Canadian Forces Attrition Forecasts

What One Should Know

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Canada

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Abstract

This report provides information on what one should know about Regular Force (RegF) attrition forecasts: the latest methodology development, data requirements and other information to correctly understand, interpret and use forecasted results. It also provides forecasts of RegF attrition as a whole, and broken down by Canadian Forces Occupation Authority (CFOA), i.e., occupations managed by Chief Land Staff (CLS), Chief Maritime Staff (CMS), Chief Air Staff (CAS) and Assistant Chief Military Personnel (A/CMP).

This work targets both analysts who perform forecasting tasks and the clients/users, such as military planners and other researchers who use these predictions. This work will help bridge the gaps between analysts and clients and improve consistency and transparency between different research groups within DRDC.

Résumé

Ce rapport sert à expliquer ce qu'il faut savoir sur les prévisions en matière d'attrition au sein de la Force régulière, c'est-à-dire qu'il expose la toute dernière méthodologie en matière de prévision de l'attrition, précise les données à recueillir et contient de l'information importante afin de comprendre, interpréter et utiliser correctement les résultats prévus. Il contient aussi des prévisions de l'attrition dans la Force régulière dans son ensemble, et par responsable de groupes professionnels militaires des FC, à savoir le Chef d'état-major de l'Armée de terre (CEMAT), le Chef d'état-major des Forces maritimes (CEMFM), le Chef d'état-major de la Force aérienne (CEMFA) et le Chef adjoint – Personnel militaire (ACPM).

Le document vise autant le personnel chargé de faire les prévisions que les utilisateur/clients, comme les planificateurs militaires et autres chercheurs qui se servent de ces prévisions. Il permet de réduire l'écart qui divise les analystes et les clients et d'assurer une meilleure uniformité et une plus grande transparence entre les groupes de recherche du RDDC.

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Executive summary

Canadian Forces Attrition Forecasts: What One Should Know

Knowledge of attrition is crucial to properly plan the recruitment and training of Regular Force (RegF) members as well as for budgeting purposes. More and more attention has been focused on RegF attrition especially recently during the Canadian Forces (CF) expansion period.

This report provides the latest attrition methodology, attrition forecasts plus important information on what one should know about RegF attrition forecasts. The work targets both analysts who perform forecasting tasks and the clients/users, e.g., military management, and the other researchers who use these predictions. From the military client's point of view, it can be used as a reference for RegF human resources plans, correctly understanding, interpreting and using the forecasting results. From the analyst's point of view, it can be used as a reference to perform forecasting tasks and update the predictions. This work will help bridge the gap between different parties on issues around RegF attrition forecasting and improve the consistency and transparency of attrition forecasting practices.

A recent improvement has been made on attrition forecasting methodology [Ref 8] by the Workforce Modelling Team in the Directorate Strategic Military Personnel Research and Analysis (DSMPRA). The first section of this report summarises the latest methodology development, which is currently used for the RegF attrition forecasts.

The second section shows what the data requirements are for performing the RegF attrition forecasts.

In the third section, using the latest methodology, attrition rates have been forecasted for the next three fiscal years starting from FY08/09.

    a.   For the total RegF, the projected attrition rates are 9.2%, 9.3% and 9.2% for FY 08/09 to FY 10/11 respectively;

    b.   For the non-commissioned members (NCM), the projected attrition rates are 10.0%, 10.2% and 9.9%;

    c.   For the Officers (OFF), the projected attrition rates are 6.8%, 6.8% and 6.7% respectively; and

    d.   The projected attrition rates for Career fields by Occupation Authorities (CFOA), i.e., occupations managed by Army, Navy, Air Force and Assistant Chief Military Personnel, are also presented in this report.

Annual attrition for FY11/12 to FY20/21 has also been forecasted based on current available information to provide a future picture of RegF attrition after the expansion period.

The fourth section provides information one should know to correctly understand, interpret and use forecasted results. The major considerations to be aware of include:

a. Critical assumptions for attrition forecasting;

b. Amount of historical data used for forecasting;

c. Interpretation of changes in attrition volume;

d. Updating and validating attrition forecasts;

e. Short-term or long-term forecasts; and

f. Forecasting practices for small populations and changing occupations.

Sommaire

Canadian Forces Attrition Forecasts: What One Should Know

Manchun Fang; Paul Bender; DRDC CORA TM 2008-060; R & D pour la défense Canada – CORA; Décembre 2008.

Une bonne connaissance du phénomène de l'attrition est essentielle afin de planifier correctement le recrutement et l'instruction des membres de la Force régulière et de faciliter l'établissement de budgets. Les Forces canadiennes portent de plus en plus d'attention à l'attrition dans la Force régulière, surtout depuis le début de leur période d'expansion.

Le présent rapport expose la plus récente méthodologie en matière de prévision de l'attrition, fournit des données pertinentes sur l'attrition et contient de l'information importante à ce sujet. Il vise autant le personnel chargé de faire les prévisions que les utilisateurs/clients, comme les gestionnaires militaires et les autres chercheurs qui se basent sur ces prévisions. Les clients militaires peuvent s'en servir comme référence pour les plans des ressources humaines de la Force régulière afin de les aider à comprendre, à interpréter et à utiliser les résultats, alors que les analystes peuvent s'en servir pour faire des prévisions et mettre à jour les données déjà existantes. Ce rapport permettra de réduire l'écart qui divise les différents groupes sur des questions relatives aux prévisions de l'attrition dans la Force régulière et d'assurer une meilleure uniformité et une plus grande transparence entre les différentes méthodologies.

L'équipe de modélisation des effectifs (DRASPM 4) de la Direction – Recherche et analyse stratégiques (Personnel militaire) a récemment perfectionné [9] la méthodologie en matière de prévision de l'attrition. La première partie du présent rapport expose la toute dernière méthodologie actuellement utilisée pour les prévisions de l'attrition dans la Force régulière.

La deuxième partie montre quelles sont les données à recueillir pour faire les prévisions de l'attrition dans la Force régulière.

La troisième partie présente les prévisions des trois prochaines années financières à partir de 2008-2009 pour :

    a.   L'ensemble de la Force régulière;

    b.   Les militaires du rang (MR);

    c.   Les officiers (offr);

    d.   Les groupes professionnels militaires relevant des quatre responsables (le CEMAT, le CEMFM, le CEMFA et l'ACPM).

Des prévisions sur l'attrition pour les AF 2011-2012 à 2020-2021 ont aussi été faites à partir des données dont nous disposons actuellement afin de peindre un portrait global de l'attrition dans la Force régulière après la période d'expansion.

