DRDC CORA's OR Scientists: Analysis of Past Hiring, Career Progression, and Attrition Trends, and Development of a Model to Forecast Future Demographics.

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DRDC CORA TM 2006–31
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Defence R&D Canada
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Technical Memorandum

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Abstract

This report examines DRDC CORA's historical and future capacity to perform traditional (quantitative) operational research (OR) by examining the past, present, and future demographics of its OR defence scientists (DS's). Trends related to the demographics of CORA's OR DS's were analyzed with respect to the size of the population, its distribution with respect to DS level, age and experience based on data from 1997-2006. Past hiring, attrition and career progression trends were also examined. Historical trends were used to develop a career progression model to simulate the future demographics of the OR DS population out to 2025. Results were interpreted from a strategic HR planning perspective with recommendations made regarding future HR strategies.

Résumé

Ce rapport étudie la capacité historique et future du Centre d'analyse et de recherche opérationnelle (CARO) de Recherche et développement pour la défense Canada (RDDC) de mener des recherches opérationnelles (RO) quantitatives traditionnelles, d'après les données démographiques passées, présentes et futures des scientifiques de la défense (SD) engagés dans des RO. On a procédé á l'analyse des tendances liées aux données démographiques des SD en RO du CARO en ce qui concerne la taille de la population et sa distribution selon le niveau, l'âge et l'expérience des SD pour la période de 1997 á 2006. On a également étudié les tendances passées de l'embauche, de l'attrition et de l'avancement professionnel. On s'est servi des tendances historiques pour élaborer un modèle d'avancement professionnel visant á simuler les futures données démographiques de la population des SD en RO jusqu'en 2025. On a interprété les résultats dans une perspective de planification stratégique des RH, et formulé des recommandations sur les futures stratégies en RH.

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Executive summary

Background

A recent hiring surge since following a hiring freeze in the 1990's has seen a near doubling of DRDC CORA's OR defence scientist (DS) population (and thereby CORA's capacity to deliver OR&A) since 1997. This report examines historical HR trends for CORA's OR DS's based on data from 1997-2006.[1] Historical demographics are summarized with respect to DS level, experience and age of the population and hiring, career progression and attrition trends are inferred. The trends are incorporated into a career progression model to simulate the effects of recent hiring on future demographics assuming past trends continue. Alternate scenarios are considered to reflect the variety of outcomes that might arise if past trends do not continue.

Principal results

The recent growth of CORA's OR DS population has been offset by attrition of senior scientists so that the size of the DS-4, DS-5 and DS-6 population (and the number of DS's with more than 5 YOS) has not changed in the past decade. DS-4 growth resulting from recent hiring is expected to begin shortly, whereas DS-5 and DS-6 levels are not expected to increase until 2015 assuming current trends continue.

The disproportionality between junior and senior scientists will continue to grow in the next 3-5 years (reaching as many as 3 junior scientists for every one senior scientist) before beginning to decline. In the next 5-7 years, 17% of senior scientists are expected to reach retirement age. Mechanisms for knowledge transfer and mentoring must therefore be put into place to prevent extensive loss of corporate knowledge.

For strategic HR planning purposes, it can be assumed that 6% of CORA's OR DS's will leave annually by attrition, meaning that 6 new OR DS's should be hired annually to maintain the organization's current size, with more or fewer new recruits resulting in growth or decline. According to the model, hiring of 10 new recruits annually would result in a growth of CORA by 40% by 2025, though this depends significantly on attrition rates.

Growth of the organization can be affected by either increasing hiring rates, or taking steps to minimize early and mid-career attrition. Decreasing attrition, though more difficult in practice, has the same effect on the total population size as increased hiring but results in a healthier mix of junior and senior scientists. It remains to be seen whether hiring scientists at the DS-4 level results in more DS-5's and DS-6's, as there is no clear evidence of this to date. Growth of the DS-5 and DS-6 populations may be expedited by increases in career progression rates, but this must be accomplished without compromising the current standards of excellence for DS's.

[1] In addition to OR DS's, CORA's staff also includes smaller populations of DS's with unique expertise, specifically, social scientists, strategic analysts, and intelligence analysts. Because of their size, known differences in career progression, attrition and hiring trends, these populations are not part of this report. Some historical trends for these subpopulations are presented in Annex D.

Significance of results

The results presented here provide management with a strategic perspective of past and future growth of DRDC CORA and should be a guide for future HR decisions as the organization continues to grow. The career progression model presented here is expected to be the first of several HR planning tools to be developed within CORA to help guide HR policies.

Future work

Future work may include identifying characteristics such as posting locations and frequency, and number of publications, which could be contributing factors to DS career progression rate. It is expected that this would allow management to identify a means of expediting the training of new recruits to fill the positions left by retirees. A decision support tool may also be developed to aid CORA's management with postings of junior scientists to field stations.

Philip T. Eles, Paul L. Massel; 2006; DRDC CORA's OR Scientists: Analysis of Past Hiring, Career Progression, and Attrition Trends, and Development of a Model to Forecast Future Demographics.; DRDC CORA TM 2006–31; DRDC – Centre for Operational Research and Analysis.

Sommaire

Contexte

Une récente hausse soudaine du recrutement suivant un gel de l'embauche survenu dans les années 1990 a presque doublé l'effectif des scientifiques de la défense (SD) engagés dans des recherches opérationnelles (RO) au Centre d'analyse et de recherche opérationnelle (CARO) de Recherche et développement pour la défense Canada (RDDC), augmentant d'autant la capacité du CARO d'effectuer des recherche et analyses opérationnelles (RAO) depuis 1997. Ce rapport examine les tendances historiques en RH des SD en RO du CARO, á partir de données sur la période de 1997 á 2006.[2] On a fait la synthèse des données démographiques historiques portant sur le niveau, l'expérience et l'âge de la population des SD, et on en a extrait des tendances sur les plans de l'embauche, de l'avancement professionnel et de l'attrition. Ces tendances sont intégrées dans un modèle d'avancement professionnel afin de simuler les effets de l'embauche récente sur les données démographiques futures, en supposant que les tendances actuelles se maintiendront. On envisage des scénarios de rechange afin de refléter la variété des résultats possibles si les tendances passées ne se maintiennent pas.

Principaux résultats

La croissance récente de la population de SD en RO du CARO a été compensée par l'attrition des scientifiques chevronnés, de sorte que la taille de la population des SD-4, SD-5 et SD-6 (et du nombre de SD qui comptent plus de cinq années de service) n'a pas changé dans la dernière décennie. On s'attend á ce que le nombre de SD-4 amorce bientôt une croissance résultant des embauches récentes, mais on ne prévoit pas d'augmentation dans les niveaux de SD-5 et SD-6 avant 2015, en supposant que les tendances actuelles se maintiendront.

La disproportion entre les scientifiques juniors et les scientifiques chevronnnés continuera á s'accentuer dans les trois á cinq années á venir (atteignant jusqu'á trois scientifiques juniors pour chaque scientifique chevronné) avant de commencer á diminuer. Dans les cinq á sept prochaines années, on s'attend á ce que 17 pour cent des scientifiques chevronnés atteignent l'âge de la retraite. Il faudra donc mettre en place des mécanismes de transfert des connaissances et de mentorat afin d'éviter la perte par le ministère de précieuses connaissances.

Pour la planification stratégique des RH, on peut supposer que 6 pour cent des SD en RO du CARO quitteront le Ministère chaque année par attrition, ce qui signifie qu'il faut embaucher six nouveaux SD en RO chaque année pour maintenir la taille actuelle de l'organisation. Si le nombre de recrues est supérieur ou inférieur á ce niveau, on observera une croissance ou un déclin. Selon le modèle, l'embauche de 10 nouvelles recrues par an aurait

[2]Outre les SD en RO, le personnel du CARO inclut également des populations restreintes de SD possédant une expérience particulière, notamment des sociologues, des analystes stratégiques et des analystes du renseignement. En raison de leur taille, de différences connues dans l'avancement professionnel et des tendances de l'embauche et de l'attrition, ces populations ne sont pas abordées dans ce rapport. Certaines tendances historiques concernant ces sous-populations sont présentées à l'Annexe D.

comme conséquence une croissance de 40 pour cent dans l'effectif du CARO d'ici 2025, bien que ce résultat soit fortement influencé par le taux d'attrition.

On peut influer sur la croissance de l'organisation en augmentant les taux d'embauche ou en prenant des mesures pour réduire au minimum l'attrition précoce et de mi-carrière. La baisse de l'attrition, bien que plus difficile en pratique, a le même effet sur la taille totale de la population que l'augmentation de l'embauche, mais permet un meilleur équilibre entre scientifiques juniors et chevronnés. Il reste á voir si l'embauche de scientifiques au niveau SD-4 se traduit par une hausse du nombre de SD-5 et de SD-6, ce dont nous n'avons aucune preuve claire jusqu'ici. Il est possible d'accélérer la croissance des populations de SD-5 et SD-6 en augmentant les taux d'avancement professionnel, mais cela doit se faire dans le respect des normes actuelles d'excellence en ce qui concerne les SD.

Signification des résultats

Les résultats présentés ici fournissent á la direction un aperçu stratégique de la croissance passée et future du CARO de RDDC. Ils devraient guider cette dernière dans la prise de ses décisions en RH, au fur et á mesure de la croissance de l'organisation. On s'attend á ce que le modèle d'avancement professionnel présenté ici soit le premier de plusieurs outils de planification des RH á être mis au point au sein du CARO pour servir de guide á l'élaboration des politiques de RH.

Travaux futurs

Les travaux futurs pourront comprendre la détermination de caractéristiques telles que le lieu et la fréquence des détachements et le nombre de publications, qui pourraient être des facteurs contribuant au taux d'avancement professionnel des SD. On s'attend á ce que cela permette á la direction de déterminer des moyens d'accélérer la formation de nouvelles recrues pour combler les postes laissés vacants par les départs á la retraite. Un outil d'aide á la décision peut également être élaboré afin de faciliter, pour la direction du CARO, la gestion des détachements de scientifiques juniors dans les stations locales.

Philip T. Eles, Paul L. Massel; 2006; Les scientifiques en RO du CARO de RDDC : Analyse des tendances historiques de l'embauche, de l'avancement professionnel et de l'attrition, et élaboration d'un modèle de prévision des données démographiques futures; DRDC CORA TM 2006–31; RDDC – Centre pour la recherche et l'analyse opérationnelles.

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Acknowledgements

The authors would like to thank Dr. A. Jesion for his insights into DS career progression, Ms. S. Ballantyne for assistance with data verification, and LCol R.M. Foster for his persistence in obtaining historical data for this study and for his support of the project.

1 Introduction

1.1 Background

Defence Research and Development Canada's Centre for Operational Research and Analysis (DRDC CORA) is one of seven DRDC research centres. DRDC CORA has over 30 small teams of defence scientists (DS's) most of whom are located in the National Capital Region working closely with various Canadian Forces (CF) and Department of National Defence (DND) level 1 organizations and the remainder whom are co-located with other level 2 military commands across the country and in some international locations.[3] While it has recently joined DRDC, CORA has existed in a number of previous organizational constructs and offered rigorous operational research and science based analysis to its primary client, the Department of National Defence, for over 60 years.

The recent hiring surge that followed a decade-long hiring freeze in the 1990's leaves CORA's DS population with a demographic skewed towards junior scientist and a shortage of senior scientists. Such a demographic raises questions regarding knowledge transfer, and may leave the organization vulnerable to changes in Canada's economic climate.

In this light, it is prudent that CORA's management have a suite of HR planning tools to assess the impact of recent organizational changes on CORA's capability to deliver OR&A expertise to DRDC, the department and government. This report presents the first of such tools: a DS career progression model to project future staffing levels based on past hiring, attrition, and career progression trends.

This work is part of a larger initiative by CORA's Senior Military Officer, LCol R.M. Foster, to assemble and maintain an accurate and up-to-date database of CORA personnel to facilitate project planning, career management, and knowledge management.

1.2 Aim of Current Work

The aim of this work was to analyze historical trends with respect to hiring, promotion and attrition of the CORA's OR DS population and to develop a model that predicts future DS levels, salary wage envelopes and attrition rates.

The historical analysis was based on a dataset obtained from a series of queries of the HRMS (Peoplesoft) database. Data was obtained for 30 November 1997 to 2005 as well as for 1 May 2006.

This report begins with a snapshot of CORA's OR DS population as of the beginning of Fiscal Year 06/07 and is followed by an analysis of historical trends. A career progression

[3]The Department of National Defence is divided into a number of broad functional areas, each led and managed by an Associate Deputy Minister or an officer of equivalent rank from the Canadian Forces. Each of these functional areas, such as VCDS, CLS, CAS, ADM Mat, and ADM IM, are collectively known as level 1 organizations. Similarly, a number of organizations external to the NDHQ region are large functional organizations in their own right but are subordinate to a level 1 organization. These organizations such as the recently stood up 6 regional Joint Task Force Commands are know as level 2 organizations.

model based on the historical trends is then described, followed by results from the model with forecasts of CORA's OR DS population out to 2025.

1.3 Scope of Current Work

The analysis of historical trends and development of the career progression model, was limited to DS's performing traditional (quantitative) OR, and excluded social scientists, strategic analysts and intelligence analysts who likely exhibit different HR trends and provide a unique set of capabilities to CORA. Because of the small size of these sub-populations, historical data would not likely yield statistically significant HR trends and modeling would yield unreliable results. Thus, for the remainder of this report, mention of DS's refers implicitly to quantitative OR DS's.[4]

Likewise, members of senior management were not included in the model and those individuals who entered the management stream were considered to have left the population of interest (via mid-career attrition).

