australia's health workforce [5], and the US Department of Defense [6]. DRDC has also developed several models investigating various aspects of the military workforce. The Enhanced Risk Assessment Model (EnRAM) is a force structure tool trying to capture all tasks assigned to the Air Force and determine the best occupational mix required to meet them based on an assessment of risk [7]. Although it may have been possible to extend EnRAM to consider the CAF, this model is very data intensive and the anticipated work was not within the timelines for the CAF Establishment Study. Another simulation model was developed in [8] to address in broad terms the CAF personnel requirements to sustain up to three battle group-size operations continuously. Other work by DRDC includes the development of a proof-of-concept discrete-event simulation model for assessing the ability of the CAF to sustain operations from a human resources perspective and applied to a contingency analysis of sustaining Task Force Afghanistan [9], the development of a force readiness simulation tool called the Managed Readiness Simulator (MARS) that allows the user

to simulate a wide range of scenarios to forecast the extent to which the resources of an establishment are available to fulfill the requirements of a set of planned tasks over time [10], and finally, the development of the Tyche Fleet Mix Model that provides the most effective mix of maritime fleet assets to address multiple demand scenarios [11].

The force mix analysis presented in this paper refined some of the work conducted in [8] and differs from other previous work by using two techniques to estimate the demand on the CAF establishment based on a set of the most likely concurrent CFDS missions. First, a constrained demand is obtained by using an approach based on historical missions. Then, a complementary unconstrained demand is estimated through an approach associating a set of desired force elements to each CFDS mission. By contrasting the range of demands to the CAF establishment, key shortfalls in personnel occupation groups are identified.

The intent of this paper is to illustrate the methodology used to conduct the force mix analysis. To ensure that this paper remains at the unclassified level, the numbers used for the supplies and demands were randomized. The occupation groups identified as experiencing shortfalls are therefore illustrative only.

The remainder of this paper is organized as follows. Section 2 describes the key CFDS missions and presents the results of a concurrency analysis defining which scenarios are to be considered in the force mix analysis. Section 3 breaks down the CAF establishment into various components to identify the supply of personnel available to meet the requirements of emerging CFDS missions. The estimation of the personnel demands created by each CFDS scenario is considered in Section 4. The personnel supplies and demands are then combined in Section 5 to identify the key shortfalls in occupation groups. Concluding remarks are made in Section 6.

2. Canada First Defence Strategy

The objective of the force mix analysis described in this paper is to assess if the current CAF establishment is able to meet its emerging operational requirements. These operational requirements are outlined in the white paper entitled the Canada First Defence Strategy [1]. This national strategy defines six core missions assigned to the CAF. These core missions are:

- Mission 1: Conduct daily domestic and continental operations;

- Mission 2: Support a major international event in Canada, such as the 2010 Olympics;

- Mission 3: Respond to a major terrorist attack in Canada;

- Mission 4: Support civilian authorities during a crisis in Canada, such as a natural disaster;

- Mission 5: Lead and/or conduct a major international operation for an extended period; and

- Mission 6: Deploy forces in response to crises elsewhere in the world for shorter periods.

To better represent the CAF operational requirements, it is important to consider that these six CFDS missions can occur concurrently. The likelihood of various CDFS missions happening simultaneously was previously assessed in [12, 13]. These concurrency analyses were based on historical CAF missions documented in a database containing as complete as possible all the unclassified CAF operations from 1945 to 2012, including both domestic and international operations [14, 15]. A subset of this database containing missions conducted from 1990 to 2012 was used to assess the most likely concurrent CFDS missions. All the operations belonging to this subset were aligned to the six CFDS missions and each CFDS core mission was assigned a random frequency and a random duration based on the associated historical operations. The concurrency analysis was conducted with the DRDC stochastic scheduling model Tyche [11] which randomly generated events over a five year time period with no restriction on the number of concurrent events. By repeating the process 1000 times, average expectations for event occurrences were calculated. The number of repetitions was chosen arbitrarily, but was deemed sufficient to capture the random behavior of the process.

In order to generate likely combinations of CFDS missions to quantify the operational requirements of the CAF, it was decided to exclude ongoing operational commitments such as Search and Rescue and

NORAD commitments, operations that occur almost 100% of the time such as the Standing NATO Maritime Group 1, certain long-running commitments such as the US Carrier Battle Group, and airlift operations. This decision was made as otherwise, the likely combinations obtained would mainly consist of ongoing operations and the percentage of the CFDS mission combinations of interest would occur in the simulation less than 1% of the time.