La quatrième partie fournit l'information qu'il faut savoir pour comprendre, interpréter et utiliser les résultats. Les points les plus importants à considérer sont les suivants :

a. Comment doit-on interpréter un changement du taux d'attrition?

b. Quelles sont les hypothèses qu'il faut conna'tre?

c. Comment savoir si les résultats sont à jour?

d. Comment préparer correctement un plan de validation et de mise à jour?

e. Jusqu'à quand doit-on remonter dans le temps pour faire des prévisions?

f. Quelle est la prise de conscience nécessaire pour faire des prévisions à plus petite échelle dans la Force régulière?

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1   Introduction

Knowledge of attrition is crucial to properly plan the recruitment and training of Regular Force (RegF) members as well as for budgeting purposes: the better the forecasts, the better the personnel management [1]. Correctly predicting attrition is also very important for accurate recruitment, promotion, planning, and budget preparation.

The Director Strategic Military Personnel Research and Analysis 4 (DSMPRA 4), the Workforce Modelling team in Directorate General Military Personnel Research and Analysis (DGMPRA), has a long history of methodological research around attrition. A number of papers that describe these methodologies have been previously published [2-7]. DSMPRA 4 continues methodological development around attrition reporting and forecasting in order to provide the best attrition analyses to clients. A refined approach to forecast RegF attrition was recently developed [8]. That improves the accuracy of previous attrition forecasting algorithms.

This report provides information one should know about RegF attrition forecasting. It addresses the following:

   a.   The methodology used for forecasting RegF attrition;

   b.   Data requirements for forecasting attrition;

   c.   Future RegF attrition forecasts; and

   d.   How to correctly understand, interpret and use attrition forecasts.

This work targets both analysts who perform forecasting tasks and clients/users, such as military Human Resources (HR) planners and other researchers who use these predictions. From a client point of view, it can be used as a reference for RegF HR resources planning, by assisting in correctly understanding, interpreting and using the forecasting results provided by the analysts. From the analyst point of view, it can be used as a reference to perform forecasting tasks and update predictions. This work will help bridge the gap between different parties on issues around RegF attrition forecasting and improve the consistency and transparency on attrition forecasting practices.

2 The Methodology Used for Forecasting Attrition

Attrition is defined herein as releases from the RegF, regardless of reason. The yearly attrition rate is the proportion of RegF members in a given population who attrite within a year.

Attrition is a function of many factors, such as occupation, demographic profile, economic factors, policies, etc. In particular, attrition is strongly related to years of service (YOS) because most attrition occurs at or shortly after exit gates between engagements, and most engagements have a prescribed duration measured in YOS.[1] Thus forecasting attrition is based on the YOS profile of the population of interest and the historical attrition behaviour at each YOS.

Table 1 lists the latest procedures for attrition forecasting, which are currently used by DSMPRA 4 in various applications. A similar table was first developed and proposed in [8], and detailed information around this methodology can be found in that report. The reader who does not perform attrition forecasting could skip the following table.

Table 1: The Procedures for Forecasting Attrition

Step	Procedures for Forecasting Attrition Volume
1	Obtain from historical databases data on RegF personnel held and maintained by DSMPRA 4: • $a'_m[n]$ (Attrition volume between year n-1 and n for members having m Years of Service (YOS) measured at the time of release), • $a_m[n]$ (Attrition volume between year n-1 and n for members having m YOS measured on the first day of year n (i.e., 1 January if calendar years are used; 1 April if fiscal years are used), • $P_m[n]$ (Population for members having m YOS on the first day of year n) • $T_m[n]$ (transfers that occurred between the years n-1 and n for members having m YOS measured on the first day of year n) Obtain from the Strategic Intake Plan (SIP): • Targeted number of recruits $T_m[n]$ for future years.

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[1] For example, at 20 YOS (with the previous Term of Service), CF members have completed their intermediate engagement (IE). At this point, the CF experiences a high attrition rate because many of its members choose to retire rather than serve on an Indefinite Period of Service (IPS). (The new Term of Service was introduced in 2005, which changed the intermediate engagement from 20 YOS to 25 YOS.)

Step	Procedures for Forecasting Attrition Volume (cont'd)
2	Using the formula developed by Okazawa 2007 [7], calculate the Weighted Average YOS-based Attrition Rate WAAR (α_m) based on $a'_m[n]$, For m>0 (i.e., YOS >0): $$WAAR(\alpha_m) = \frac{\sum_{n=1}^{N} a'_m[n]}{\sum_{n=1}^{N}\left(\frac{1}{2}P_{m-1}[n-1] + \frac{1}{2}p_m[n-1] + \frac{1}{3}T_m[n] + \frac{1}{6}T_{m+1}[n]\right)} \qquad (1)$$ When m=0, (i.e., YOS=0) $$WAAR(\alpha_0) = \frac{\sum_{n=1}^{N} a'_0[n]}{\sum_{n=1}^{N}\left(\frac{1}{2}p_0[n-1] + \frac{1}{2}T_0[n] + \frac{1}{6}T_1[n]\right)} \qquad (2)$$
3	Calculate the future population for year *n* at each YOS *m* by using following formula: $$P_m[n] = \left(1 - WAAR(\alpha_{m-1,m})\right)P_{m-1}[n-1] + \left(1 - \frac{1}{2}WAAR(\alpha_{m-1,m})\right)T_m[n] \qquad (3)$$ where $P_m[n]$ is the population with m YOS measured on January 1st or April 1st of year n; and $P_{m-1}[n-1]$ is the population with m-1 YOS measured on January 1st or April 1st of year n-1; For m>0 (i.e., YOS >0): $$WAAR(\alpha_{m-1,m}) = \frac{\sum_{n=1}^{N} a_m[n]}{\sum_{n=1}^{N}\left(P_{m-1}[n-1] + \frac{1}{2}T_m[n]\right)} \qquad (4)$$ When m=0, $$WAAR(\alpha_0) = \frac{\sum_{n=1}^{N} a_0[n]}{\sum_{n=1}^{N}\left(\frac{1}{2}T_0[n]\right)} \qquad (5)$$