Postings of DS's to field stations and teams was not considered in this work. The current dataset did not provide a complete picture of past postings, and the current modeling techniques were not appropriate for determining optimal posting strategies. It was expected that this would form the basis of future work.

[4]See Annex D for a cursory analysis of historical trends for CORA's social scientists, strategic analysts, and intelligence analysts.

2 Current and Historical Demographics of OR DS's

Historical data including DS level, pay step, age, and years of service (YOS), were obtained for all OR DS's within DRDC CORA through a query to DND's HRMS (Peoplesoft) database. Data was obtained for 30 November 1997 through to 1 May 2006. Annex A summarizes the data fields obtained, and methods used to cross-reference fields with other sources of data and cleanse the data from obvious errors. The final dataset contained 698 person-years of data from 114 distinct individuals, with enough information to reconstruct the results of 564 annual reviews: an average of 5 reviews per DS.

2.1 A Snapshot as of 1 May 2006

As of 1 May 2006, there were 88 OR DS's in CORA with another 17 expected to join the organization as a result of the 2005 junior recruit hiring campaign (six DS-2's, nine DS-3's and two DS-4's).

As depicted in Figure 1, a large fraction (68%) of DS's were at the DS-3 and DS-4 level, reflecting the hiring surge of recent years. The 2006 DS level distribution was far from a steady state distribution and the relative DS populations are expected to undergo significant change in the coming years as the large number of recent recruits progress through their careers.[5]

Figure 2 depicts the age distribution of DS's (excluding new recruits whose age was not known at the time of writing). As of 1 May 2006, the average age of DS's was 40.7, with 40% of individuals younger than 35, and 10% over 55.

DS's averaged 11.6 years of experience, though Figure 3 shows that the YOS frequency distribution was skewed towards inexperienced DS's with a long tail towards those with many YOS. Including the 2006 new recruits, 52% of DS's had less than 5 years of experience and 70% had less than 10 YOS. Conversely, only 30% had more than 10 YOS, with more than half of those having more than 25 YOS and expected to retire in the near future.

A better indicator of imminent retirements was the number of YOS an individual had left before they could retire without penalty.[6] The 2006 YTR distribution, shown in Figure 4, reveals that 10% of DS's were past retirement age and could retire without penalty at any time, while another 7% had less than 5 YTR and could be expected to retire in the next 5 years. Thus, 17% of the DS population may be expected to retire in the near future.

[5]The effects of recent hiring surge on future demographics were a major focus of this study and are a revisited often in this report.

[6]Public servants are entitled to receive superannuation without penalty once they reach age 55 with 30 YOS, or age 60 with 2 YOS. Either of these age/YOS milestones is herein referred to as *retirement age* and the number of years required to meet the milestone as *Years To Retirement, YTR*.

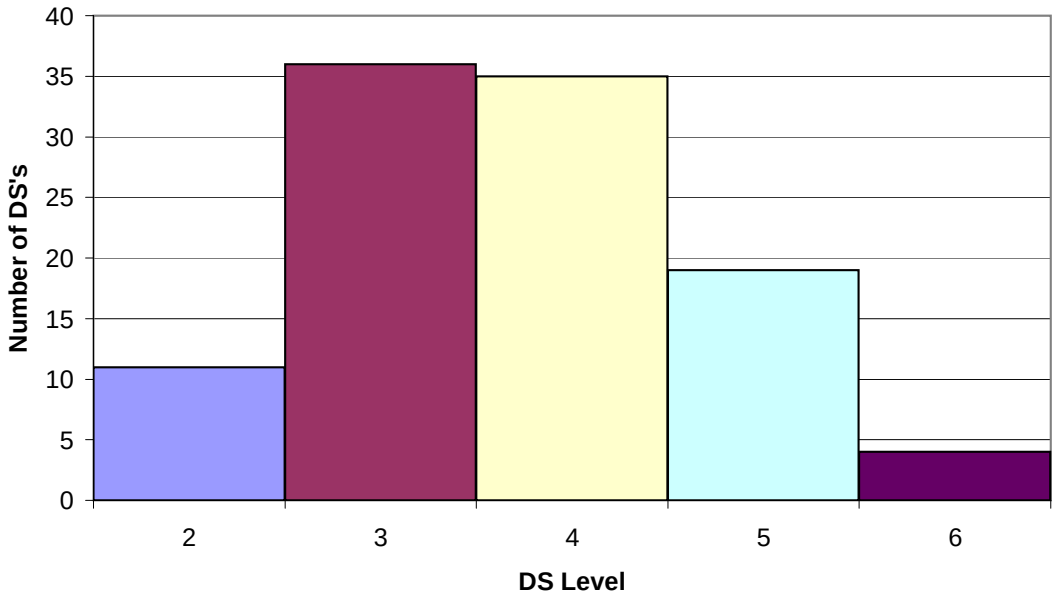


Figure 1: *DS population by DS level as of May 2006. Includes 2006 recruits.*

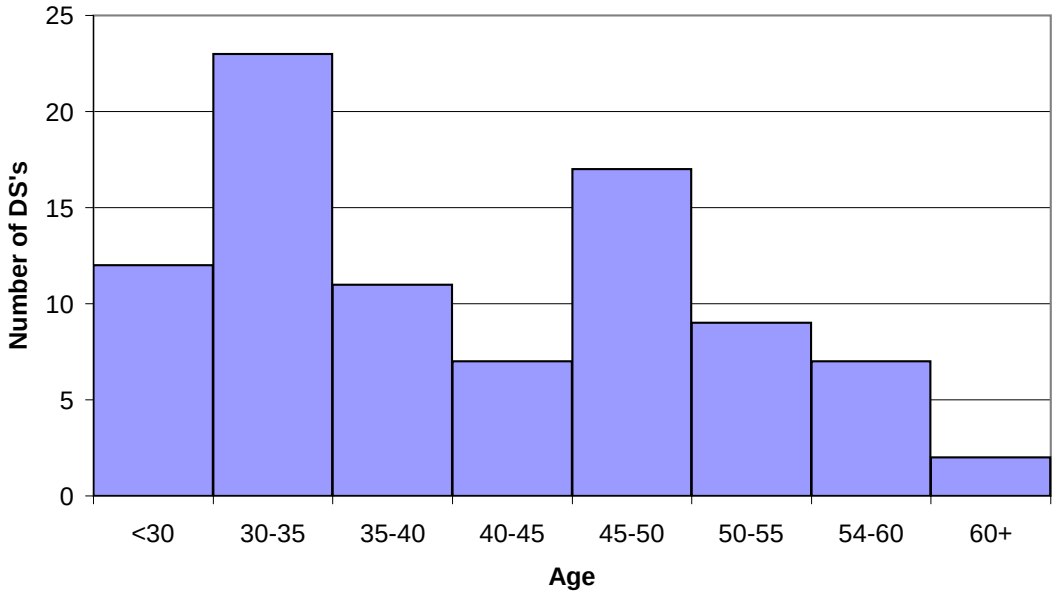


Figure 2: *DS population by age as of May 2006. Does not include 2006 recruits.*

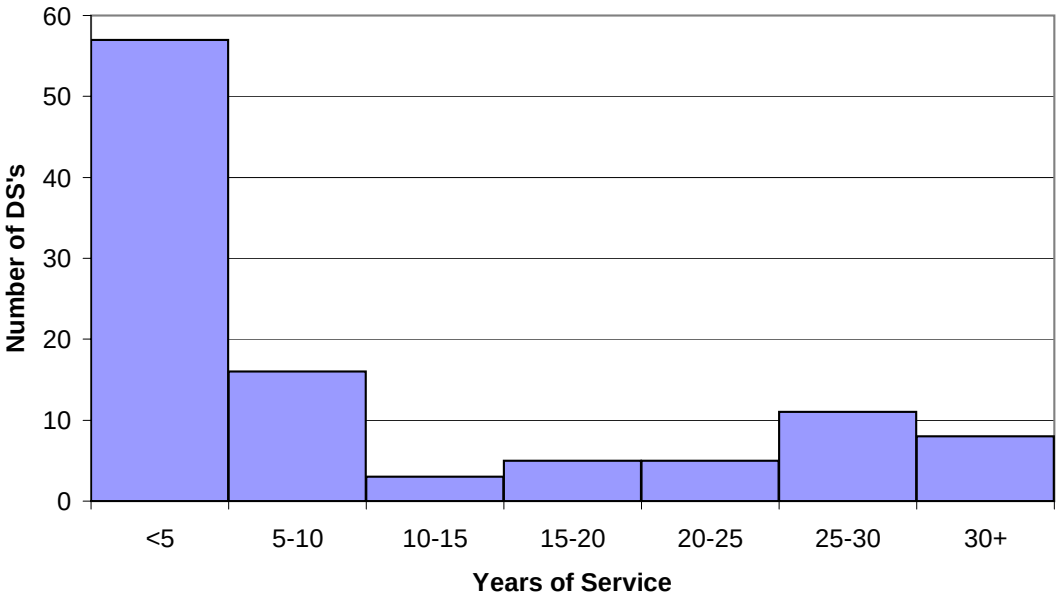


Figure 3: *DS population by YOS as of May 2006. Includes 2006 recruits.*

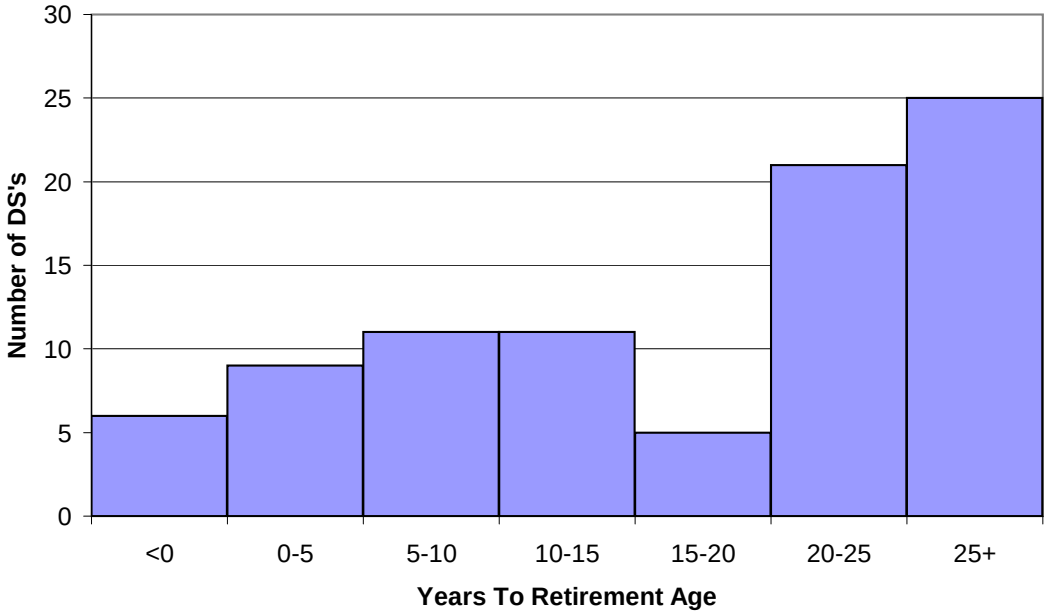


Figure 4: *DS population by YTR as of May 2006. Does not include 2006 recruits.*

2.2 Historical Trends from 1997-2006

2.2.1 Size of DS Population

The size of DRDC CORA's OR DS population increased substantially over the past decade, from 53 in 1997 to 105 in 2006, as shown in Figure 5. The size of the DS-4, DS-5 and DS-6 populations have not change significantly over the past decade despite the fact that over the past 10 years, new hires have had ample time to reach DS-4. The growth has come in form of DS-2's and DS-3's joining the organization.

A breakdown of the historical DS population by YOS (Figure 6) verifies that CORA's growth was indeed driven by junior scientists. The total number of experienced DS's (with more than 5 YOS) did not changed in the past decade despite the fact that those hired before 2001 should have reached 5 YOS by 2006. This implies that CORA's recent growth has been offset by attrition of senior scientists.

There are obvious concerns regarding knowledge transfer and mentoring for the junior scientists as discussed later in this report in light of the simulation results that show how these trends will play out in the near future. In order to make an accurate prediction of future staffing levels, past hiring, attrition and career progression trends need to be evaluated.