The set of concurrent CFDS missions obtained in [13] was used for this force mix analysis and is summarized in Table 1. The first 10 combinations of CFDS missions are those that occurred the most frequently in the Tyche simulation. In these top 10 combinations, none included CFDS mission 2, CFDS mission 3 and CFDS mission 6. Therefore, additional combinations were added to the 10 most likely for completeness. These added combinations were the two combinations that included a CFDS mission 2 that occurred the most frequently in the simulation, the two combinations that included a CFDS mission 3 that occurred the most frequently in the simulation and the two combinations that occurred the most frequently and included a CFDS mission 6. In addition, the last combination described in Table 1 represents the situation that occurred in 2010 when the CAF were simultaneously tasked to support the Vancouver Olympics (mission 2), were sent to Haiti to provide disaster relief (mission 6) and were still engaged in Afghanistan (mission 5).

Mission Combination	Description	Probability
1	Mission 5 - 1 op	9.1%
2	Mission 5 - 2 ops	8.4%
3	Mission 5 - 3 ops	6.0%
4	Mission 1 - 1 op, Mission 5 - 1 op	3.7%
5	Mission 1 - 1 op, Mission 5 - 2 ops	3.6%
6	Mission 5 - 4 ops	3.4%
7	Mission 1 - 1 op, Mission 5 - 3 ops	2.5%
8	Mission 1 - 1 op	2.0%
9	Mission 4 - 1 op, Mission 5 - 1 op	2.0%
10	Mission 4 - 1 op, Mission 5 - 2 ops	1.9%
11	Mission 2 - 1 op, Mission 5 - 1 op	0.32%
12	Mission 2 - 1 op, Mission 5 - 2 ops	0.30%
13	Mission 3 - 1 op, Mission 5 - 3 ops	0.01%
14	Mission 3 - 1 op, Mission 5 - 2 ops	0.03%
15	Mission 5 - 1 op, Mission 6 - 1 op	1.4%
16	Mission 5 - 2 ops, Mission 6 - 1 op	1.3%
17	Mission 2 - 1 op, Mission 5 - 1 op, Mission 6 - 1 op	0.05%

Table 1: CFDS mission combinations

3. Supply

To determine how well the CAF is able to meet the demands of the CFDS scenarios identified in Section 2, it is necessary to find out how many CAF members are available to deploy and support operations. A departmental mapping study was conducted in [16] to breakdown the CAF establishment in multiple components, including an emerging CFDS operations component identifying the number of CAF personnel available to meet any emerging requirements. This departmental mapping was used for the force mix analysis in this paper and is shown in Figure 1. The CAF establishment based on the Regular Force was first broken down into two groups: a non-effective group (personnel in training, on leave, etc...) and an effective group made of the personnel able to contribute to the CAF commitments. This effective group was then further broken down into personnel contributing to the institutional capabilities of the CAF (providing training, acquiring and servicing equipment, etc.) and personnel contributing to military operations. In line with Section 2 where the ongoing operations were considered separately from the emerging CFDS missions, the

personnel dedicated to executing operations was further refined into two groups: ongoing operations and emerging CFDS operations. This last group defines the personnel supply considered in this paper.
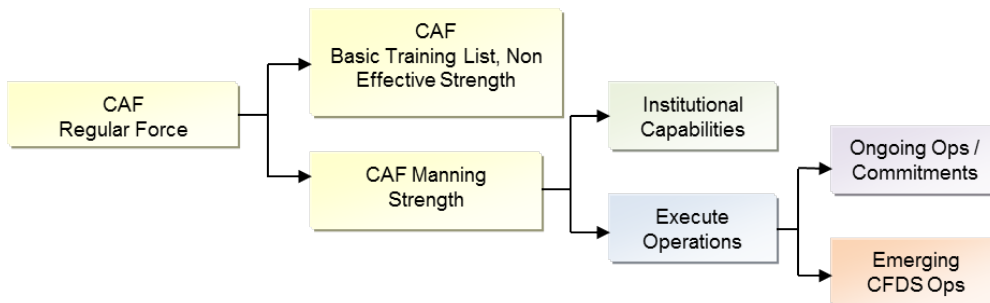

Figure 1: Breakdown of the CAF Regular Force population.

The personnel supply identified though the departmental mapping in [16] was also divided into two populations of interest: the officers and the non-commissioned members (NCMs). The officers and NCMs of the CAF are further categorized based on almost 100 occupations. In this paper, for tractability, these various occupations were grouped into 12 main occupation groups of interest summarized in Table 2.