Step	Procedures for Forecasting Attrition Volume (cont'd)
4	Calculate $A_m[n]$, the forecast attrition volume for the population with m YOS during year n (i.e., between the first and last days of year n). At the CF wide level, there are no occupational transfers. Therefore, $$A_m[n] = WAAR(\alpha_m) \times \left(\frac{1}{2} P_{m-1}[n-1] + \frac{1}{2} P_m[n-1] \right) \qquad (6)$$ At a sub-population level, e.g., NCM/OFF or for different military occupation groups, transfers between population groups exist, e.g., $T_m[n]$ and $T_{m+1}[n] \neq 0$. For these situations, the forecasting is as follows: For m>0 (i.e., YOS>0): $$A_m[n] = WAAR(\alpha_m) \times \left(\frac{1}{2} P_{m-1}[n-1] + \frac{1}{2} P_m[n-1] + \frac{1}{3} T_m[n] + \frac{1}{6} T_{m+1}[n] \right) \qquad (7)$$ When m=0 (i.e., YOS=0): $$A_0[n] = WAAR(\alpha_0) \times \left(\frac{1}{2} P_m[n-1] + \frac{1}{2} T_0[n] + \frac{1}{6} T_1[n] \right) \qquad (8)$$ Note that $WAAR(\alpha_m)$ used in formula (7) and (8) is calculated from $a'_m[n]$ not $a_m[n]$.
5	Obtain the predicted annual attrition volume $a[n]$ and attrition rate $\alpha[n]$ for year n, $$a[n] = \sum_{m=0}^{\max(YOS)} A_m[n], \qquad (9)$$ $$\alpha[n] = \frac{a[n]}{P[n-1] + 0.5T[n]} \qquad (10)$$ where $A_m[n]$ is calculated by using the above four steps.

3   The Data Requirements for Forecasting Attrition

The second question regarding attrition forecasting is: what data are required for forecasting? The three key data requirements include:

a.   Historical YOS-based **population** profiles including the current population profile. For example, the YOS-based population profile of the RegF as of 31 Mar 2008 is shown in Figure 1;

b.   Historical YOS-based **attrition** profiles (e.g., the YOS based attrition profile for FY07/08 is shown in Figure 2); and

c.   Planning figures for recruitment.

DSMPRA 4 maintains its own historical HR databases for analysis purposes. These databases contain personnel information of RegF members from 1982 to the present. The population and release data from 1997 onwards originates from Human Resources Management System (HRMS) extracts[2]. Data prior to this came from the Military Personnel Information System (MPIS). The historical population and attrition profile required for forecasting are typically obtained using these databases. (See the following Figure 1 and Figure 2 for examples of both profiles.)
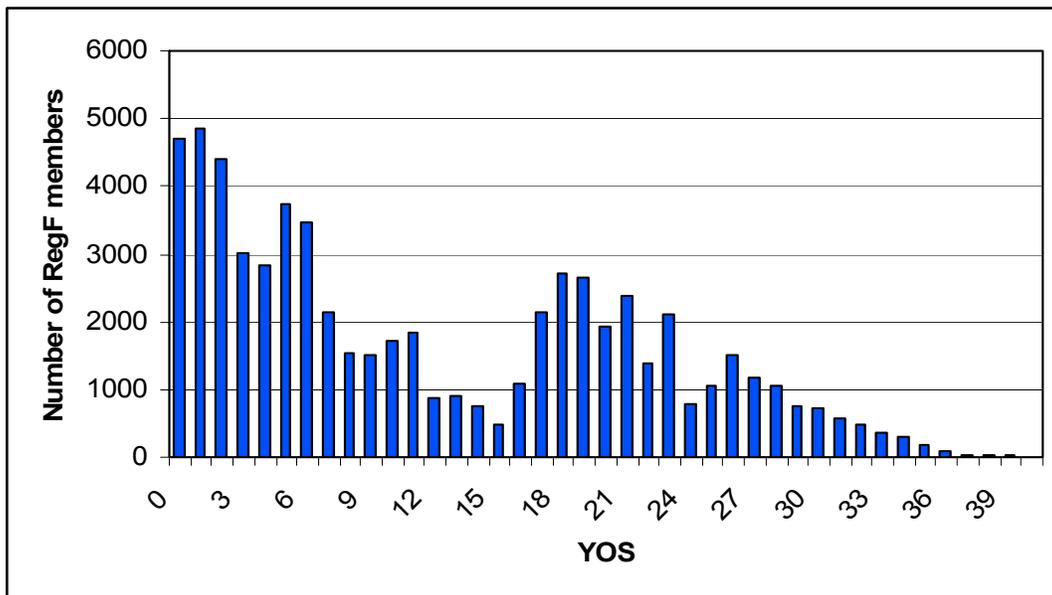

Figure 1: RegF Population Profile as March 31 2008

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2   HRMS is maintained by the Director Human Resources Information Management (DHRIM).

RegF Attrition Profile FY07/08
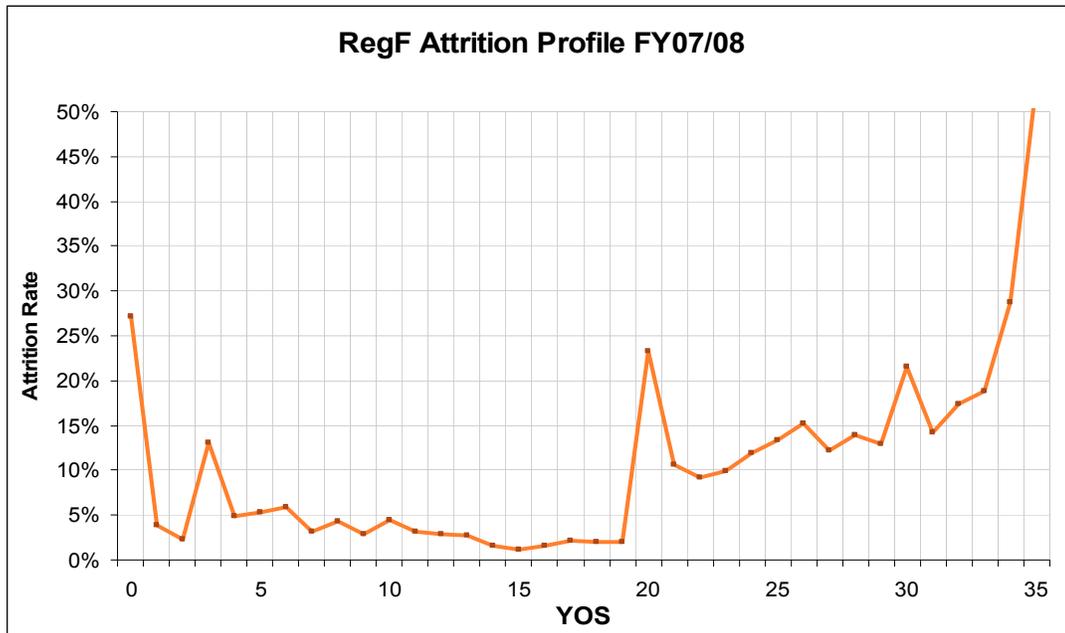
Figure 2: Attrition Model used for Forecasting RegF-wide Attrition

The Canadian Forces is currently in an expansion period, with the goal of reaching 68,000 RegF members by FY 11/12. Planned recruitment can be obtained from the current and future Strategic Intake Plans (SIP), which are published on the Director Personnel Generation Requirements (DPGR) intranet site. A summary of the SIP for FY 08/09 to 10/11 can be found at Annex A.2. After expansion, it can be assumed that the RegF will recruit to sustain its allowable total paid strength (TPS); recruitment targets will then be approximately the number of forecast releases.