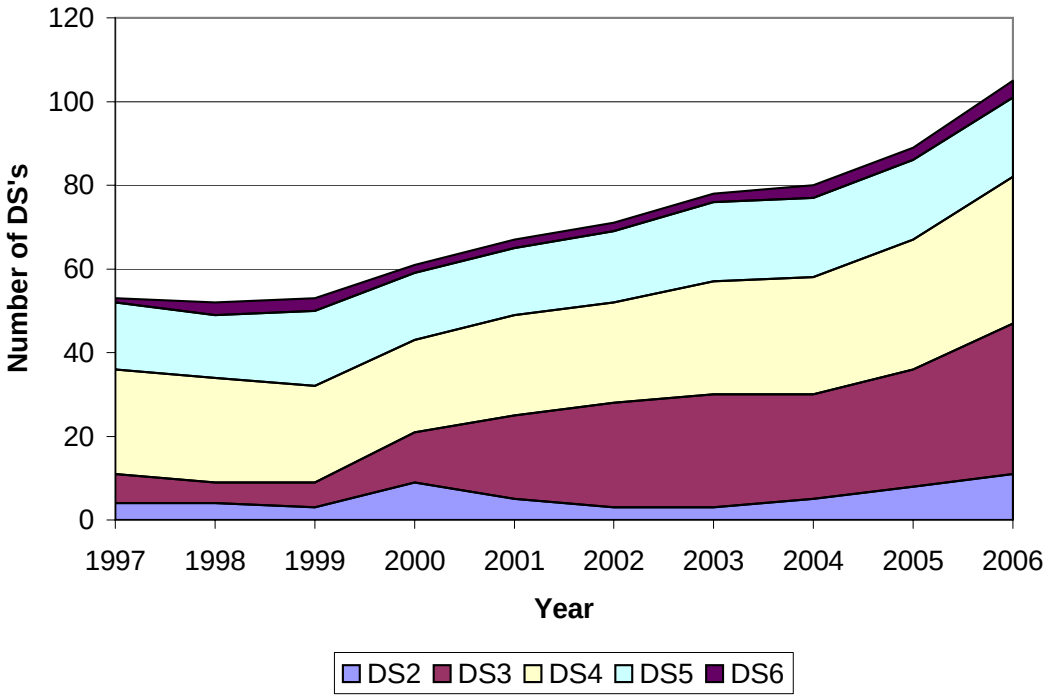


Figure 5: *Number of OR DS's in CORA as of 30 November for each year except 2006 which is as of 1 May.*

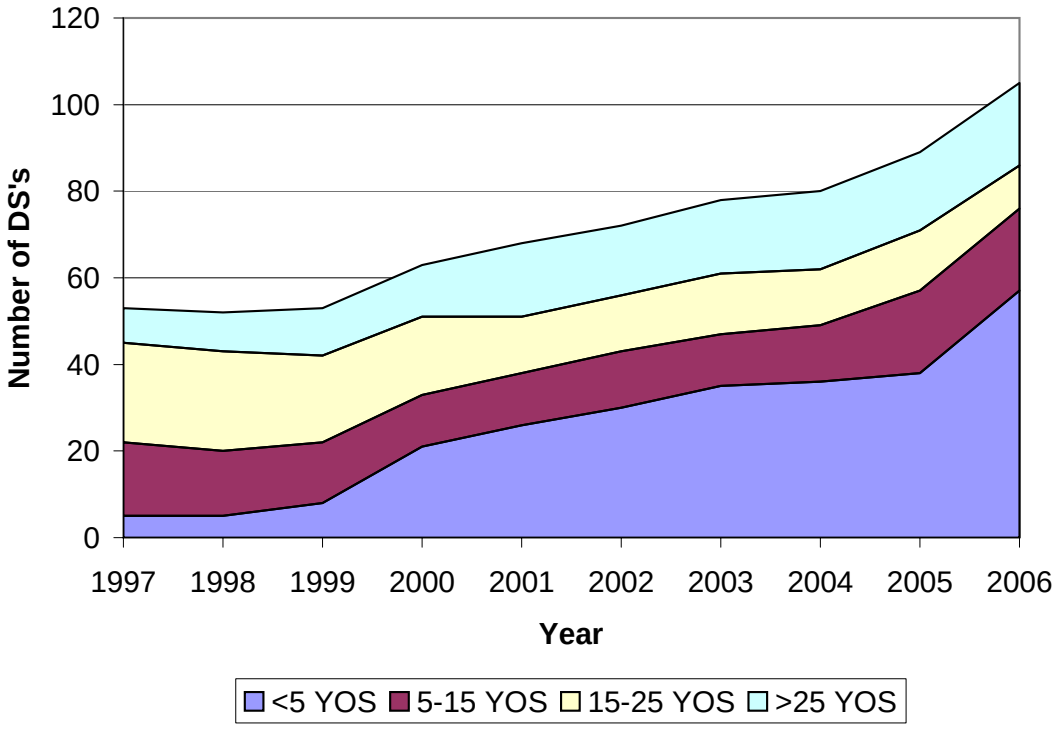


Figure 6: *Number of OR DS's in CORA by Year and YOS.*

2.2.2 Hiring Trends

The annual number of new hires and their DS level are plotted in Figure 7. Since 2000, there were an average of 10.9 new recruits hired annually with roughly half of new recruits hired as DS-3's and almost 40% as DS-2's (Table 1).

The age distribution of new recruits since 1997 is plotted in Figure 8, showing that the majority of DS-2's were in range 26-28 years old, while DS-3's were evenly distributed between 26 and 34 years old. DS-4's and DS-5's tended to be in their late 30's or older. Upon closer inspection, DS-2 new recruits were typically hired at the fourth pay step of the level, DS-3 recruits tended to start between pay steps 2 and 6, while DS-4's were evenly distributed throughout the pay scale.[7]

Table 1: *Total number of OR DS's hired between 1997 and 2006*

DS Level	Number hired	Fraction of all hires
DS-2	32	37.6%
DS-3	42	49.4%
DS-4	9	10.6%
DS-5	2	2.4%
Total	85	100%

[7]See Annex E for a description of the DS levels and pay steps that make up the DS Pay Plan.

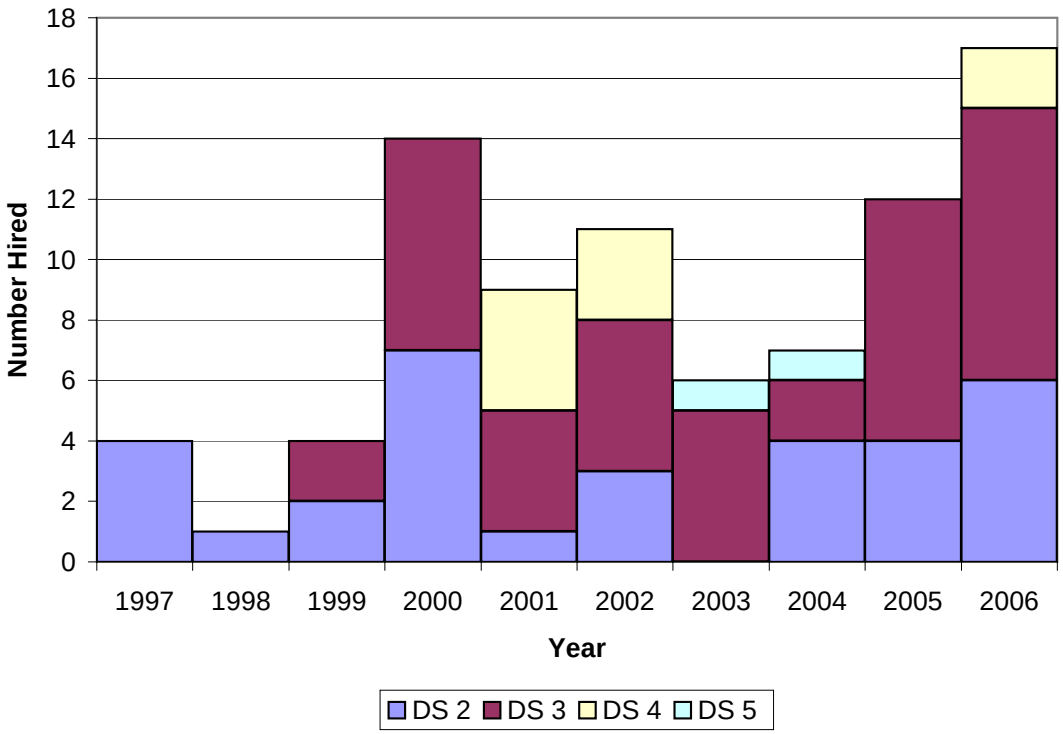


Figure 7: *DS level of new recruits by year.*

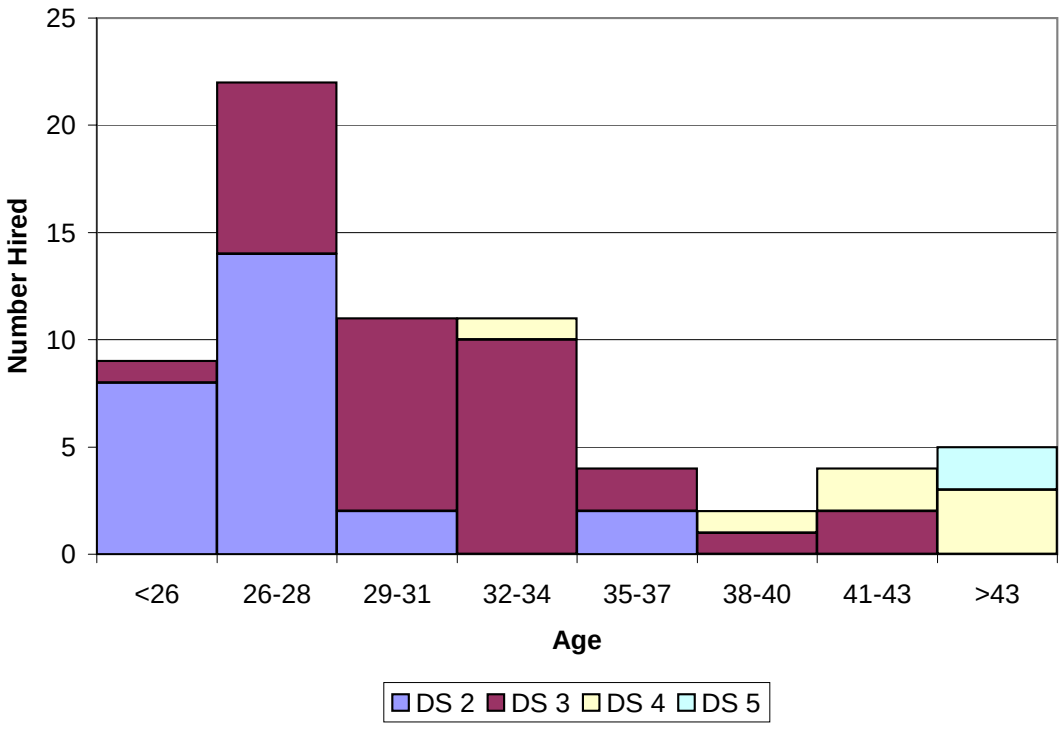


Figure 8: *Age distribution of new recruits from 1997-2005.*

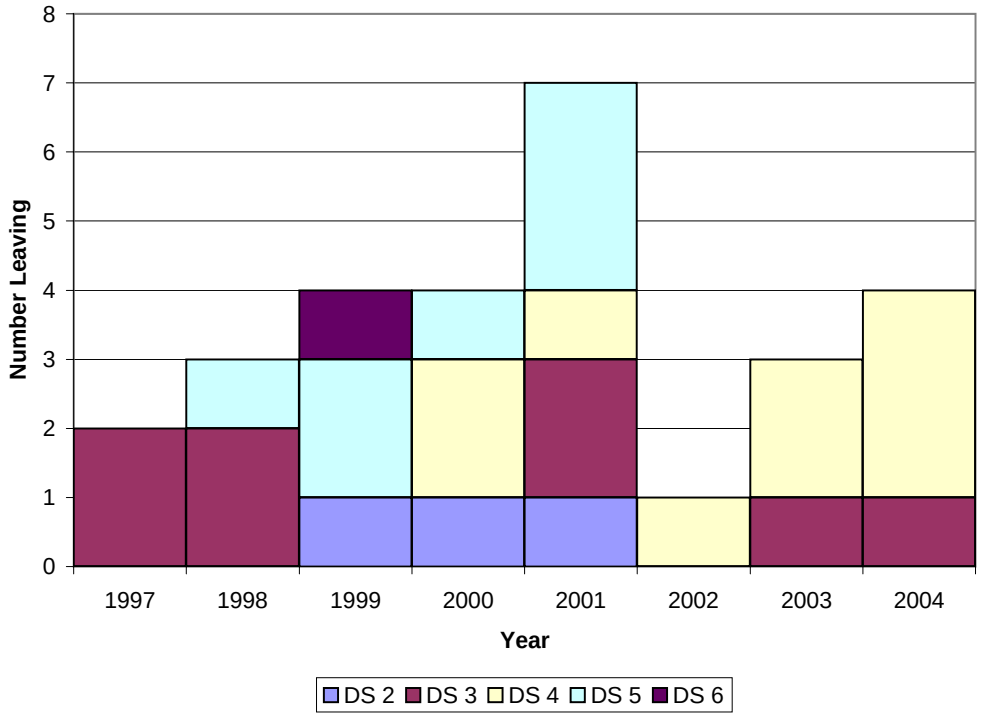


Figure 9: *Attrition by year and DS level. Attrition occurred between 30 November of the year indicated and 30 November of the following year.*

2.2.3 Attrition Trends

The annual number of DS's leaving DRDC CORA over the past decade is plotted in Figure 9, with the totals summarized in Table 2. On average, 3.5 individuals left the organization per year, though it was expected that as the organization grew, the number leaving annually would also increase. It was not possible to extrapolate future attrition rates from historical trends due to the complex dependence on the demographics of the population (i.e. how many DS's are close to retirement age, etc). An accurate prediction of attrition numbers for the coming years depends on attrition probabilities at varying career stages and the number of DS's at each career stage. Thus an accurate measure of attrition probabilities was required for modeling purposes.