Having decomposed the CAF establishment into officer and NCM occupation groups, a force mix analysis can be conducted to identify if the various occupation groups are manned appropriately or if some occupation groups experience shortfalls when faced with the requirements of concurrent CFDS missions. For illustrative purposes, Figure 2 provides personnel supply levels for officers and NCMs, broken down into the 12 occupation groups of Table 2. To keep this paper at the unclassified level, these illustrative supply numbers are not the real numbers, but were derived from the fiscal year 2013/2014 manning strength and are representatives of the patterns observed with the composition of the CAF establishment. These supply numbers will be used as is and will also be reduced by a 15% "Departure Assistance Group Red" (DAG Red) factor modeling the fact that not all personnel included in the emerging CFDS operations category are always available for deployment.

Occupation Groups
Air Operations (AO)
Air Operations Tech (AOT)
Health Services (HS)
Information Management (IM)
Intelligence, Surveillance and Reconnaissance (ISR)
Land Operations (LO)
Land Support (LS)
Naval Operations (NO)
Naval Technician Support (NTS)
Operations Support (OS)
Facility Support (FS)
Other (OTH)

Table 2: Breakdown of officer and NCM occupation groups (OTH refers to groups such as lawyers, military police members, chaplains, musicians, etc.).

4. Demand

To identify the key shortfalls in occupation groups within the CAF, the personnel supplies identified in Section 3 have to be compared to the personnel demands generated by the CFDS scenarios considered
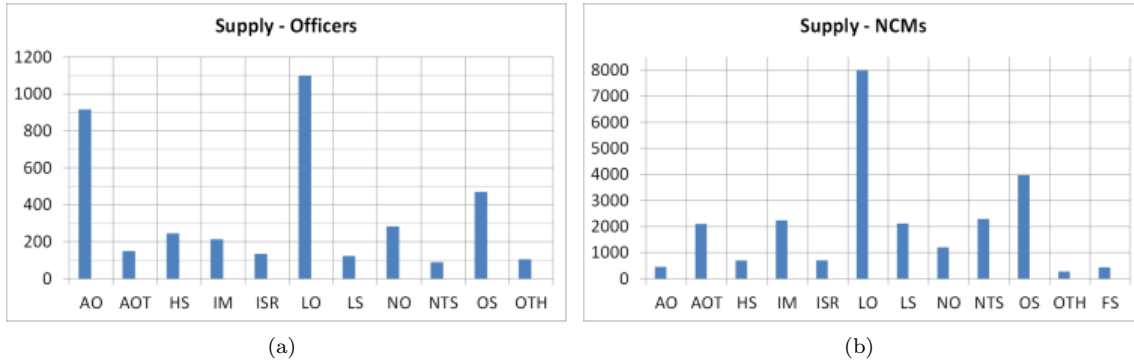
Figure 2: Supply by occupation group (for illustrative purposes only): (a) officers; (b) non-commissioned members (NCMs).

in Section 2. To estimate these personnel demands, two complementary methods were used. Section 4.1 presents the first method providing a constrained demand by using an approach based on historical missions. Section 4.2 summarizes the second method used to obtain an unconstrained demand estimated through associating a set of desired force elements to each CFDS mission. The demand estimates obtained from both methods can be compared as both methods are based on the same set of future operations (outlined in Table 1) and both use the same personnel supply available to deploy and support operations (shown in Figure 2). Once more, these numbers are for illustrative purposes only and were randomized to ensure that this paper remains unclassified.

4.1. Method One

The first method used to estimate the personnel demands generated by concurrent CFDS missions is based on the personnel levels used during previous CAF operations. In [17], a subset of all operations that the CAF participated in from 1990 to 2012 was utilized as the scenario dataset for a force structure study. The same subset of operations was used for this force mix analysis. Each historical operation was aligned to the six CFDS missions described in Section 2. From the list of 209 operations provided in [17], 48 operations were selected to be used for this force mix analysis. The number of historical operations selected for each CFDS mission is shown in Table 3.

CFDS Mission	Number of Historical Operations
1	8
2	3
3	1
4	8
5	20
6	8

Table 3: Number of historical operations used to estimate the demand of each CFDS mission.

The personnel levels deployed to each historical operation were obtained from the Canadian Forces Taskings, Plans and Operations (CFTPO) database, for both officers and NCMs grouped according to the occupations outlined in Table 2. Some operations contained multiple rotations and each rotation was considered individually. The total personnel demands for CFDS mission 4 based on two representative historical operations are shown in Figure 3. Operations PONTOON and LENTUS were CAF operations providing assistance to provincial governments in response to major flooding. Operation PONTOON was conducted in British Columbia in 2007 and operation LENTUS was conducted in Alberta in 2013.