3.1   The Choice of Historical Data

Attrition forecasts based on different historical periods and/or with different amounts of historical data will vary. Preliminary research on determining the volume of historical data to use has been published [9]. This subject remains an active area of research in DSMPRA 4. And a research project was recently initiated to investigate new methodologies on attrition analyses. One part of the project is to investigate the choice of the historical data to use for building the attrition model for forecasting. The result of this research was presented at the TTCP Workforce Modelling and Analysis Working Group in May 2008 [10], which proposed three steps to determine the choice of the historical data to use. Here is the summary:

1. The first step is to ask, from a statistical point of view, what historical period/data should be used for attrition modelling for forecasting.

    This question should be answered objectively. Sample size should be considered based on the various questions of interest. The fundamental point from statistics is to gather as much relevant and high quality evidence/data as possible, since statistical power will be increased

as more data is synthesized. A range of techniques (statistical tests, control charts, change point analysis [11], etc.) can be applied to detect whether there is a sudden change in attrition along the history; whether a mean shift in attrition has occurred; or whether there is a trend with respect to attrition. Here are a few scenarios:

a. If there is no difference found in the attrition history, from a statistical power point-of-view, it is better to use all the data to build the model;

b. If there is a sudden change detected in the attrition history, indicating a different period/point from all the other periods, then that abnormal period/point should be removed and not used to build the model;

c. If there is a mean shift in the history, we recommend using data from the period more likely to be representative of the future to build the attrition model. This will involve a discussion with Subject Matter Experts (SMEs); and

d. If there is seasonality and/or trends found in the attrition history, time series techniques should be used for forecasting. For forecasting using time series, at least two periods are needed to be able to detect seasonality and/or trends.

The choice of the historical period to use should be made first according to these statistical considerations. This step will help the analyst choose appropriate historical periods, as well as choose the appropriate approach to build the attrition model.

2. The second step is to ask whether the time period suggested from step 1 should be modified as a result of additional information or empirical knowledge/evidence.

Analysts should work closely with SMEs who are familiar with the policies related to attrition, such as the Terms of Service, and when doing attrition analyses for specific military occupations, SMEs with occupation-specific knowledge. This step will help to identify a reasonable historical period or combination of several periods, which can be assumed to be internally consistent and representative of the future situation and thus will be appropriate for predicting future attrition. This part of the selection decision is made based on subjective considerations.

3. The third step is to perform a sensitivity analysis using different selections of the data, in order to assess the robustness of the results. This procedure will also provide clients with the worst and best scenarios for future attrition.

Above all, the choice of historical period to use should be made based on both objective and subjective considerations of the data you have and knowledge about the population you want to investigate. Therefore, the final selection of the data to be used may be different in each situation.

4   RegF Future Attrition Forecasts

4.1   Total RegF Attrition Predictions

Following the method describe in 3.1 and consultations with SMEs, RegF historical data from the latest completed year, FY07/08, is the most appropriate choice for building the attrition model for forecasting future RegF attrition after FY07/08; there were a total of more than 64,000 RegF members in the year. Using the procedures listed in Table 1, the RegF attrition rates and attrition volumes were forecasted for the next three fiscal years. Table 2 presents these forecasts, split between Non-Commissioned Members (NCM) and Officers (OFF). As mentioned previously, the forecasts are based on the attrition behaviour observed in FY07/08.

Table 2: Forecast RegF Attrition for the Current and Next Three Fiscal Years

	FY08/09		FY09/10*		FY10/11*		FY11/12*	
	Volume	Rate (%)	Volume	Rate (%)	Volume	Rate (%)	Volume	Rate (%)
NCM	5275	10.0	5484	10.2	5436	9.9	5310	9.6
OFF	1085	6.8	1097	6.8	1094	6.7	1068	6.5
Total	6360	9.2	6581	9.3	6530	9.2	6361	8.9

* The predictions are based on recruiting targets set in the current SIP (see Annex A.) and attrition patterns of FY07/08. These will be updated if there is a change in the SIP and when new data are available.

The RegF attrition volume is projected to be 6360, 6581, 6530 and 6361 for FY08/09, FY09/10, FY10/11 and FY 11/12 respectively. This translates to an overall RegF attrition rate of 9.2%, 9.3% and 9.2% for the next three fiscal years. It is worth noting that the curve of forecasted attrition rates is smoother than that for historical attrition rates. This is because the forecasts are based on the assumption that there will be no significant change in attrition behaviour from that observed in FY 07/08.

Figure 3 showed the RegF historical and forecasted attrition rates. The historical annual attrition rates from FY83/84 to FY07/08 are listed in Annex A. Forecasts for FYs 12/13 to 20/21, which are presented in Table 3, provide a longer term picture on RegF attrition. The forecasts for FY 12/13 and beyond could not be based on SIP recruitment data because it is unavailable. Instead, the recruitment in those years was estimated to be the number required to maintain a TPS of 68,000. Generally speaking, short-term forecasts (which are the focus of this report) are more reliable than long-term forecasts.