Early- and mid-career attrition depends most heavily on YOS, since junior and senior DS's typically have a different annual attrition probability due to a variety of economic and social factors. Figure 10A summarizes the number of retirements and total person-years observed as a function of YOS. Due to the limited size of the dataset, annual attrition probabilities were obtained by averaging over several YOS (Figure 10B and Table 3). For late-career attrition (including retirement), YTR was a better predictor of attrition.[8] Figure 11A sum-

[8]It was important to consider YTR in addition to YOS because some new recruits joined the organization at an advanced age (e.g. through a senior DS recruiting campaign), and would be expected to retire well before reaching 30 YOS.

marizes the observed yearly attrition and total person-years as a function of YTR, with the annual attrition probabilities, averaged over several years, shown in Figure 11B and Table 4. The annual attrition probabilities for those with more than 30 YOS and for those eligible for retirement ($\leq$0 YTR) were the same within errors (18.2% and 15.8% respectively), as are the attrition rates for the preceding 10 years (1.3% for 20-30 YOS and 1.4% for 1-10 YTR), reflecting the correlation between YOS and YTR.

2.2.4 Trends Pertaining to Leave Without Pay

The historical dataset contained 16 cases where individuals went on leave with out pay (LWOP). In 8 cases, individuals returned within two years. Another five individuals are currently on LWOP, though only one has been on leave for more than 2 years. Only one individual did not return from LWOP. Of the 16 individuals who went on LWOP only 2 had more than 16 YOS. There did not appear to be any trends with respect to the DS level or age for those going on LWOP.

Table 2: *Total number of DS's who left CORA between 1997 and 2006*

DS Level	Number Retired	Fraction of Retirees
DS-2	3	10.7%
DS-3	8	28.6%
DS-4	9	32.1%
DS-5	7	25.0%
DS-6	1	3.6%
Total	28	100%

Table 3: *Historical attrition by YOS*

	YOS			
	0-5	5-20	20-30	$\geq$30
Number Retired	8	12	2	6
Number Stayed	158	151	152	27
Total Observed	166	163	154	33
Fraction Retiring Annually	4.8%	7.4%	1.3%	18.2%
Standard Error (Upper bound)	7.1%	10.0%	3.0%	27.5%
Standard Error (Lower bound)	3.2%	5.3%	0.5%	11.2%

Table 4: *Historical attrition by YTR*

	YTR	
	0-10	$\leq$0
Number Retired	2	6
Number Stayed	145	32
Total Observed	147	38
Fraction Retiring Annually	1.4%	15.8%
Standard Error (Upper bound)	3.1%	24.0%
Standard Error (Lower bound)	0.5%	9.7%

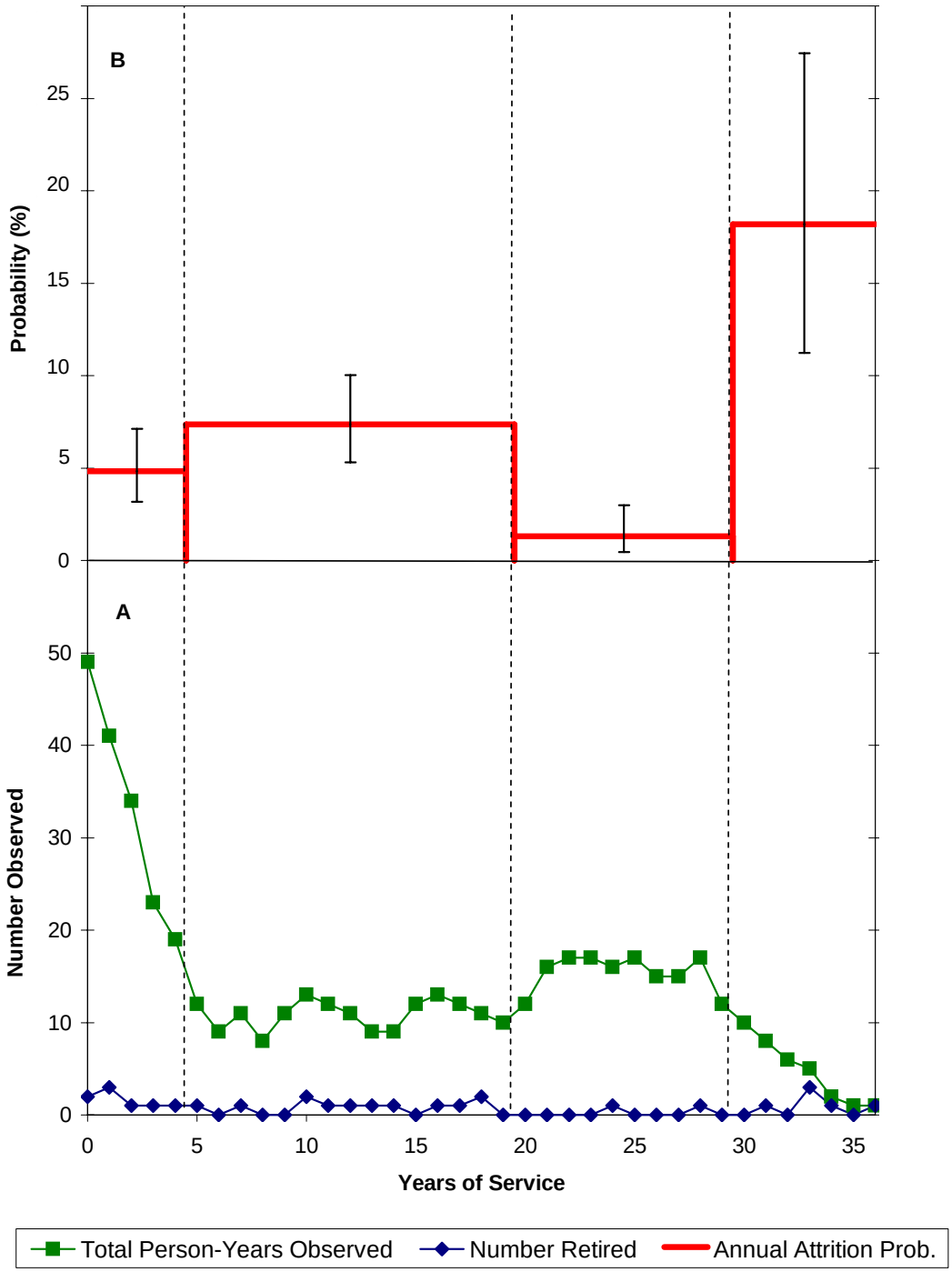


Figure 10: *A) Attrition and total person-years by YOS. B) Annual attrition probability obtained by binning year ranges. Error bars depict standard errors due to finite sample sizes.*

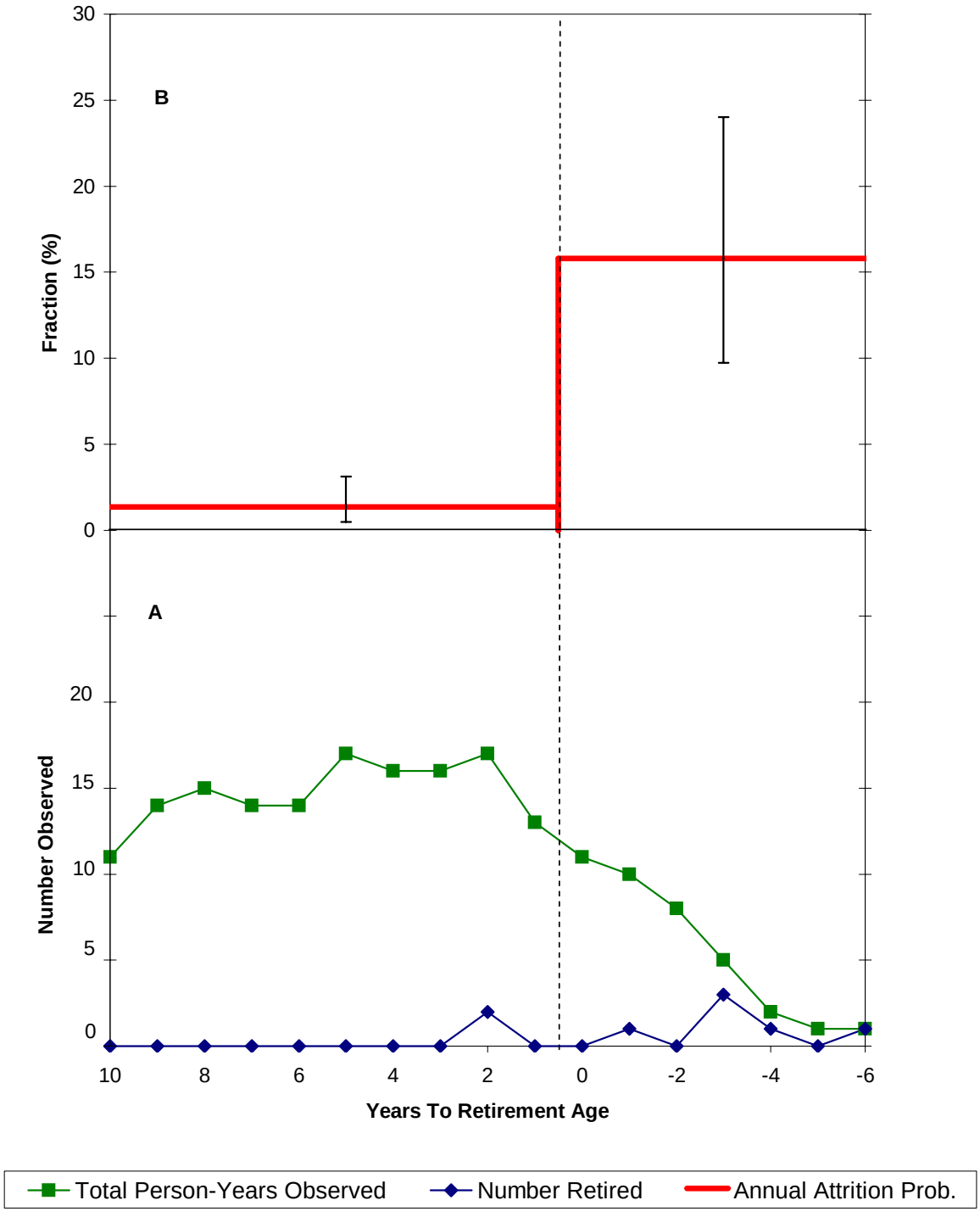


Figure 11: *A) Attrition and total person-years by YTR. B) Annual attrition probability obtained by binning year ranges. Error bars depict standard errors due to finite sample sizes.*

2.2.5 Career Progression Trends

The results of annual reviews could be determined when DS level and pay step were available for two consecutive years. The 1997-2006 dataset contained the results of 564 annual reviews. Table 7 summarizes the number of promotions/pay increments observed at each step of the DS Pay Plan.[9]

Normal Progression

A closer analysis of the multi-year progression for individual DS's revealed that a large majority of careers followed what will be referred to as a *normal* progression scheme, the details of which are outlined in Figure 12 and Table 5. Of the 564 promotions/pay increments observed, 498 (88.3%) followed this scheme. Furthermore, of the 114 distinct DS's, 72 (63.2%) followed *normal* progression for all years observed, as summarized in Table 6.

In the following sections the details of those individuals whose careers didn't follow *normal* progression are discussed. This was considered to be important for developing an accurate career progression model.

Table 5: *Normal career progression.*[†]

DS-2 A A A A B
DS-3 A A A|A A|A B
DS-4 A A|A A|A A|A C||D|D|D|D|E
DS-5 A|A|A|A|A|A|C||D|E
DS-6 A|A|A|A|A|A|E
DS-7 A|A|A|A|E

A: Single step annually.
B: Promotion.
C: Held for one year followed by either promotion or a single step.
D: Single step every other year.
E: No step - held indefinitely.

[†] The table is constructed in such a way that upon promotion, an individual always moves one step down and one step right. For example a promotion from DS-2.5 leaves the individual at DS-3.2.

Table 6: *Summary of career progression trends.*

Number of times observed	Results of Annual Reviews	Distinct individuals
1997-2006 dataset	564 (100%)	114 (100%)
Normal progression	498 (88.3%)	72 (63.2%)
Accelerated progression	40 (7.1%)	29 (25.4%)
Delayed progression	26 (4.6%)	13 (11.4%)

[9]The DS Pay Plan is the set of DS levels and pay steps through which DS's progress during their careers. It is described in more detail in Annex E.