The calculation of the personnel demands for each CFDS scenario outlined in Table 1 involved randomly selecting a rotation from each of the CFDS mission indicated in the combination and then adding these
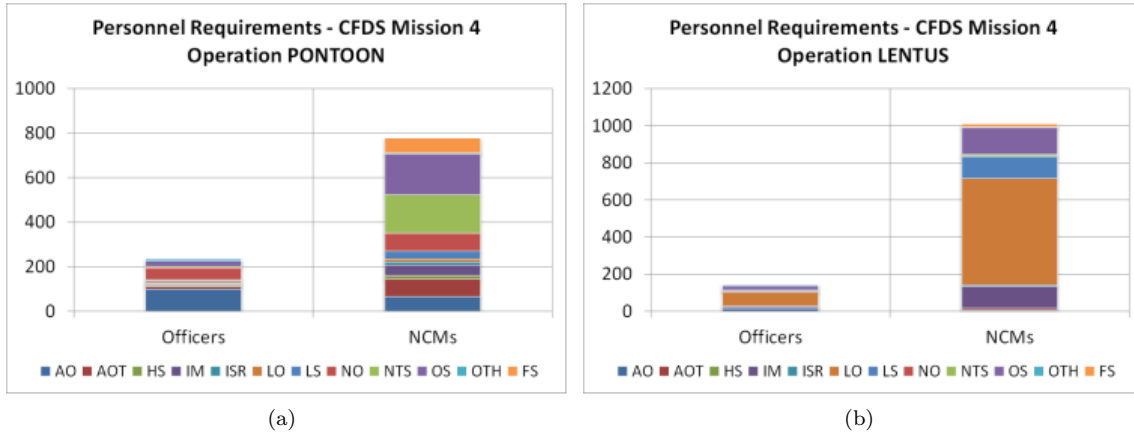
(a)   (b)

Figure 3: Personnel requirements for CFDS mission 4 based on two historical operations: (a) Operation PONTOON; (b) Operation LENTUS.

rotations together across occupation groups. For example, combination 4 in Table 1 is one operation of CFDS mission 1 and one operation of CFDS mission 5, therefore a rotation corresponding to an operation representative of CFDS Mission 1 was randomly selected, as well as a rotation corresponding to CFDS Mission 5. Then, the demand requirements for each occupation group were added together from both these rotations. This process was then repeated 1000 times to generate a set of random demands for each of the 17 CFDS scenarios. Once more, the number of repetitions was chosen arbitrarily, but was deemed sufficient to capture the random behavior of the process.

4.2. Method Two

To complement the historical personnel demands obtained with method one, a second demand estimation method is used. Contrary to the first method, this second method is forward-looking and estimates the personnel demands based on the projected personnel levels to be deployed to meet the requirements of each of the CFDS scenario considered. This method provides aspirational demands based on what the CAF would like to deploy if no constraints existed.

Method two first associates force elements to each CFDS mission. These force elements are representative of the many CAF units existing and are quite varied, going from frigates to helicopter detachments, and from armored squadron to field hospitals. A total of 67 different force elements were used. For illustrative purposes, Table 4 shows a set of force elements required to successfully manage CFDS mission 4.

Force Generator	Force Elements	Number of Force Elements
Maritime	Coastal Defence Vessel	5
Maritime	Frigate	1
Maritime	Explosive Ordnance Disposal Team	1
Maritime	Naval Boarding Party	1
Land	Battalion Immediate Response Unit	1
Air	Medium Heavy Air Lift Detachment	3
Air	Tactical Helicopter Detachment	2
Air	Medium Heavy Lift Helicopter Detachment	1
Air	Maritime Helicopters Detachment	4
Joint	Joint Headquarters	1
Joint	Health Services Hospital	1

Table 4: Illustration of the force elements required for CFDS mission 4.

For each CFDS mission, the required sets of force elements were obtained from two sources: 1) the short term CAF readiness planning process of the Strategic Joint Staff; and 2) the long term force development process of the Director General Capability and Structure Integration. As some CFDS missions were assigned multiple courses of action, multiple vignettes containing different sets of force elements were obtained. The number of vignettes per CFDS mission is summarized in Table 5. By exhaustively combining these vignettes (with repetition) to build the scenarios outlined in Table 1, a large number of scenario variations were obtained. The number of scenario variations for each CFDS mission combination is presented in Table 6.

CFDS Mission	Number of Force Element Vignettes
1	3
2	1
3	1
4	3
5	7
6	3

Table 5: Number of vignettes containing different sets of force elements for each CFDS mission.