RegF Attrition Rate: History and Forecasts
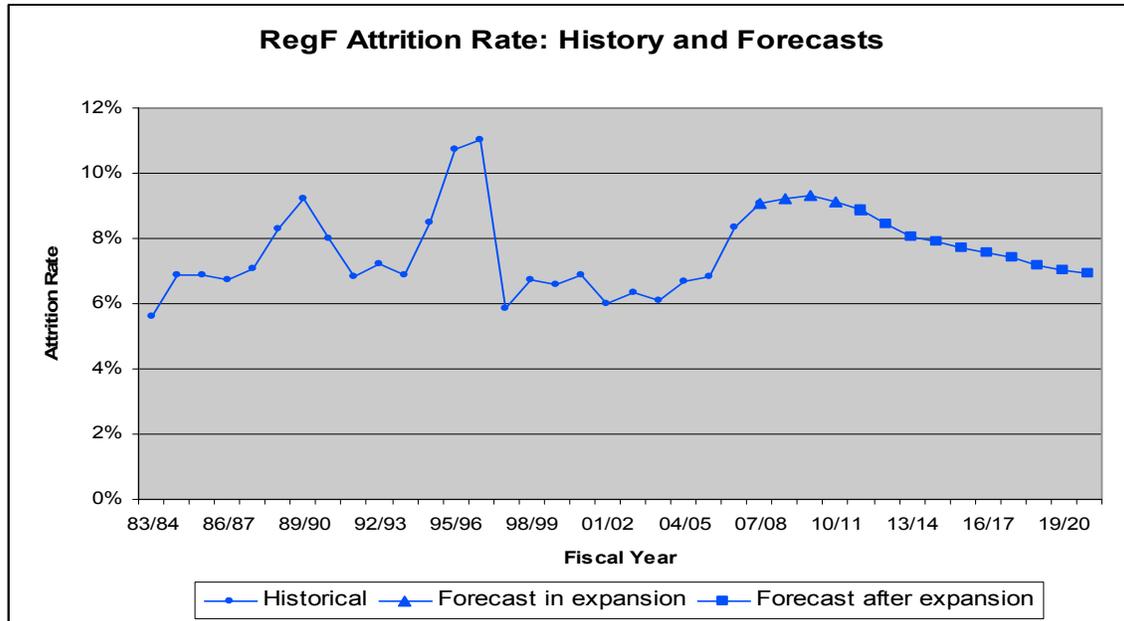
Figure 3: Historical and Projected RegF Attrition Rates

The attrition volume is projected to gradually reduce after RegF expansion. Two contributing factors are that 1) there will be fewer recruits after the expansion period and 2) fewer RegF members will be approaching pensionable YOS, beginning about FY12/13.[3] According to historical attrition patterns, both new recruits (those with YOS=0) and pensionable members (those with 20+YOS) have relatively high attrition rates. Therefore, it can be expected (under the assumption that there will be no significant change in the attrition behaviour) that there will be reduced attrition volumes from around FY 12/13 and beyond. It will be important to keep this trend in mind when considering strategic HR planning beyond 2013.

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[3]   During and shortly after the Force Reduction Program (FRP), from 1992 to 1996, there were significantly fewer recruits and more releases across most segments in the RegF. The demographic profile resulting from these years does and will continue to influence many RegF human resource issues. For example, from FY12/13 (20 years after 1992) and beyond, there will be significantly fewer RegF members with 20 or more YOS.

Table 3: RegF Attrition Forecasts beyond the CF Expansion Period

	Attrition	
	Volume	Rate (%)
FY12/13	6090	8.4
FY13/14	5837	8.1
FY14/15	5725	7.9
FY15/16	5576	7.7
FY16/17	5480	7.6
FY17/18	5378	7.4
FY18/19	5220	7.2
FY19/20	5118	7.0
FY20/21	5056	7.0

4.2 Attrition Predictions for Segments within the RegF

The procedures used for forecasting the RegF-wide attrition can be applied to forecasting attrition of different segments of interest within the RegF. Table 4 presents forecast attrition volumes and rates by Canadian Forces Occupation Authority (CFOA), i.e., the group of occupations for which the Chief Maritime Staff (CMS), Chief Land Staff (CLS), Chief Air Staff (CAS) and Assistant Chief Military Personnel (A/CMP) are the occupation authorities.

The definition of attrition for the CFOA attrition forecasts remains as the number of members releasing from the RegF, regardless of reason. In this sense, transfers within the RegF are not counted as attrition. It is believed that transfer behaviour is different from attrition behaviour. Attrition is strongly related with YOS (fundamentally it is related to Terms of Service). Therefore, it is predictable based on the historical attrition behaviour by YOS. Since transfer behaviour is less statistically predictable, research on historical transfers may not help very much with the prediction for future transfers. The transfers may be better predicted by consulting with the SMEs or managers for the specific segments of interest.

Using the same forecasting techniques and currently available information, the attrition for FY08/09 to FY11/12 was predicted for the four major CFOAs. (See data in Table 4.)

Table 4: Attrition forecasts for sub-population groups within the RegF

CFOA	FY08/09		FY09/10*		FY10/11*		FY11/12*	
	Volume	Rate (%)	Volume	Rate (%)	Volume	Rate (%)	Volume	Rate (%)
CMS (Navy)	778	9.0	817	9.1	816	9.0	835	9.0
CLS (Army)	2853	10.7	2961	10.7	2919	10.3	2863	9.9
CAS (Air)	1073	7.0	1098	7.1	1075	6.9	1028	6.5
A/CMP	1615	9.1	1644	9.2	1633	9.1	1575	8.8
* The predictions are based on recruiting targets set in the current SIP (see Annex A.) and attrition patterns of FY07/08. These will be updated if there is a change in the SIP and when new data are available.								

5 Understanding, Interpreting and Correctly Using the Attrition Forecasts

This section provides additional information one should be aware of to correctly understand, interpret, and use attrition forecasts.

5.1 Assumptions

It is inevitable that all the forecasts are based on assumptions. There are three general assumptions for forecasting attrition using current methodologies:

   a. Attrition behaviour (i.e., attrition rate at each YOS point), which is based on historical data, will remain the same in the future years;

   b. The targeted number of recruits in the SIP provides a good prediction of the actual number of new recruits; and

   c. Other factors that may have an impact on attrition (e.g., policies related to retention and recruitment strategies and the Total Paid Strength limit) will not change.

If these assumptions are violated, the forecasts may deviate from reality. The unpredictability of the future is always a challenge for forecasting. For example, if there is an attrition behaviour change between what is observed now and what occurs in the future, or the actual number of recruits is quite different from the target set in the SIP, or new strategies on retention are introduced, etc., then all these changes would likely influence attrition. Nevertheless, using the best available data and methodologies will provide the best possible predictions.

5.2 Understanding a Change in the Total Attrition Rate

It is worth noting that even though attrition behaviour is assumed to stay the same, the forecasted annual attrition volumes and rates can vary. A change in attrition volume or rate does not necessarily mean a change in attrition behaviour. An attrition analysis presented to the National Retention Team Working Group [12] explained that there are two major factors that influence attrition: RegF population demographics and its attrition behaviour.