Table 7: *Observed results of annual reviews*

	Number of times result observed						
DS level.step (before review)	No Step	Single Step	Double Step	Promotion	Total Observed	Accel. Step	Delayed Step
DS-2.3	0	2	0	0	2	0	0
.4	0	20	-	1	21	1	0
.5	0	-	-	17	17	0	0
DS-3.1	1	4	0	0	5	0	1
.2	0	26	0	0	26	0	0
.3	0	24	2	0	26	2	0
.4	0	19	3	0	22	3	0
.5	1	15	6	2	24	8	1
.6	0	16	-	3	19	3	0
.7	6	-	-	17	23	0	6
DS-4.1	0	18	1	0	19	1	0
.2	0	17	1	0	18	1	0
.3	0	16	3	0	19	3	0
.4	1	12	2	0	15	3	1
.5	0	11	2	0	13	2	0
.6	0	10	0	5	15	5	0
.7	1	14	0	0	15	0	1
.8	9	7	0	3	19	3	0
.9	5	3	0	0	8	0	0
.10	4	1	0	0	5	0	2
.11	9	3	0	1	13	0	6
.12	4	4	-	0	8	0	0
.13	43	-	-	1	44	1	0
DS-5.1	1	12	0	0	13	0	1
.2	2	12	0	0	14	0	2
.3	0	13	0	0	13	0	0
.4	1	14	0	1	16	1	1
.5	0	11	0	0	11	0	0
.6	0	10	0	0	10	0	0
.7	0	9	0	1	10	1	0
.8	15	8	0	1	24	1	4
.9	7	6	0	0	13	0	0
.10	23	-	0	1	24	1	0
DS-6.1	0	1	0	0	1	0	0
.2	0	2	0	0	2	0	0
.3	0	3	0	0	3	0	0
.4	0	3	0	0	3	0	0
.5	0	2	0	0	2	0	0
.6	0	2	-	0	2	0	0
.7	7	-	-	0	7	0	0
Total Observed	140	350	20	54	564	40	26

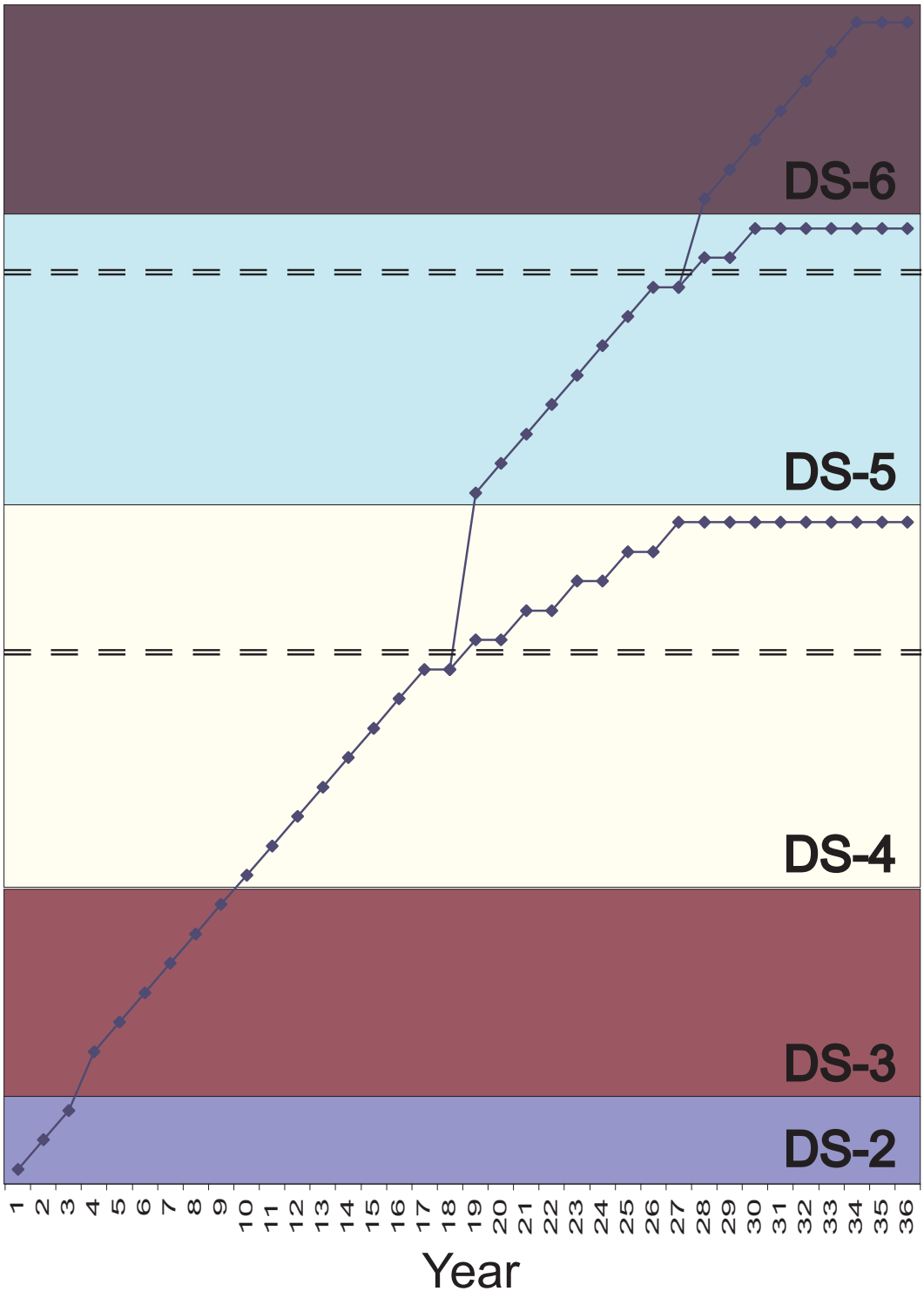


Figure 12: *Normal career progression*

Accelerated Progression

Only 40 cases were observed where progression occurred at a rate faster than *normal* (i.e. a double pay increment or early promotions were granted). These cases were spread over 29 individuals so that most DS's received only one *accelerated* step while only 8 individuals received accelerated steps on more than one occasion within the 9 year observation window (Table 6).

In order to identify the trends associated with an individual changing to *accelerated* progression, the number of times that *accelerated* steps were observed at each step in the DS Pay Plan was tabulated in Table 7. To increase the counting statistics, certain ranges in the Pay Plan were binned as summarized in Table 8. Note that two or more accelerated steps may have been taken by the same individual, so that the probability of being identified as *accelerated* was expected to be less than the fractions in Table 8.

The following trends were identified for *accelerated* career progression:

- *accelerated* steps generally occurred after two years of experience within a level and before the double barriers in DS-4 and DS-5;
- those individuals who received multiple accelerated steps received them within a single level until they were promoted, consistent with an individual being identified as satisfying (or quickly approaching) the criteria for promotion to the next level and being accelerated to that level, whereupon they returned to *normal* progression.

Table 8: *Number of accelerated steps observed.*

Pay Plan Range	total steps observed	number accelerated	fraction accelerated
DS 2.3 - 2.5	39	1	2.6%
DS 3.1 - 3.2	31	0	0.0%
DS 3.3 - 3.6	91	16	17.6%
DS 3.7	23	0	0.0%
DS 4.1 - 4.2	37	2	5.4%
DS 4.3 - 4.8	114	16	14.0%
DS 4.9 - 4.13	78	1	1.3%
DS 5.1 - 5.2	27	0	0.0%
DS 5.3 - 5.8	84	3	3.6%
DS 5.9 - 5.10	37	1	2.7%
DS 6.1 - 6.7	20	0	0.0%
Total	564	40	

Delayed Progression

Of the 564 results of annual reviews observed, there were only 25 where progression occurred slower than *normal* (i.e. a promotion/pay increment was withheld). These delays were spread over 13 individual DS's, 6 of whom were held back more than once. Thus, it was rare for a DS to be held back, but those that were, were likely to be held back more than once.

Table 7 summarizes the number of times *delayed* progression was observed at each step of the DS Pay Plan, and in Table 9 the instances were binned to improve counting statistics. The fraction of individuals delayed at each step was expected to be significantly less than the fractions reported in Table 9 because individuals were often held back more than once.

The following trends were identified for *delayed* career progression:

- delays were most prevalent at the end of DS-3 (note that being held back at the end of DS-4 and DS-5 was assumed to be *normal* progression);
- delays within DS-4 seemed to occur preferentially at step 8 and beyond, while in DS-5 it seemed to be uniformly distributed across the level (i.e. no discernible trend was observed);
- except for the last step of DS-3, delays were not observed within DS-2, DS-3, and DS-6;
- those individuals who were delayed one year, were likely to be delayed the following year.

Table 9: *Number of delayed steps observed.*

Pay Plan Range	total steps observed	number delayed	fraction delayed
DS 2.3 - 2.5	39	0	0.0%
DS 3.1 - 3.6	122	2	1.6%
DS 3.7	23	6	26.1%
DS 4.1 - 4.7	132	2	1.5%
DS 4.8 - 4.12	53	8	15.1%
DS 4.13	44	0	0.0%
DS 5.1 - 5.7	87	4	4.6%
DS 5.8 - 5.9	37	4	10.8%
DS 5.10	24	0	0.0%
DS 6.1 - 6.7	20	0	0.0%
Total	564	26	

3 A Career Progression Model for Defence Scientists

3.1 Overview

A career progression model was developed to simulate the DS community using an stochastic entity-based approach with the ARENA software package (Trellisys, Pointe-Claire QC). An overview of this model and its key assumptions and inputs are presented in the following sections while a detailed explanation of the model is given in Annex B. A user's guide for the ARENA model is published in a separate Technical Note. [1]

The model simulated individual DS's as they gained experience, aged, and received pay increments or promotions according to *normal*, *accelerated* and *delayed* career progression rates. Hiring of new recruits, attrition (both mid-career and retirement), and leave without pay were also included in the model. The flow of DS's through the simulation is conceptually depicted in Figure 13.

In the simulation, the state of each DS's career was governed by a number of attributes. As the simulation ran, some attributes, like age and YOS, were updated in a predictable manner (i.e. were deterministic variables), while others, like DS level, pay step, age at hire, and time of retirement, were random in nature (i.e. were stochastic variables). Updates to the stochastic variables were based on trends determined from the historical dataset as described in Section 2.2 and Annex B. The simulation was initialized with data for CORA's OR DS population as of 1 May 2006, and was run 200 times with model outputs averaged.

A summary of the model's assumptions and inputs are presented in the next section, followed by the results of the model. Results for alternate scenarios are presented in Annex C, which assessed the sensitivity of the model to attrition and hiring rates.

3.2 Key Model Assumptions and Inputs

The simulation began at the start of FY 06/07. An entity was generated to represent each OR DS presently in CORA and was initialized with a DS level, pay increment, age, years of service, years in current DS level, years in current pay increment, and current progression rate, as obtained from the historical dataset. Entities representing new recruits who joined in summer 2006 were initialized using random distributions for age, and pay increment; their YOS, years in current DS level and years in current pay increment were set to zero; their progression rate was set to *normal*; and their DS level was obtained from CORA's HR Assistant.

At the beginning of each subsequent year, entities representing new recruits were added. For the baseline scenario, 10 new recruits were assumed to join CORA annually. Their DS level, pay increment, age were set according to predefined statistical distributions (see Annex B), while their YOS, years in DS level, years in pay increment were set to zero and their progression rate was set to *normal*.

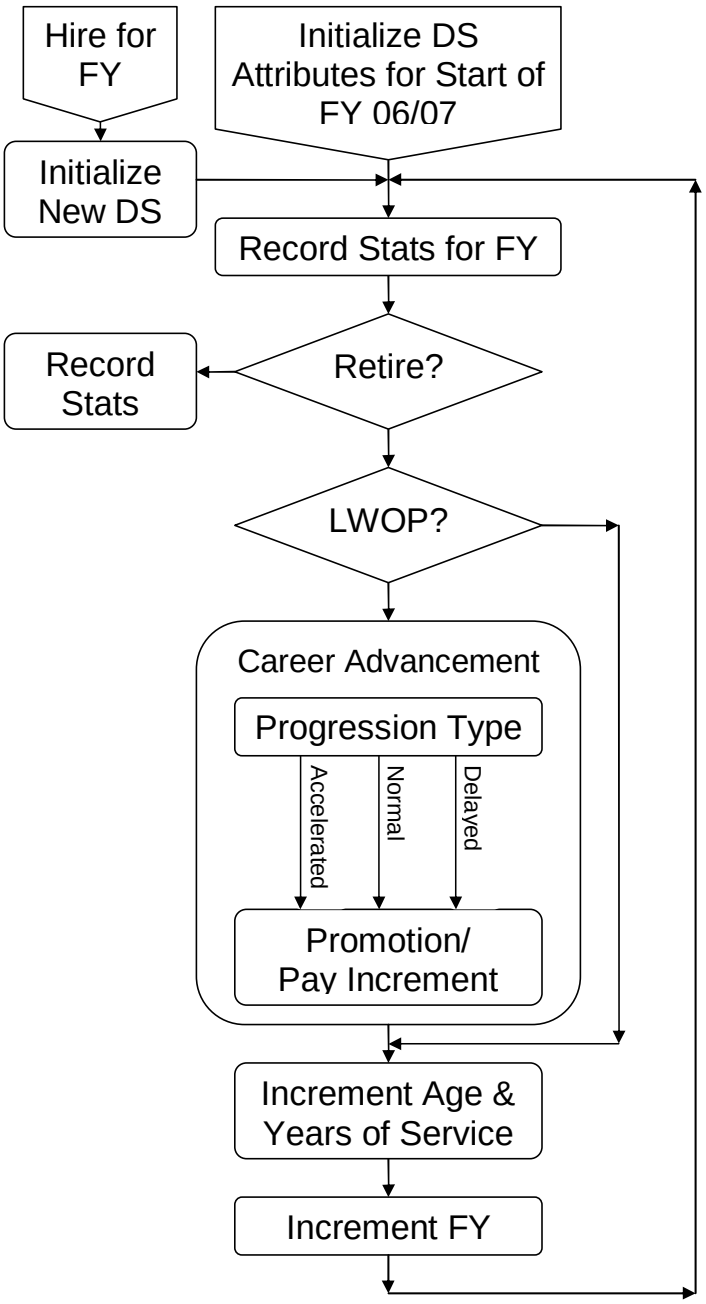


Figure 13: *Career progression model flow chart.*

During each yearly iteration of the simulation, each entity was considered for attrition, LWOP, changes in career progression rate, and career advancement, as described briefly below, and in more detail in Annex B. At the end of each fiscal year a report was generated and output to an Excel spreadsheet, detailing the number of DS's each DS level, the number that retired that year for each DS level, the number on LWOP, the number having less than 10 YOS, the number having more than 10 YOS, and the total salary wage envelope (SWE).

Attrition was determined by a random number draw, with the probability or retirement a function of career stage (as determined by YOS and Age). As derived from the historical analysis in Section 2.2, early and mid-career individuals had a 4.8% and 7.4% annual attrition probabilities, for late career individuals (pre-retirement age) individuals, the probability was 1.35%, while for those who had passed retirement age the annual probability rose to 15.8%. DS's who reached 10 years past retirement age were automatically retired.