Mission Combination	Description	Vignette Combinations
1	Mission 5 - 1 op	7
2	Mission 5 - 2 ops	28
3	Mission 5 - 3 ops	84
4	Mission 1 - 1 op, Mission 5 - 1 op	21
5	Mission 1 - 1 op, Mission 5 - 2 ops	84
6	Mission 5 - 4 ops	210
7	Mission 1 - 1 op, Mission 5 - 3 ops	252
8	Mission 1 - 1 op	3
9	Mission 4 - 1 op, Mission 5 - 1 op	21
10	Mission 4 - 1 op, Mission 5 - 2 ops	84
11	Mission 2 - 1 op, Mission 5 - 1 op	7
12	Mission 2 - 1 op, Mission 5 - 2 ops	28
13	Mission 3 - 1 op, Mission 5 - 3 ops	84
14	Mission 3 - 1 op, Mission 5 - 2 ops	28
15	Mission 5 - 1 op, Mission 6 - 1 op	21
16	Mission 5 - 2 ops, Mission 6 - 1 op	84
17	Mission 2 - 1 op, Mission 5 - 1 op, Mission 6 - 1 op	21
	Total	**1067**

Table 6: Number of vignette combinations considered for each CFDS scenario.

After having created various sets of CFDS force elements, method two then maps each force element to its required personnel levels to create total personnel demands for each CFDS mission. The personnel mapping was done in terms of officers and NCMs, both grouped according to the occupation groups outlined in Table 2. To complete this mapping from force element to personnel, access to various human resources databases was made possible by the Directorate Capability and Structure Analysis Support. Most personnel estimations were based on the current staffing of each force element, but historical manning data had to be used in the case of some force elements that existed only during active expeditionary operations, such as during Canada's commitment in Afghanistan. The total personnel demand related to the CFDS mission 4 force elements outlined in Table 4 is shown in Figure 4.
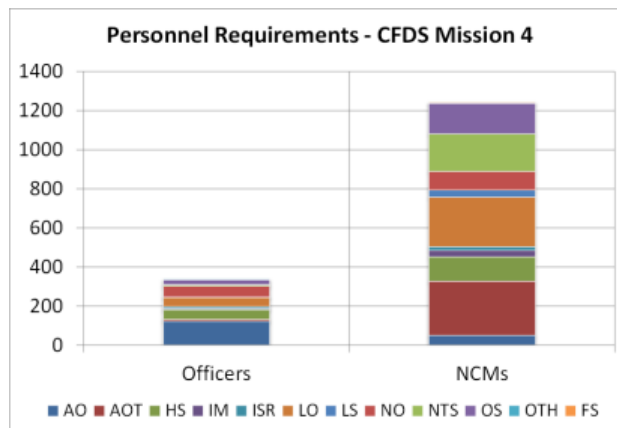
Figure 4: Personnel requirements for one vignette of CFDS mission 4 based on the force elements outlined in Table 4.

5. Results

By combining the illustrative personnel supplies obtained in Section 3 to the randomized demands estimated in Section 4, a force mix analysis can be conducted to assess if the current occupation group structure of the CAF establishment is positioned to meet the CFDS operational requirements and to identify if shortages exist for some occupation groups. While contrasting supply and demand, the worst case scenarios for the demand are considered. That is, for method one, of the 1000 demands randomly generated for a given CFDS mission combination, the maximum demand was chosen as the demand for this combination. For method two, the highest demand of all the vignettes available for a given CFDS scenario was chosen.

Figure 5 shows the results obtained for the officers, broken down by CFDS scenario and occupation group. The maximum demands were subtracted from the illustrative supply of each occupation group with and without applying a DAG Red reduction factor of 15% to the supply. Figure 5 presents the results in the case where the 15% DAG Red factor is applied. Based on the demand estimated with method one and no DAG Red factor applied, the occupation groups NO, OTH (namely public affairs, legal and military police), NTS and HS experience shortfalls. After applying a DAG Red factor of 15%, the occupation groups LO and ISR also have shortfalls. Similar results are obtained when the demand is estimated with method two. Without a DAG Red factor, the occupation groups NO, OTH (public affairs), NTS, HS and ISR experience shortfalls. After the 15% reduction factor is applied, the occupation group IM also has shortfalls.

Figure 6 shows the results obtained for the NCMs by CFDS scenario and by occupation group. The numbers shown are based on a DAG Red reduction factor of 15% applied to the NCM illustrative personnel supplies. Based on the demand estimated with method one, with or without DAG factor, only the OTH (military police) group experiences shortfalls. The OTH (military police) occupation group is also identified when the demand is based on method two. In addition, the occupation groups ISR and NTS experience shortfalls based on the demand from method two without a DAG Red factor, and the occupation groups NO and HS have shortfalls when a DAG Red factor of 15% is applied.