Attrition behaviour is represented as an attrition rate at each YOS point. If the attrition behaviour changes (i.e., attrition rate at a certain YOS changes), the attrition volume will change correspondingly (assuming the same population).

On the other hand, if there is no attrition behaviour change, i.e., attrition rate at each YOS stays the same, but the RegF population demographic profile changes[4], the attrition volume will also change. For example, if the population has the bulk of its members with 20 YOS and above[5],

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[4]   See Figure 1 for the demographic profile of the RegF as of 1 Apr 2008.

[5]   As shown in Figure 2, usually the attrition rate of this group is higher than the other YOS groups.

one would expect a higher attrition volume and overall rate than from a population with the bulk of members with between four and 19 YOS. As shown in Figure 2, usually the attrition rate of this group is lower than the other YOS groups, in particular those with 20 YOS and above. In this case, the difference in attrition between those two populations will primarily be due to the demographic effect.

The overall yearly attrition rate is predicted based on the historical attrition rate reported (calculated using YOS-based Weighted Average Attrition Rate WAAR (α_m)), the RegF population profile at the beginning of the year and the expected number of new recruits in the year. Thus even if attrition behaviour does not change, the forecast yearly attrition volumes and/or rate may vary with any change in the latter two factors.

5.3   A Prediction with Lower and Upper Bounds

Point estimation involves the use of samples to calculate a single value which serves as a best estimate for an unknown population parameter. A confidence interval is an interval estimate of a population parameter. Instead of estimating the parameter by a single value, an interval that is likely to include the true value of the parameter is given. The confidence interval[6] is used to indicate the reliability of an estimate. Without such a confidence interval, the point estimate is less meaningful and useful.

Attrition forecasts are based on an attrition estimation from historical data. The current attrition estimation used by DSMPRA 4 is a YOS-based Weighted Average Attrition Rate WAAR(α_m) as presented in formula (1) in Table 1. When forecasting attrition, one first determines the volume of historical data required for attrition estimation; then the attrition is estimated by using WAAR(α_m) to obtain a pooled estimate. These estimates are used to represent the best estimate for an unknown true population rate. It is straightforward to work out the confidence interval for the attrition rate, if the attrition rate is simply calculated as a proportion. However, it is challenging to derive the confidence interval for WAAR(α_m) as shown in Formula (1).

The forecast based on the point estimation is provided as a single predicted value without lower and upper bounds on the prediction. Point estimations are prone to sampling error. Therefore the difference observed from the actual attrition volume and the single value of a prediction may be due to a sampling error rather than other reasons. Moreover, a range within which the population parameter will lie is of more interest than a point estimate. The interval estimation will provide a range within which the population parameter lies with a certain probability. Methodology development for providing a prediction interval has been conducted since early 2008 and was first presented at the TTCP Workforce and Analysis Working Group in May 2008 [10]. With this methodology, meta-analysis techniques are used to derive a calculation of a confidence interval for the attrition estimation. The extra information from an interval estimation will help in providing reliability. The prediction with lower and upper bounds will provide clients with more useful information and improve their human resource planning.

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[6]   The confidence level associated with an interval estimate is a measure of the likelihood that the true value of the parameter is contained within the specified interval.

5.4   Validating and Updating Forecasts

Management and other parties who use attrition forecasts need to be aware that:

a.   The forecasts for multiple years in the future are provided based on data currently available. Table 5 shows the data used for the attrition forecasts provided in this document;

b.   The forecasts can be updated when new data are available; and

c.   It is important to use the most current forecasts.

Table 5: Data used for attrition forecasts

Forecast Year	Data Used		
	Attrition Model Based on Data From	SIP	Additional Data
FY08/09	FY07/08	FY08/09	N/A
FY09/10*	FY07/08	FY09/10	FY08/09 Predictions
FY10/11*	FY07/08	FY10/11	FY09/10 Predictions

 * The prediction will be updated when the new evidence is available

The accuracy of reported and forecasted attrition is influenced by data currency. Table 6 outlines a validation and updating scheme for revisiting forecasts. Once new data are available, validation will be done to compare the prediction with the actual attrition volume in FY08/09, and attrition forecasts for FY09/10 and FY10/11 will be updated to take into account the new data. Then, at the end of FY09/10, when actual FY09/10 data are available, the forecast for FY09/10 will be validated and FY10/11 forecasts will once again be updated. This updating process will provide evidence-based and improved forecasts and also provide a means for ensuring the accuracy of the forecasts.

Table 6: Updates and Validations on Attrition Forecasts

Forecast Year	At the end of FY08/09	At the end of FY09/10	At the end of FY10/11
FY08/09	Validation		
FY09/10	1st update	Validation	
FY10/11	1st update	2nd update	Validation

Theoretically, FY 08/09 forecasts will not need to be updated if data for the entire FY07/08 are used. However, in reality, there can be a time lag between a change in personnel status and the entry of this change in the HRMS database. A more accurate picture of the FY07/08 situation is generally not available until several months after the end of the fiscal year and the DSMPRA databases are updated. Because of this, DSMPRA usually generates or updates attrition forecasts

after the summer updating in order to try to get complete data for the FY. Based on previous experience, even after a year, small changes can still be observed, although the error after the summer update would typically be quite small. The data used in the forecasts contained herein was updated to end of March 2008, but prior to the update.