Individuals going on LWOP were determined randomly with the annual probability being 2% for early and mid-career individuals (those with more than 5 years to retirement, and less than 20 YOS), and 0% for more senior individuals. Those on LWOP did not undergo career advancement, their years in DS level and years in pay increment were not incremented, nor were they included in annual SWE calculations. They did age and gain YOS while on LWOP. Each year while on LWOP, they had a 50% chance of returning from leave.

Each individual went through the career advancement submodel, with the chance of receiving a pay increment or promotion determined by their current DS level and increment and progression rate.

Those following *normal* progression typically received a single pay increment until they reached a double barrier or the end of a DS level. At the end of DS-2 and DS-3, individuals were automatically promoted, while at the DS-4 and DS-5 double barrier, promotion occurred with 25% and 10% probability respectively. Those not being promoted at the double barrier received a pay increment every other year above the double barrier, until the end of the DS level, where they were held indefinitely.

Each year, an individual could be marked for *accelerated* progression with a small probability that depended on their DS level, their position within the DS level, and the number of years spent in the level (as detailed in Annex B). Upon being identified as *accelerated*, they received a double pay increment (or promotion if they were close enough to the double barrier), and had an increased chance of receiving another pay increment (or early promotion) for the remainder of that DS level. Individuals identified as *accelerated* were automatically promoted at double barriers. Once they reached the next DS level, they were reset to *normal* progression.

Individuals progressing at the *normal* rate had a small probability (which depended on their DS level and pay increment) of being identified as *delayed*, whereupon a normal pay increment/promotion was withheld. Individuals identified as *delayed* in one year, had a 50% chance of being *delayed* the following year. Once returned to *normal* progression, there was no memory of having been *delayed*.

3.3 Simulation Results

The following results of the simulation are for a baseline set of parameters based closely on the historical data analysis of Section 2.2. These parameters reflect conservative estimates of attrition and promotion rates as well as annual hiring representing modest growth of the organization.

Size of the DS Population

The simulation was run out to the year 2025 and averaged over 200 replications using the baseline parameters as described in Annex B, and assuming 10 new recruits hired annually.

Figure 14 shows an increase in number of DS-4's shortly after the start of the simulation, reflecting promotion from DS-3 of those hired in the 2001-2003 period. The DS-4 population size continued to increase as those hired between 2003 and 2006 were promoted from DS-3. However, the size of the DS-5 population remained constant for approximately 10 years after the start of the simulation before it too started to increase, reflecting the time required for new recruits to progress to DS-5.

It was seen as important that such time lags be taken into account when planning for future growth and replacement of personnel lost due to attrition. To this end, an analysis was performed on the expected career paths of new recruits, with results detailed later in this section.

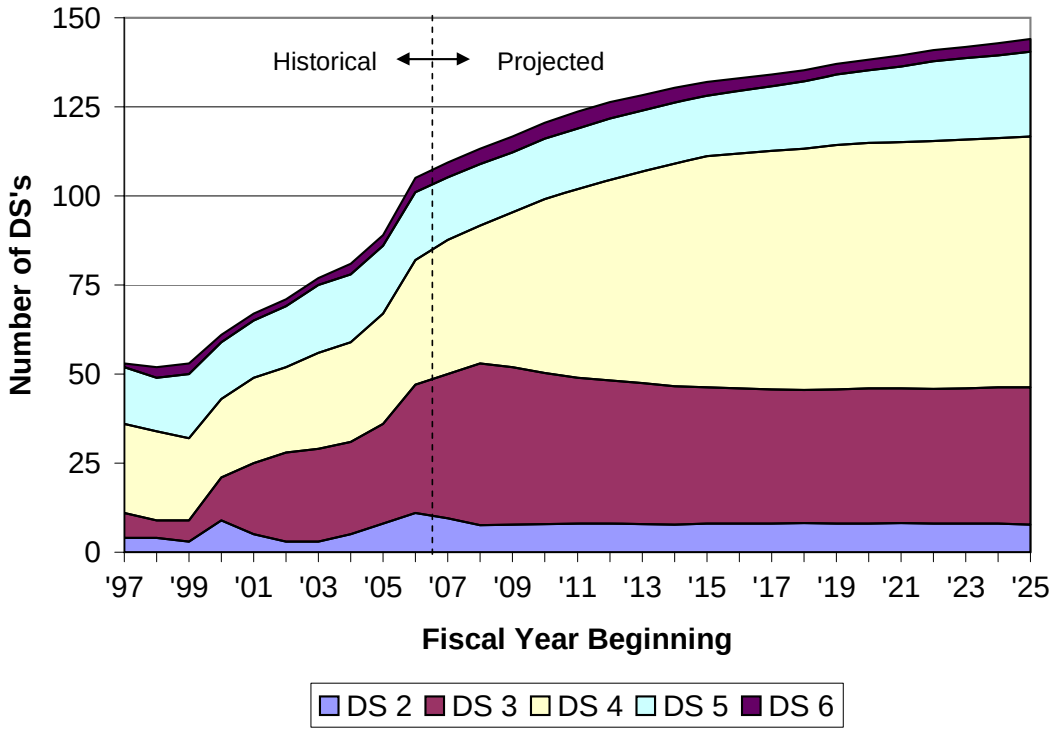


Figure 14: *Forecast of DS population size and DS level.*

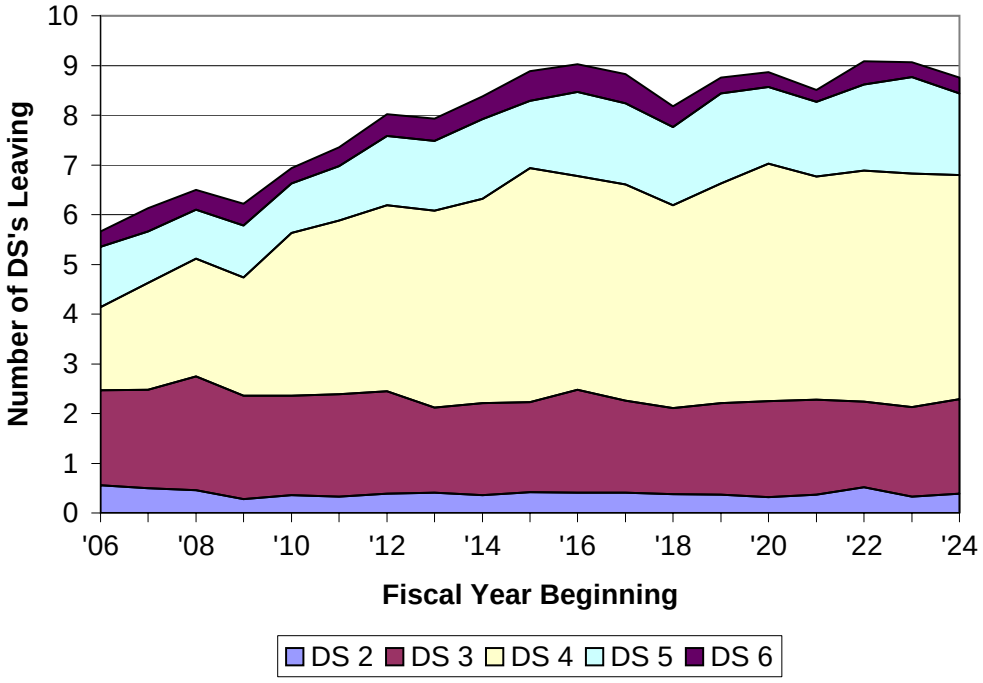


Figure 15: *Forecasted yearly attrition.*

Attrition and Growth

As seen in Figure 14, the fist 5 years of the simulation saw the total DS population grow by 4-5 DS's annually, slowing to around 1 DS's per year in the last 5 years of the simulation. Thus growth was significantly less than the 10 annual hires, the difference being accounted for by attrition. As the size of the organization increased the number of DS's leaving annually also increased.

The average number of DS's that left CORA each year, as is shown in Figure 15, increased from around 6 annually in 2007 up to 9 by 2020. It should be noted that though there was significant year-to-year variation in the number leaving, the average over several years was expected to be less variable (i.e. variability in year-to-year attrition rates were correlated). That is to say that although the exact year a DS chose to retire after reaching retirement age was highly variable from one simulation replication to the next, it was certain that they would retire within several years of reaching retirement age. By extension, a similar argument can be made regarding the expected attrition rates for the coming years. Though it is impossible to predict that 5-6 DS's will leave CORA next year, it is more accurate to estimate that 20-24 will leave in the next 4 years.

An average annual attrition rate (i.e. the fraction of the organization leaving annually) was calculated by dividing the annual number leaving by the annual number of DS's.[10] The

[10]It should be noted, that number leaving annually has a complicated dependence on the demographics of the population (i.e. how many are close to retirement age, etc.), and care must be exercised when using an average annual attrition rate. However, for strategic HR planning an average annual attrition rate may be useful.

result was an average annual attrition rate of 6.0% (i.e. 6.0% of the organization leaves annually). This number remained relatively constant from year to year. This result suggests that CORA should hire on average 5-6 new OR DS's annually to maintain its 2006 size. Any hires in excess of this represents growth, while fewer hires represents deflation of the organization.

The calculated average annual attrition rate was sensitive to the parameters governing the attrition model, namely the attrition probability as a function of YOS and YTR (Annex B.3). A sensitivity analysis showed that the average annual attrition rate varied by 0.55% for every 10% change in attrition probability. Thus, as long as the error in the estimate for the attrition probability was less than 25%, the average annual attrition rate was expected to be in the range 4.6-7.4%, which translates to an average of 5-7 new hires per year required to maintain CORA's current size.

Salary Wage Envelope

The SWE for OR DS's was calculated during the simulation and is shown in Figure 16 in 2006 dollars using 2006 wages (as summarized in Table E.2).

Over the course of the simulation, SWE increased at a faster pace than did the size of the DS population (38% increase in total number of OR DS's from 2006 to 2025 versus a 44% increase in SWE). In general, the increase in SWE compared to size of DS population has a complicated dependence on the attrition, hiring and career progression trends. Annual pay increments drive up the SWE in the absence of attrition, while attrition of senior DS's with replacement by junior DS's drives down the SWE. In a steady state, these two effects cancel out and the SWE growth follows DS population growth exactly. The fact that it doesn't means that CORA's DS population is far from the steady state.

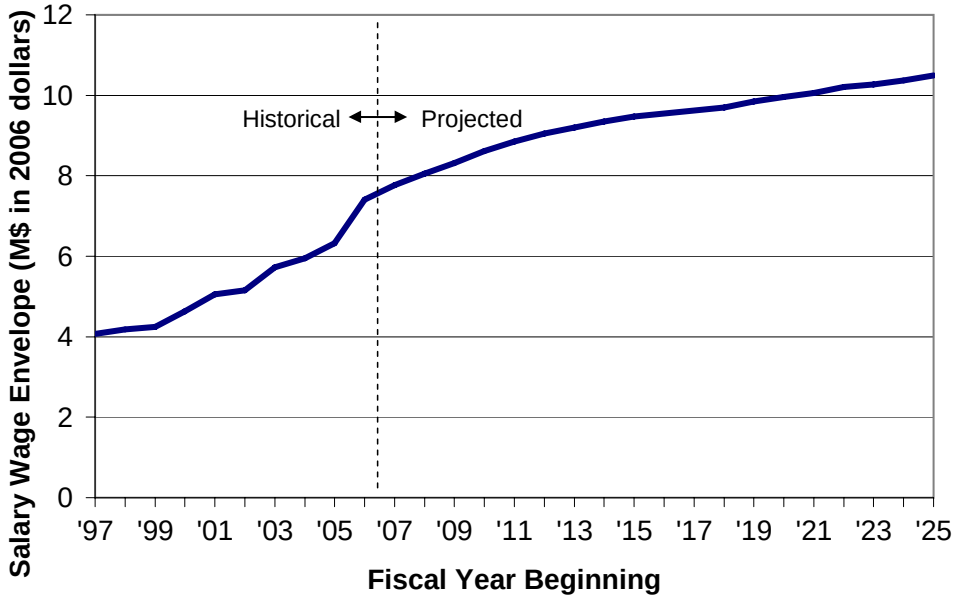


Figure 16: *Forecast of salary wage envelope for OR DS's.*

Expected Career Path of New Hires

To quantify the lag between a new recruit joining the organization and having them working as an experienced scientist at DS-4 or higher, the simulation was run with a single cohort of new recruits, all hired simultaneously. Figures 17, 18, and 19 show the expected career path of new recruits hired into DS-2, DS-3 and DS-4 respectively with age and pay increment taken from the statistical distribution assumed for the model (Annex B.2).

The results show that an average new recruit hired into DS-2 required on average 8 years to reach DS-4 and 16 years before being eligible for DS-5 (Figure 17). Those hired into DS-3 took on average 4 years to reach DS-4 and over 12 years to reach DS-5 (Figure 18). New recruits hired into DS-4 still took more than 6 years to begin reaching DS-5 (Figure 19). The fraction of DS-4 new recruits that were eventually promoted to DS-5 was less than for those hired into DS-2 and DS-3 because the model assumed that some DS-4's were hired at or above the double barrier, and therefore had a smaller chance of promotion (see Annex B.1). Of the 7 DS-4's that were hired in 2001/2002, none of them had reached DS-5 as of 2006. Thus, it remains to be seen whether hiring DS-4's results in an increase in the number of DS-5's.