Through discussions with the stakeholders of the CAF Establishment Study, it was determined that the illustrative shortfalls in occupation groups identified in Figures 5 and 6 could be mitigated by using some of the personnel working in the institutional component of the CAF. A maximum of 10% of the institution was assumed to be available to mitigate the shortfalls identified through the force mix analysis. To assess the magnitude of the shortfalls identified in terms of the percentage of the institution required to mitigate them, the maximum shortfall for each occupation group over all 17 CFDS scenarios considered was used and expressed as a percentage of the institutional component. These results are shown in Figure 7. It is worth noting that by taking the maximum demand over all 17 CFDS scenarios, it is assumed that all 17 scenarios have the same importance. This could be refined in future work by weighting the maximum demand of each CFDS scenario by its probability to obtain an overall expected demand. For the officers, the results

FY 13/14 Manning Strength - 15% DAG Factor		Maximum Shortage										
Combination	Mission Description	OFF AO	OFF AOT	OFF HS	OFF IM	OFF ISR	OFF LO	OFF LS	OFF NO	OFF NTS	OFF OS	OFF OTH
1	Mission 5 - 1 op											
2	Mission 5 - 2 ops											36
3	Mission 5 - 3 ops			29					53	15		51
4	Mission 1 - 1 op, Mission 5 - 1 op								23			
5	Mission 1 - 1 op, Mission 5 - 2 ops								54	16		33
6	Mission 5 - 4 ops			38					100	28		64
7	Mission 1 - 1 op, Mission 5 - 3 ops			17					55			60
8	Mission 1 - 1 op											
9	Mission 4 - 1 op, Mission 5 - 1 op											
10	Mission 4 - 1 op, Mission 5 - 2 ops											41
11	Mission 2 - 1 op, Mission 5 - 1 op								46			36
12	Mission 2 - 1 op, Mission 5 - 2 ops								120	18		66
13	Mission 3 - 1 op, Mission 5 - 3 ops			29	9	22						75
14	Mission 3 - 1 op, Mission 5 - 2 ops											35
15	Mission 5 - 1 op, Mission 6 - 1 op											9
16	Mission 5 - 2 ops, Mission 6 - 1 op								56	14		42
17	Mission 2 - 1 op, Mission 5 - 1 op, Mission 6 - 1 op								37			58

(a)

FY 13/14 Manning Strength - 15% DAG Factor		Maximum Shortage										
Combination	Mission Description	OFF AO	OFF AOT	OFF HS	OFF IM	OFF ISR	OFF LO	OFF LS	OFF NO	OFF NTS	OFF OS	OFF OTH
1	Mission 5 - 1 op											
2	Mission 5 - 2 ops											
3	Mission 5 - 3 ops			30		42			111	31		47
4	Mission 1 - 1 op, Mission 5 - 1 op								73			
5	Mission 1 - 1 op, Mission 5 - 2 ops					18			175	39		41
6	Mission 5 - 4 ops			98	42	87			213	62		87
7	Mission 1 - 1 op, Mission 5 - 3 ops			33	30	63			278	70		81
8	Mission 1 - 1 op											
9	Mission 4 - 1 op, Mission 5 - 1 op											
10	Mission 4 - 1 op, Mission 5 - 2 ops								77	13		
11	Mission 2 - 1 op, Mission 5 - 1 op											
12	Mission 2 - 1 op, Mission 5 - 2 ops								78	13		
13	Mission 3 - 1 op, Mission 5 - 3 ops			31		50			176	44		50
14	Mission 3 - 1 op, Mission 5 - 2 ops								74	13		10
15	Mission 5 - 1 op, Mission 6 - 1 op											
16	Mission 5 - 2 ops, Mission 6 - 1 op					15			105	30		29
17	Mission 2 - 1 op, Mission 5 - 1 op, Mission 6 - 1 op								72			

(b)

Figure 5: Officer shortages by occupation group and CFDS mission combination (for illustrative purposes only: randomized demand, supply derived from the fiscal year 2013/2014 manning strength and reduced by 15%): (a) demand based on method one; (b) demand based on method two.

indicate that the shortfalls for the occupation groups IM and LO could be completely mitigated by using personnel coming for the institutional component. For the NCMs, only the shortfall identified for the HS occupation group could be mitigated completely by using the institution. For the other occupation groups experiencing shortfalls, both for the officers and NCMs, other mitigation measures such as the use of Reserve Force personnel or civilians would have to be considered to mitigate the lack of personnel. Interestingly, when contrasting the total number of officers and NCMs required to the total number available, without considering each occupation group separately, both groups are experiencing shortfalls that are less than 10% of the institution. This indicates that an occupation group rebalancing might be considered to address the shortfalls identified for both the officers and the NCMs.