5.5   Attrition Forecasts for RegF or Segments within RegF

The forecasting procedures can be applied not only to RegF-wide attrition forecasting but also to attrition forecasting for segments within RegF. However, the attrition model used for forecasting attrition for different segments within RegF should be different. For example, the attrition models used for forecasting Army attrition should be built on Army historical data. Therefore the model for the Army will be different from the model used for the whole RegF or the other CF segments' forecasting. Forecasting procedures require attrition information by YOS, therefore, the model used for forecasting is a YOS-based model. Figure 4 plots the specific YOS-based attrition models for CLS and CAS forecasts.
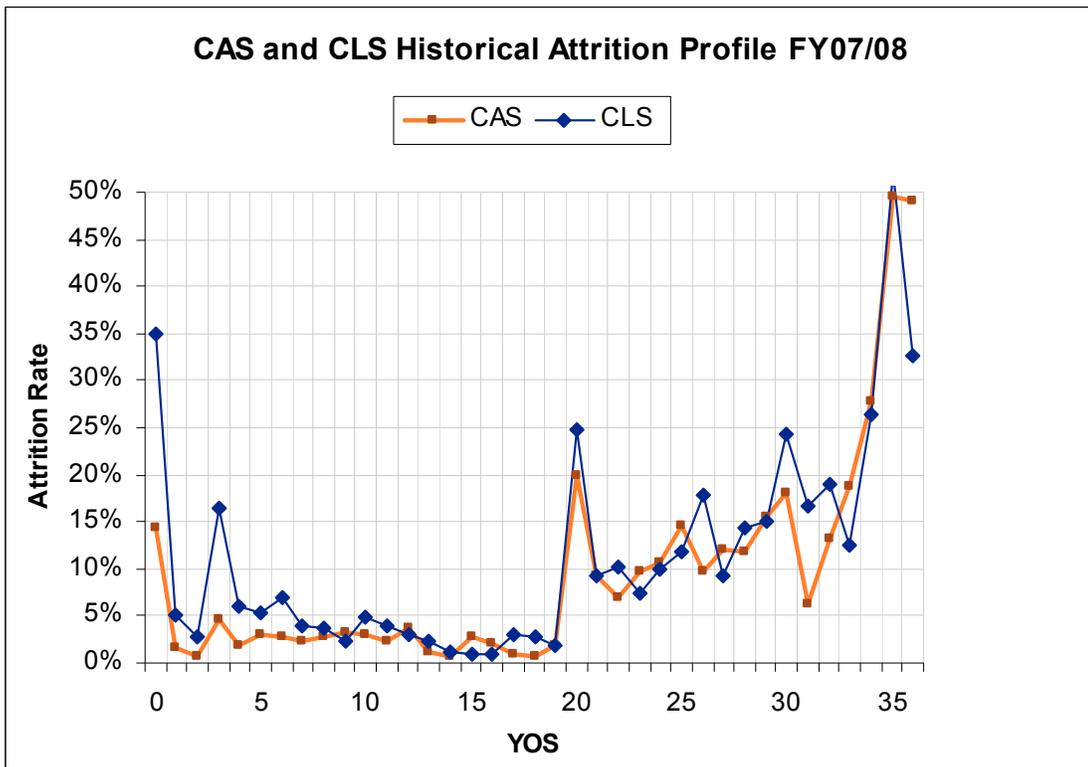

Figure 4: Attrition Models used for Forecasting CLS and CAS Attrition

5.5.1 Forecasting Attrition for Small Populations

Attrition forecasting for small segments (i.e., a small military occupation) is a special case because of the sensitivity of the attrition rate to small changes in attrition volume and the subsequent variability around the prediction result. For small occupations, it is recommended that attrition volumes be presented along with the attrition rates, because in some circumstances, only a few more/less releases will have large impact on the attrition rate. The attrition rates are less meaningful in such a situation.

If the total annual attrition needs to be forecasted, there are two ways to forecast. One way is the YOS-based attrition forecasting and another way is simply applying the historical *annual attrition rate* (not the YOS-based attrition rate) for forecasting. Statistical speaking, in general, YOS-based attrition forecasting will provide better predictions (See details and comparisons in [8]). However, when the population of interest is small, special attention need to be paid if YOS-based attrition forecasting procedures are used, since the procedures needs to break the population down into the individual YOS sub-groups and calculate the attrition rate at each YOS. The uncertainty of these calculated attrition rates will be high because the population of the sub-group at each YOS will be even smaller. In such a case, applying historical annual attrition rate for forecasting can provide an alternative. Furthermore, a statistical methodology research *Systematic Review on Attrition* [10] provided a solution on attrition modelling and forecasting for small populations.

5.5.2 Forecasting Attrition for Changing Occupations

An additional special case can occur when the characteristics of an occupation or its intake has just changed or is about to change. In these cases, using historical data from one or more additional occupations with characteristics similar to these change(s) would improve the forecasts.

Here is an example provided by Latchman 2008 [13]. The intake to the Airborne Electronic Sensor Operator (AES Op) occupation has traditionally been exclusively only occupational transfers-in. As a result, population and attrition data is either non-existent or very sparse for the lower YOS, particularly the up to 6 YOS group. This FY the occupation will be open to unskilled Direct Entry (DE) recruits, on a trial basis. The AES Op will soon have personnel in the lower YOS, where historically there have been none or very few. As a result, attrition rates at these YOS based on historical AES Op data, would not be representative of future behaviour of the DE entrants to this occupation.[7] Forecasts for this occupation should then consider the use of historical data from another occupation(s) in order to more accurately reflect future behaviour. For the case of the AES Op, CAS SMEs deemed that it was reasonable to assume that the attrition behaviour of DE recruits to the AES Op occupation would be similar to that of the DE recruits to the Aerospace Control Operator (AC Op) occupation, and forecasts in [14] incorporated AC Op historical population and attrition data for zero to 10 YOS.[8]

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[7] If there have been no personnel, there cannot have been any attrition and the historical attrition rate is thus zero.

[8] 1150-1 (DSMPRA). Preliminary Analysis of AES Op Production Scenarios. DRDC Letter Report. 18 July 2008.

5.6   Short-Term or Long-Term Forecasts

Generally speaking, a short-term forecast is more reliable than a long-term forecast. One reason is that the near term information used for a forecast, such as future recruitment, is more likely to be accurate. As well, attrition behaviour in the near term is likely to be similar to the observed attrition behaviour (which is assumed to be reflective of the attrition behaviour in the longer term), while the attrition behaviour farther into the future is more likely to be influenced by policy changes, economic changes, and so on.

An attrition behaviour shift between the historical and the future will inevitably have an impact on the accuracy of the attrition forecasts. The preliminary analysis described in [9] suggested that typically, "longer term forecasts should use more history, but the results do not conclusively quantify how much more." Additional history has the potential of obscuring emerging trends, while on the other hand, less history may reflect a short term behavioural cycle. The forecasting analyst needs to make an informed decision as to the amount of history to consider and the balance between the short and long term forecasts. Just as importantly, timely monitoring of attrition behaviour and updating the forecasts are required.

6 Conclusion and Future Research

This work targets both analysts who perform forecasting tasks and the clients/users of these predictions. It provides information that helps clients and end users understand, correctly interpret and use the predictions provided to them. It includes the latest methodology and data requirements for performing the forecasts, and describes a validation and updating scheme. It also provides forecasts of RegF attrition for the CF as a whole, and broken down by CFOA.