The results from the DS-2, DS-3 and DS-4 cohorts were combined to obtain the expected career progression of a typical cohort of new recruits composed of 40% DS-2's, 50% DS-3's and 10% DS-4's. Figure 20 shows that 4-5 years were required for the majority of new hires to reach DS-4, and over 14 years were required before a significant number reached DS-5.

Figure 20 also shows that, of all new recruits, 50% could be expected to leave within 12 years of being hired, while just over a quarter were expected to stay with the organization as OR DS's until retirement. New recruits hired into DS-4 were expected to have the shortest careers due to their advanced age at hiring, while DS-2 hires were expected to have the longest.

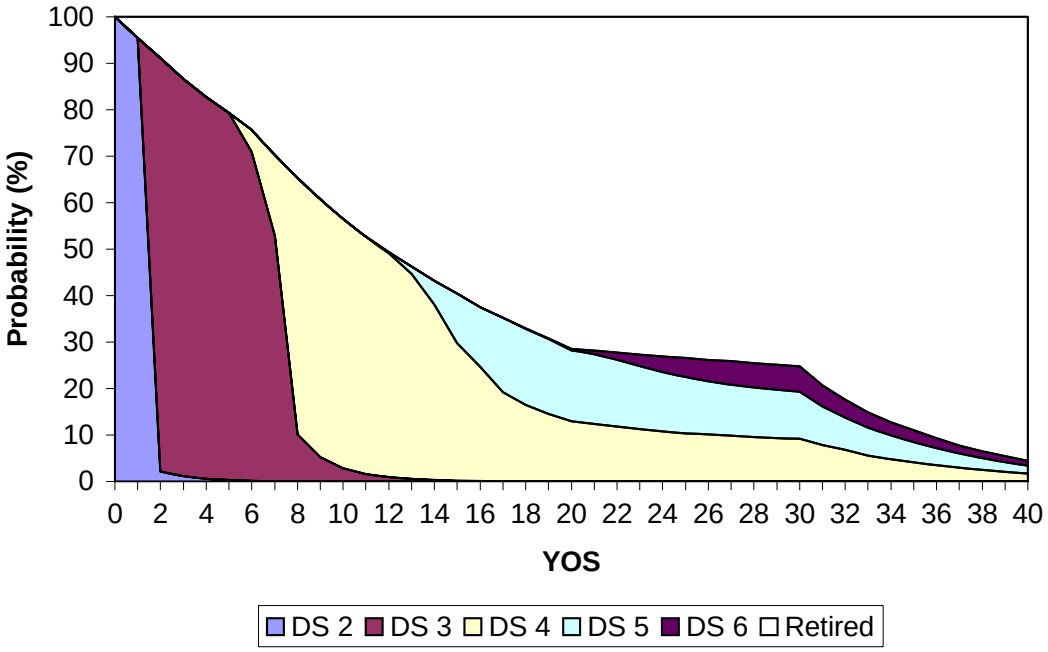


Figure 17: *Expected DS level of a cohort of new recruits hired at DS-2.*

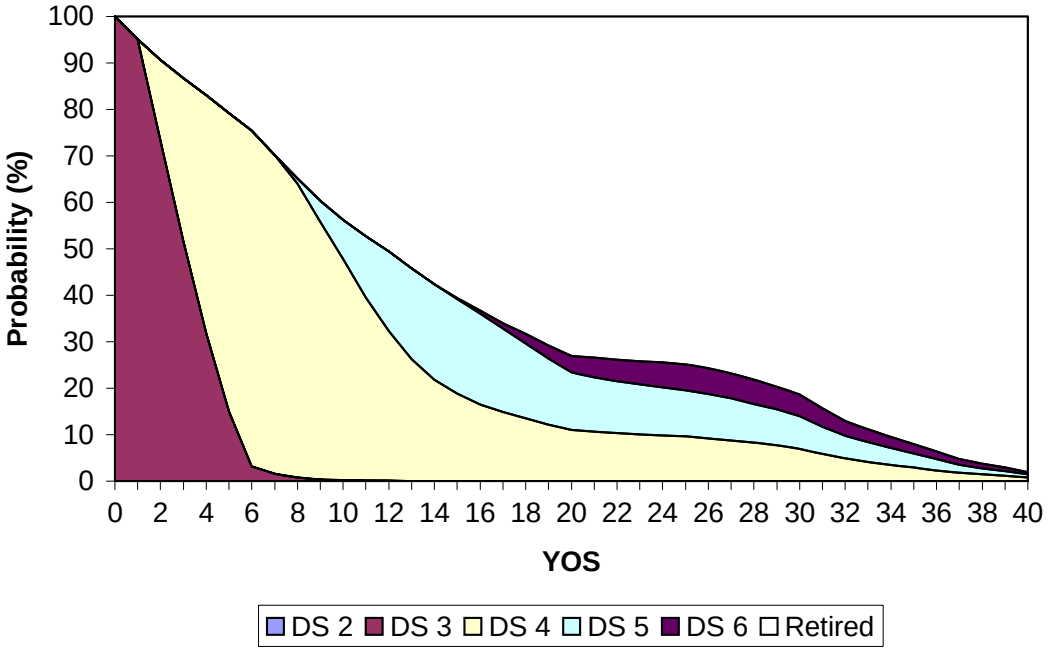


Figure 18: *Expected DS level of a cohort of new recruits hired at DS-3.*

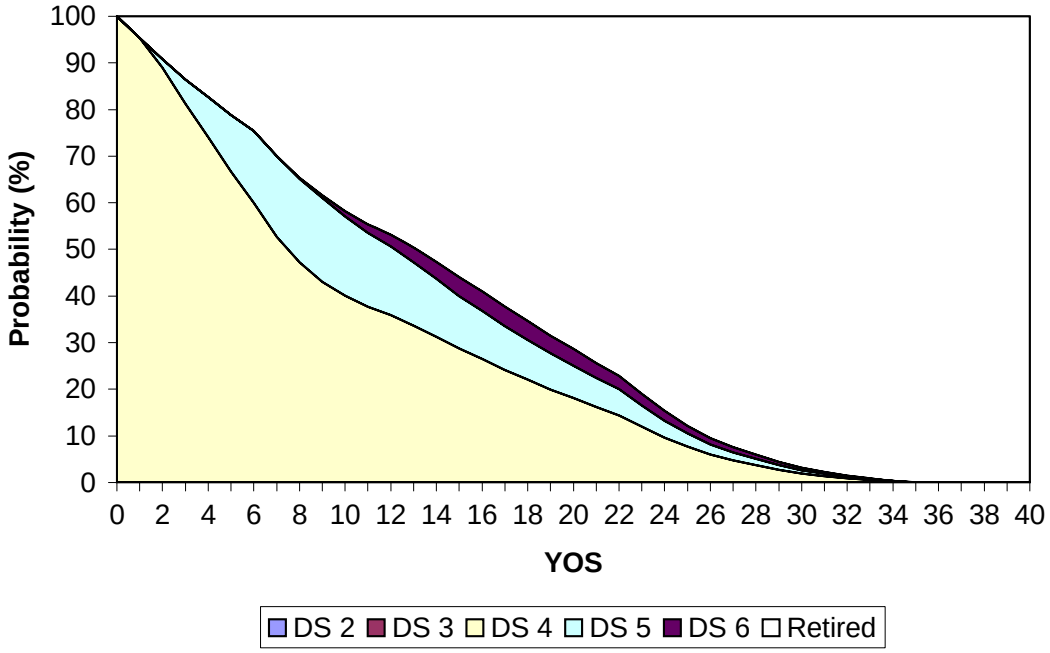


Figure 19: *Expected DS level of a cohort of new recruits hired at DS-4.*

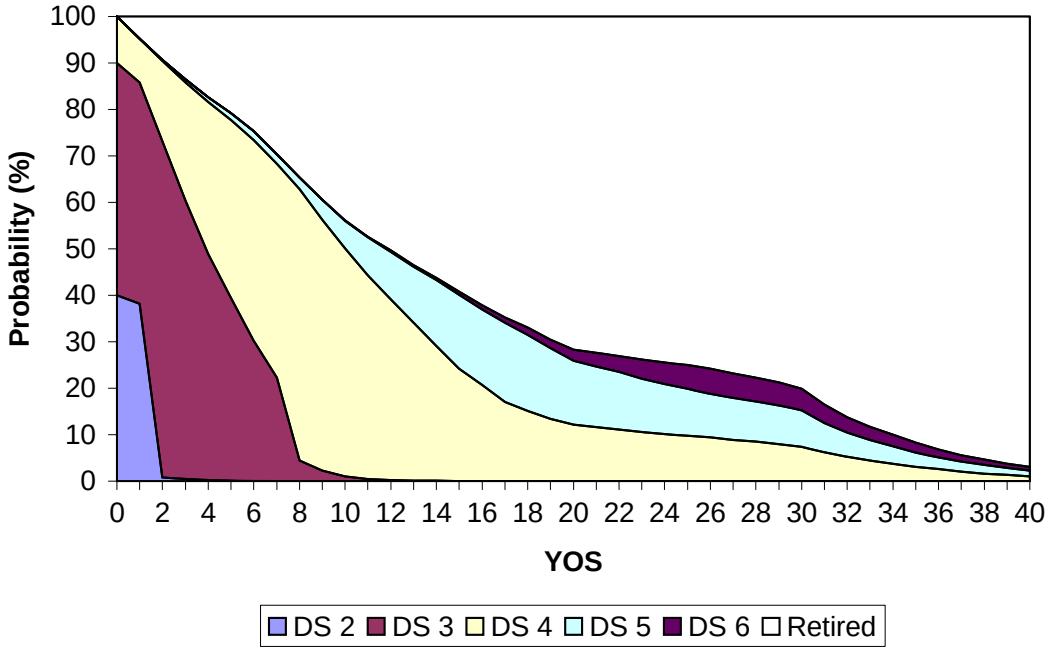


Figure 20: *Expected DS level of a typical cohort of new recruits.*

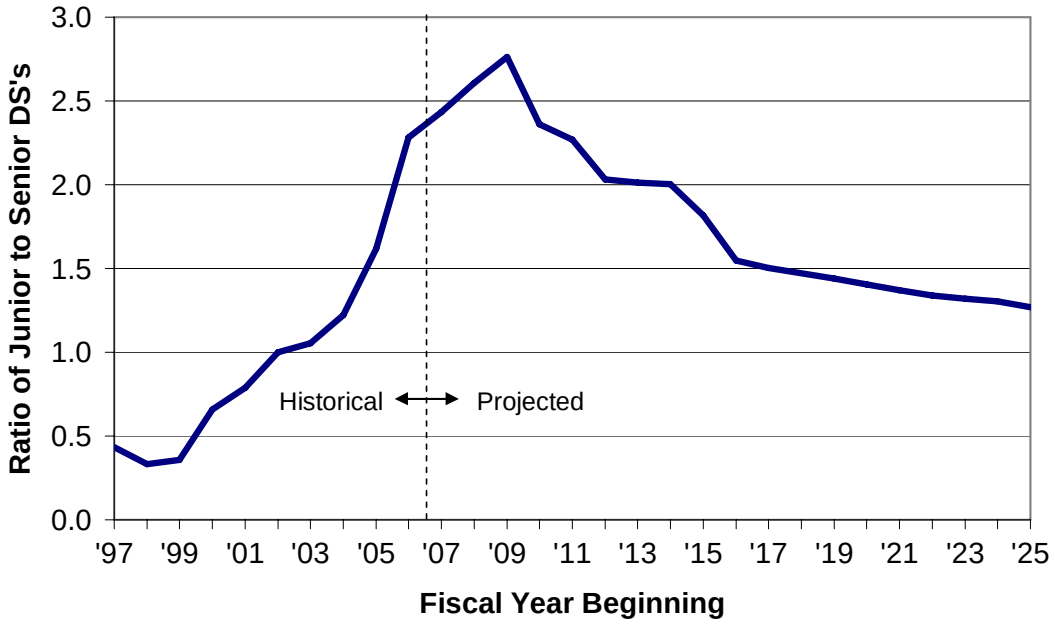


Figure 21: *Ratio of junior (<10 YOS) to senior (≥10 YOS) DS's.*

Ratio of Senior to Junior Scientists

Knowledge transfer from senior to junior scientists through mentoring, supervision and guidance is an important aspect of succession planning. This is especially true for knowledge workers such as DS's and even more so considering the *ad hoc* nature of the work performed by CORA's DS's, where certain software programs and methodologies, may be developed, administered and maintained by a single individual. Reports detailing these intellectual products cannot entirely replace the hands-on guidance of a subject matter expert. With the large number of new recruits, and the imminent retirement of senior scientists (as detailed previously), DRDC CORA faces a potential gap in the knowledge transfer chain.

An important indicator for knowledge transfer and management is the ratio of the number of junior to senior DS's. For this purpose, a junior DS's was defined as someone with less than 10 YOS while senior DS's had at least 10 YOS.

Figure 21 depicts the historic and projected ratio of junior to senior DS's. Over the past decade, the ratio increased from a favourable two senior DS's per junior, to just over two junior to one senior DS in 2006. Based on the baseline scenario, the ratio was expected to continue to increase to a maximum of close to 3 juniors to 1 senior DS by 2009 before starting to decline. The exact value that the ratio takes on at the maximum, and when that maximum occurred depends on the hiring and attrition in the coming years. However, the upward trend is expected to continue regardless of the input parameters. Thus, establishing meaningful channels for knowledge transfer between incoming recruits and those close to retirement will be critical in the coming years.