The occupation group shortages shown in Figure 7 were quantified in terms of the maximum demand possible over all the 17 CFDS scenario demands. To obtain more realistic estimates of the number of personnel required to mitigate the shortfalls, this assumption was relaxed to consider the level of supply needed to resolve shortfalls 80% of the time. For a given occupation group, the shortages over all 17 CFDS scenarios were ranked in ascending order and the scenario occurrence probabilities (based on Table 1, but rescaled to add to 100%) were summed to obtain a cumulative probability of shortfall. This process is illustrated in Figure 8 for the NO officers occupation group. For instance, it can be seen in Figure 8(a) that in at most 80% of the time, a shortage size of 53 officers is experienced. By using this 80% cumulative

	FY 13/14 Manning Strength - 15% DAG Factor	Maximum Shortage											
Combination	Mission Description	NCM AO	NCM AOT	NCM HS	NCM IM	NCM ISR	NCM LO	NCM LS	NCM NO	NCM NTS	NCM OS	NCM OTH	NCM FS
1	Mission 5 - 1 op												
2	Mission 5 - 2 ops												
3	Mission 5 - 3 ops											48	
4	Mission 1 - 1 op, Mission 5 - 1 op												
5	Mission 1 - 1 op, Mission 5 - 2 ops												
6	Mission 5 - 4 ops											97	
7	Mission 1 - 1 op, Mission 5 - 3 ops											65	
8	Mission 1 - 1 op												
9	Mission 4 - 1 op, Mission 5 - 1 op												
10	Mission 4 - 1 op, Mission 5 - 2 ops											26	
11	Mission 2 - 1 op, Mission 5 - 1 op											41	
12	Mission 2 - 1 op, Mission 5 - 2 ops											103	
13	Mission 3 - 1 op, Mission 5 - 3 ops											38	
14	Mission 3 - 1 op, Mission 5 - 2 ops												
15	Mission 5 - 1 op, Mission 6 - 1 op												
16	Mission 5 - 2 ops, Mission 6 - 1 op											18	
17	Mission 2 - 1 op, Mission 5 - 1 op, Mission 6 - 1 op											85	

(a)

	FY 13/14 Manning Strength - 15% DAG Factor	Maximum Shortage											
Combination	Mission Description	NCM AO	NCM AOT	NCM HS	NCM IM	NCM ISR	NCM LO	NCM LS	NCM NO	NCM NTS	NCM OS	NCM OTH	NCM FS
1	Mission 5 - 1 op												
2	Mission 5 - 2 ops					43							
3	Mission 5 - 3 ops					271						68	
4	Mission 1 - 1 op, Mission 5 - 1 op												
5	Mission 1 - 1 op, Mission 5 - 2 ops					93				22		8	
6	Mission 5 - 4 ops			26		499				187		145	
7	Mission 1 - 1 op, Mission 5 - 3 ops					321			97	405		86	
8	Mission 1 - 1 op												
9	Mission 4 - 1 op, Mission 5 - 1 op												
10	Mission 4 - 1 op, Mission 5 - 2 ops					57							
11	Mission 2 - 1 op, Mission 5 - 1 op												
12	Mission 2 - 1 op, Mission 5 - 2 ops					56							
13	Mission 3 - 1 op, Mission 5 - 3 ops					284				17		69	
14	Mission 3 - 1 op, Mission 5 - 2 ops					57							
15	Mission 5 - 1 op, Mission 6 - 1 op												
16	Mission 5 - 2 ops, Mission 6 - 1 op					146						20	
17	Mission 2 - 1 op, Mission 5 - 1 op, Mission 6 - 1 op												

(b)

Figure 6: NCM shortages by occupation group and CFDS mission combination (for illustrative purposes only: randomized demand, supply derived from the fiscal year 2013/2014 manning strength and reduced by 15%): (a) demand based on method one; (b) demand based on method two.