DSMPRA 4 continues to conduct research on CF attrition methodology. The types of research include calculating the confidence intervals for the predictions in order to provide the variability of the predictions [10], detecting trends and shifts in attrition behaviour, determining the optimal volume of historical data to use and attrition methodologies to analyze small segments in the RegF. As well DSMPRA 4 is preparing the first annual report on RegF Attrition, which will be similar in structure to the Annual Report on RegF Personnel but will deal exclusively with attrition. These efforts will augment the tools used on reporting and forecasting RegF attrition, and provide valuable information to the senior decision-makers within DND/CF.

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Annex A

A.1   Historical RegF Yearly Attrition Rates

The yearly attrition rates for FY83 to FY06 are presented in Table 7. It provides a general picture of the fluctuation in the attrition rates over the years.

Table 7: Annual attrition rates for FY83/84 to FY06/07

FY	Attrition Rate Percent	FY	Attrition Rate Percent
83/84	5.6	**95/96**	10.7
84/85	6.9	**96/97**	10.9
85/86	6.9	**97/98**	5.8
86/87	6.7	**98/99**	6.7
87/88	7.1	**99/00**	6.6
88/89	8.3	**00/01**	6.9
89/90	9.2	**01/02**	6.0
90/91	8.0	**02/03**	6.3
91/92	6.8	**03/04**	6.1
92/93	7.2	**04/05**	6.7
93/94	6.9	**05/06**	6.8
94/95	8.5	**06/07**	8.2

A.2 Summary from Strategic Intake Plan

The data on the future Strategic Intake Plan can be found using the following link,

http://hr.ottawa-hull.mil.ca/dgmp/dpgr/engraph/reports/description_e.asp?sec=2&report=bpd

The data may be changed over time due to updates.

Table 8: Draft Future Strategic Intake Plan

SIP Intake Summary/Sommaire Inscrits	FY 09/10	FY 10/11	FY 11/12
Based on 2008 AMOR (amend 2)			
Offr Recruiting/Recrutement off	1230	1219	1194
NCM Recruiting/Recrutement MR	6426	6184	5883
REG F RECRUITING TOTAL/TOTAL RECRUT F REG	**7656**	**7403**	**7077**
Offr In-Svc/Off en service	438	411	406
NCM In-Svc/MR en service	713	742	732
REG F IN-SVC TOTAL/TOTAL SERVICE INTERNE F REG	**1151**	**1153**	**1138**
Offr Total/Total Off	1668	1630	1600
NCM Total/Total MR	7139	6926	6615
REG F TOTAL INTAKE/TOTAL INSCRITS F REG	**8807**	**8556**	**8215**
RES F RECRUITING TOTAL/TOTAL RECRUTEMENT F RÉS	**TBD**	**TBD**	**TBD**
TOTAL FORCE RECRUITING/TOTAL RECRUTEMENT FORCE	**TBD**	**TBD**	**TBD**

MES Authority - Reg Force Recruiting Totals/Totaux recrutement AG F Reg	FY 09/10	FY 10/11	FY 10/11
CLS/CEMAT	3726	3513	3363
CMS/CEMFM	1018	999	995
CAS/CEMFA	1215	1236	1099
Asst CMP/ACPM	1697	1655	1620
Total	**7656**	**7403**	**7077**

List of acronyms

$a_m[n]$	Volume of releases in year n-1, with m YOS measured at the end of year n-1
$a'_m[n]$	Volume of releases in year n-1, with m YOS measured at the time of release
α_m	YOS based attrition rate
$\alpha_{m-1,m}$	Net attrition rate for YOS based attrition rate for a population with m-1 YOS
$A_m[n]$	Predicted volume of releases with m YOS measured on Jan. 1st/ Apr. 1st of year n
$P_m[n]$	Population with m YOS on Jan. 1st/ Apr. 1st of year n
$T_m[n]$	Transfers/Recruits between year n-1 and n with m YOS measured on Jan. 1st/ Apr. 1st of year n
A/CMP	Assistant Chief Military Personnel
AES Op	Airborne Electronic Sensor Operator
CAS	Chief Air Staff
CF	Canadian Forces
CFOA	Canadian Forces Occupational Authority
CLS	Chief Land Staff
DE	Direct Entry
DND	Department of National Defence
DGMPRA	Director General Military Personnel Research Analysis
DPGR	Director Personnel Generation Requirements
DSMPRA	Director Strategic Military Personnel Research Analysis
FRP	Force Reduction Program
MPIS	Military Personnel Information System
HRMS	Human Resources Management System
NCM	Non Commissioned Member
OFF	Officer
RegF	Regular Force
SIP	Strategic Intake Plan
SME	Subject Matter Expert
TPS	Total Paid Strength

TTCP	The Technical Cooperation Program
WAAR	Weighted Average Attrition Rate
YOS	Years of Service

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This report provides information on what one should know about Regular Force (RegF) attrition forecasts: the latest methodology development, data requirements and other information to correctly understand, interpret and use forecasted results. It also provides forecasts of RegF attrition as a whole, and broken down by Canadian Forces Occupation Authority (CFOA), i.e., occupations managed by Chief Land Staff (CLS), Chief Maritime Staff (CMS), Chief Air Staff (CAS) and Assistant Chief Military Personnel (A/CMP).

This work targets both analysts who perform forecasting tasks and the clients/users, such as military planners and other researchers who use these predictions. This work will help bridge the gaps between analysts and clients and improve consistency and transparency between different research groups within DRDC.

Ce rapport sert à expliquer ce qu'il faut savoir sur les prévisions en matière d'attrition au sein de la Force régulière, c'est-à-dire qu'il expose la toute dernière méthodologie en matière de prévision de l'attrition, précise les données à recueillir et contient de l'information importante afin de comprendre, interpréter et utiliser correctement les résultats prévus. Il contient aussi des prévisions de l'attrition dans la Force régulière dans son ensemble, et par responsable de groupes professionnels militaires des FC, à savoir le Chef d'état-major de l'Armée de terre (CEMAT), le Chef d'état-major des Forces maritimes (CEMFM), le Chef d'état-major de la Force aérienne (CEMFA) et le Chef adjoint – Personnel militaire (ACPM).

Le document vise autant le personnel chargé de faire les prévisions que les utilisateur/clients, comme les planificateurs militaires et autres chercheurs qui se servent de ces prévisions. Il permet de réduire l'écart qui divise les analystes et les clients et d'assurer une meilleure uniformité et une plus grande transparence entre les groupes de recherche du RDDC.

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