Occupation Groups	Shortage as % of Institution	
	Method 1	Method 2
HS	6.2%	16.1%
IM	0.0%	7.5%
ISR	8.0%	77.0%
LO	1.9%	0.0%
NO	27.4%	63.5%
NTS	6.8%	16.9%
OTH	8.9%	10.3%
Total	1.9%	9.2%

(a)

Occupation Groups	Shortage as % of Institution	
	Method 1	Method 2
HS	0.0%	2.9%
ISR	0.0%	107.8%
NO	0.0%	12.7%
NTS	0.0%	32.2%
OTH	8.3%	11.6%
Total	0.0%	1.3%

(b)

Figure 7: Illustrative shortages as a percentage of the institutional capabilities: (a) officers; (b) NCMs.

probability threshold, mitigation estimates for the number of officers or NCMs required were obtained for each occupation group. These mitigation estimates are summarized in Tables 7 and 8.
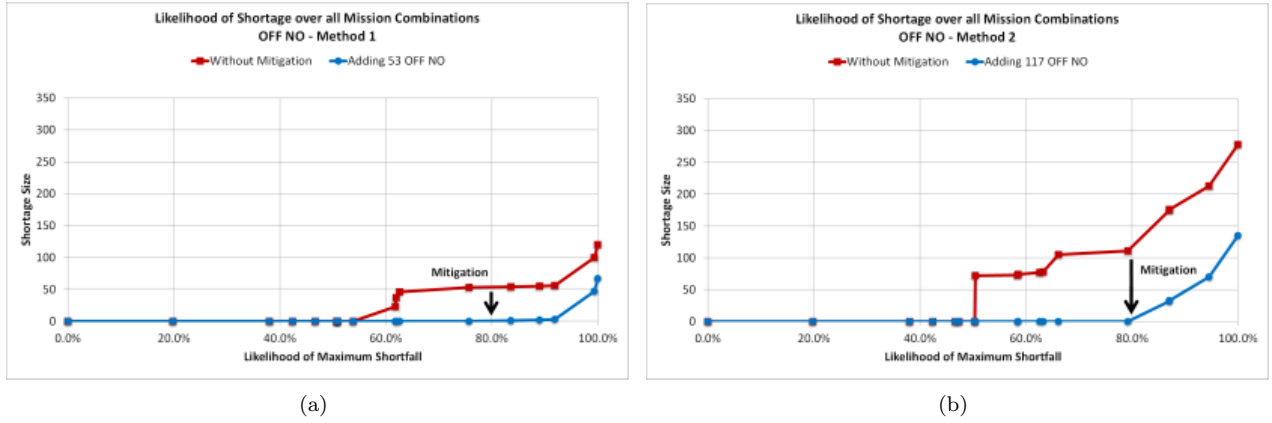
Figure 8: Additional officers required for the occupation group NO to resolve 80% of the maximum shortfalls over all combinations (for illustrative purposes only): (a) demand based on method one; (b) demand based on method two.

Occupation Groups	Method 1	Method 2
HS	17	14
IM	0	0
ISR	0	29
NO	53	117
NTS	15	32
OTH	47	44

Table 7: Officers required to resolve 80% of the maximum shortfalls over all CFDS mission combinations with a 15% reduction factor applied to the supply derived from the fiscal year 2013/2014 manning strength (for illustrative purposes only).

Occupation Groups	Method 1	Method 2
HS	0	0
ISR	0	203
NO	0	0
NTS	0	17
OTH	44	42

Table 8: NCMs required to resolve 80% of the maximum shortfalls over all CFDS mission combinations with a 15% reduction factor applied to the supply derived from the fiscal year 2013/2014 manning strength (for illustrative purposes only).

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6. Conclusions and Future Work

This paper presented the methodology and some illustrative results of the force mix analysis component of the CAF Establishment Study assessing if the current occupation group structure of the CAF can meet the operational commitments outlined in the Canada First Defence Strategy. Two techniques were used to estimate the demand on the CAF establishment based on a set of the most likely concurrent CFDS missions. First, a constrained demand was obtained by using an approach based on historical missions. Then, a complementary unconstrained demand was estimated through an approach associating a set of desired force elements to each CFDS mission. By contrasting these demands to the CAF establishment personnel supply, key shortfalls in personnel occupation groups were identified.

To ensure that this paper remained at the unclassified level, the numbers used for the supplies and demands were randomized. The occupation groups identified as experiencing shortfalls are therefore illustrative only. For the officers, both demand estimation methods identified shortfalls in the occupation groups NO, OTH (public affairs), NTS, ISR and HS. For the NCMs, shortfalls were identified by both techniques for the occupation group OTH (military police). Mitigating these personnel shortages can be done by reaching out to the institutional component of the CAF establishment and also by using Reserve Force personnel and civilians, or even by rebalancing the various occupation groups within the officers and NCMs populations.

The force mix analysis presented in this paper is currently being extended to account for the need to sustain CFDS mission 5, conduct a major international operation for an extended period of time. Although not completely realistic, the "no sustainment" assumption contained in this paper provided a way to test the methodology and gain meaningful insights into the force mix of the CAF. The "no sustainment" approach represents the lowest demand case and the occupation groups experiencing deficits under this assumption will have greater deficits in the "with sustainment" case and should be investigated as a priority.

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