A Comment on Errors and Sensitivity to Model Parameters

To simplify the presentation of the simulation results, errors due to the stochastic nature of the model were not shown in Figures 14, 15, 16 and 21. Comments on the size and nature of these errors are made in this section.

The standard deviation of the predicted size of the total DS population (Figure 14) were 2.2% in the first year of the simulation, increasing to 5.2% by the final year. However, the average standard deviation in size of the DS-2, DS-3, DS-4, DS-5 and DS-6 populations were roughly 28%, 11%, 9%, 20%, and 45% respectively. The reason that the fluctuations in the population in each DS level were significantly higher than for the entire population was due to a correlation between fluctuations in the size of adjacent DS levels. That is, in one replication, a DS may have received a promotion, while in another the same DS may not have. Thus, the fluctuation in relative populations of two adjacent DS levels does not translate into a fluctuation in the total DS population. Though this correlation between the errors in the number of individuals at each DS level population is difficult to visualize and quantify, it should be recognized.

Though the model parameters were based on the available historical data, they may not be indicative of future trends (for a variety of reasons including changes in promotion policy, etc). Therefore, there was potentially a systematic source of error in the relative populations of the DS levels introduced by choice of parameters used in the model (i.e. probabilities of promotion at double barriers, accelerated steps, etc). Similarly, the size of the forecasted DS population was highly dependent on attrition rates used. Once again, these numbers were based on historical data but may not be indicative of future trends. Annex C explores alternate scenarios with variations in hiring and attrition rates, and gives an intuitive measure of the sensitivity of the data to these parameters. The sensitivity to annual attrition probabilities was also discussed previously.

4 Discussion and Recommendations

4.1 DRDC CORA's OR DS Population in 2006

As has been described in some detail in Section 2.2, a period of zero growth for 5 years in the mid 90's followed by a 6 year period of steady hiring of mostly young DS's has left CORA's core OR DS population in an almost bimodal distribution where 52% of the DS's have less than 5 years experience in CORA; a total 70% of the DS's have less than 10 years of experience; and, at the other end of the distribution, a full 17% of the DS population will be eligible for retirement within the next 5 years. Further analysis of the past ten years of the CORA OR DS population reveals that during the period of hiring and growth in CORA beginning in 2000 and continuing to the current time CORA has, on average, hired 10.9 new scientists annually. The majority of these new hires have been at the DS 2 and 3 pay levels. As well, in terms of attrition rates, which is the number of OR DS's that left the organization, whether through retirement, to another job, or accepting a position in DRDC management, an average of 3.5 individuals left the OR scientist population annually in the past ten years. This initial analysis provides a good understanding of CORA's current demographic profile and an equally solid starting point for projecting CORA's future demographic profile.

4.2 Projecting DRDC CORA's OR DS Population to 2025

The DS Career Progression Model takes the current CORA OR DS population and projects it out over the next twenty years. Based upon a set of baseline assumptions and inputs it concludes that:

- the disproportionality between junior and senior scientists will continue to grow in the next 3-5 years, peaking at close to 3 : 1 in 2009 before it begins to decline and approach a more balanced ratio of 1 : 1 by 2025;
- despite growth of the total DS population, the size of the DS-5 and DS-6 populations won't increase significantly for another decade;
- that 17% of CORA's DS's will be eligible for retirement in the next 5 years;
- the annual rate of attrition of CORA's OR scientists will be 6.0%($\pm$1.4%);
- an annual hiring rate of 5-7 new recruits would allow CORA to maintain its current size, with hiring in excess of this representing growth, while fewer hires resulting in a gradual decline in CORA's DS population.
- with a steady hiring rate of 10 DS per year the overall size of CORA would grow from its present day size of 105 OR DS's to a total of 145 OR DS's in 2025; and
- growth of this amount will result in a increase in CORA's annual SWE budget from its current level of $7.4 million to approximately $10.5 million in 2006 dollars.

A sensitivity analysis with respect to hiring and attrition rates (Annex C), showed, not surprisingly, that growth of the organization is closely tied to hiring and attrition rates. The sensitivity analysis revealed that halving the attrition rate allows for more rapid growth of the organization not unlike the impact of increasing the hiring rate by 50%. Similarly, increasing attrition rates has a similar impact on total DS population as decreasing hiring rates. However, the changes have different impacts on the relative populations of at each DS level. Since management has some influence over both of these levers (it can raise or lower hiring rates, or create conditions and inducements that may positively or negatively influence attrition rates) it is useful to understand the effects of changing each. While it is easier for management to control the hiring rates to maintain or attain a desired level of stability or growth, the model does show that favourable changes in attrition rates, while harder to achieve in practice, do result in a better balance of junior and senior scientists over time.

4.3 Limitations of This Study

One limitation of this study is that only the CORA OR DS population was studied. It is true that CORA has grown in size over the past 10 years and it has also grown in terms of expertise. The CORA DS population that was studied was the large group of OR DS's that form close to 80% of CORA's scientific and analytical expertise. The other DS's in CORA including social scientists, strategic analysts, and intelligence analysts each are a smaller pool of researchers; and each have very different hiring, retention, posting, and attrition characteristics from that of the larger OR DS pool. For these reasons they were excluded from both the historical analysis and the modeling portions of this study. They each merit a closer look but given the above noted differences, it is not reasonable to apply the results from this study to their particular circumstances.[11]

A second limitation is that this study in no way looked at the impact of frequency of posting or posting location has on DS career progression. Similarly, it didn't study the relationship that productivity, in terms of number and rate of publications generated, may have on career progression. While neither of these factors were part of the original problem that this study set out to investigate, they are important components of a normal DS career and their relationship to career progression both in terms of rate of progression and retention may merit further investigation.

[11] See Annex D for a preliminary analysis of historical trends for these subpopulations.

5 Conclusion

DRDC CORA has experienced considerable growth over the past 6 years. Historical analysis of the largest sub-group of CORA DS's, the OR DS's, reveals that this growth has resulted in an increasing ratio of junior DS's to senior DS's. A DS Career Progression Model has been developed that allows for the impact of various hiring and attrition scenarios on the size and cost of the CORA OR DS population to be studied. The results of this study provide for a better understanding of the impact that various managerial decisions will have on the short and longer term size and health of the CORA OR DS population.

References

1. Eles, P.T. (2006). A User's Guide to the Defence Scientists Career Progression Model. (Technical Note DRDC CORA TN 2006–06). DRDC - Centre for Operational Research and Analysis. Ottawa, Canada.

Annex A
CORA OR Scientist Career Progression Dataset - 1997 to 2006

Table A.1 summarizes the relevant fields returned by the HRMS query. A second dataset was obtained for CORA's DS population as of November 2005 from LCol R.M. Foster, CORA's current senior military officer and on behalf of CORA's management team, the lead sponsor of this study, (herein referred to as the Foster dataset). This dataset was cross-referenced with the 2005 data from the HRMS dataset.

The HRMS query returned information on DS's at all DRDC centres and information for CORA DS's was extracted using the DRDC centre affiliation field. All social scientists, strategic analysts, DSI scientists and managers were removed by cross-referencing with the Foster dataset and the online departmental phone directory, and by consultation with several senior DS's. The resulting dataset contained 698 person-years of data from 114 distinct individuals, with enough information to reconstruct the results of 564 annual reviews.

Table A.1: *Summary of relevant fields included in the HRMS dataset*

Field	Description	Cross-referenced with
As Of	Date of entry. 30 November for 1997 to 2005 inclusively.	
Department Description	The DRDC centre with whom the DS is employed	Foster dataset, senior DS's
Surname	Employee's surname	
First Name	Employee's given name	
Classification	DS level	Foster dataset, PER, expectation of reasonable progression, Comp Rate field
Compensation Rate	Not including terminable or bilingual bonus	
Step	Step along the Pay Plan	Foster dataset, PER, expectation of reasonable progression, Comp Rate field
YOS as DS	Years of Service as a DS.	
Pens YOS	Pensionable YOS including all time as public servant	Foster dataset, PERs
On LWOP	Flag for those on leave without pay.	PERs, Step and Classification field
Birth year	Employee's birth year	
Position Number	Number associated with the team in which the DS worked.	Foster dataset, phone list, position numbers held by others

A.1 Data Cleansing

Cross-referencing of the HRMS data set with the Foster dataset revealed a 25% error rate in DS level and pay step for the year 2005 of the HRMS dataset. This included those for whom HRMS reported a pay step of "0". Data points conflicting with the Foster dataset were corrected, invariably making individual career progression look less erratic (i.e. following a more *normal* stepping through the Pay Plan).

Other potential errors were identified by examining the annual progression for each DS. Instances where an individual was denied a pay increment one or more years but received two or more increments the following year to put them back in step with *normal* progression were labeled as suspect. These data points were corrected under the assumption that they were an error in the dataset, though it is possible that these errors represented "virtual" increments given during a salary freeze period. Corrections to the data points in this event would still be warranted. Other pay steps that appeared suspect were corrected by cross-referencing the salary field with the expected DS level and pay step for the given year.

The LWOP data field was highly suspect, showing individuals on LWOP for longer than was known to be the case while still receiving annual pay increments and/or promotions. Under consultation with senior DS's, and by examining pay step field during the supposed leave, these fields were corrected as best as possible. Two individuals who left the organization and returned one and three years later at a different pay level, were reclassified as having been on LWOP, rather than as having left and been re-hired. This was done so as not to skew attrition and hiring rates. The DS level and pay increment for these individuals was left blank in the final dataset.

A small subset of entries that were thought to contain errors were corrected by cross-referencing with annual PERs. The authors thank Suzan Ballantyne, CORA HR Assistant at the time, for her assistance in performing this function on behalf of this study.

Most position numbers could be associated with a team by cross-referencing with the Foster dataset. However, it was known that this association changed over time as new posting positions and teams were created. Thus, the cross-referencing may not have provided accurate information regarding where DS's were posted in previous years. In some cases, two individuals shared a position number though it was known that they were not in the same team. Though the position number data field was not used in the present work, care should be taken in using it in future studies.

The accuracy of the CORA OR Scientists Career Progression Dataset was expected to be close to 95%. A partial copy of the cleansed dataset is shown in Tables A.1 – A.11. Names, position numbers and compensation rates have been removed to eliminate the need to unnecessarily restrict this document, allowing for maximum distribution throughout CORA. The complete dataset can be obtained from the authors upon request.

Figure A.1: *DRDC CORA OR Scientist Career Progression Dataset*

As Of	DS Level	Step	Pens YOS	On Lwop	Birth Yr
30-Nov-2000	3	2	0.06		1973
30-Nov-2001	3	3	1.06		1973
30-Nov-2002	3	4	2.06		1973
30-Nov-2003	3	5	3.06		1973
30-Nov-2004	3	7	4.06		1973
30-Nov-2005	4	1	5.06		1973
1-May-2006	4	2	5.49		1973
30-Nov-2001	3	5	0.41		1967
30-Nov-2002	3	6	1.41		1967
30-Nov-2003	3	7	2.41		1967
30-Nov-2004	4	1	3.41		1967
30-Nov-2005	4	2	4.41		1967
1-May-2006	4	3	4.83	LWOP	1967
30-Nov-2002	4	12	0.55		1955
30-Nov-2003	4	13	1.55		1955
30-Nov-2004	4	13	2.55		1955
30-Nov-2005	4	13	3.55		1955
1-May-2006	4	13	3.97		1955
30-Nov-2005	2	4	0.24		1980
1-May-2006	2	5	0.67		1980
30-Nov-1997	5	2	16.88		1958
30-Nov-1998	5	3	17.88		1958
30-Nov-1999	5	4	18.88		1958
30-Nov-2000	5	5	19.88		1958
30-Nov-2001	5	6	20.88		1958
30-Nov-2002	5	7	21.88		1958
30-Nov-2003	5	8	22.88		1958
30-Nov-2004	5	9	23.88		1958
30-Nov-2005	5	9	24.88		1958
1-May-2006	5	10	25.30		1958
30-Nov-2000	3	2	0.40		1967
30-Nov-2001	3	3	1.40		1967
30-Nov-2000	2	4	0.17		1974
30-Nov-2001	3	1	1.17		1974
30-Nov-2002	3	2	2.17		1974
30-Nov-2003	3	3	3.17		1974
30-Nov-2004	3	4	4.17		1974
30-Nov-2005	3	5	5.17		1974
1-May-2006	3	7	5.59		1974
30-Nov-2001	3	6	0.30		1969
30-Nov-2002	3	7	1.30		1969
30-Nov-2003	4	1	2.30		1969
30-Nov-2004	4	2	3.30		1969
30-Nov-2005	4	3	4.30		1969
1-May-2006	4	5	4.73		1969
30-Nov-2001	3	5	0.12		1971
30-Nov-2002	3	6	1.12		1971
30-Nov-2003	3	7	2.12		1971
30-Nov-2004	3	7	3.12		1971
30-Nov-2005	4	1	4.12		1971
1-May-2006	4	2	4.55		1971
30-Nov-1997	3	3	5.24		1969
30-Nov-1998	3	4	6.24		1969
30-Nov-1999	3	5	7.24		1969
30-Nov-2000			8.24	LWOP	1969
30-Nov-2001	4	7	9.24		1969
30-Nov-2002	4	7	10.24		1969
30-Nov-2000	2	5	0.47		1974
30-Nov-2001	3	2	1.47		1974
30-Nov-2002	3	3	2.47		1974
30-Nov-2003	3	4	3.47		1974
30-Nov-2004	3	5	4.47		1974
30-Nov-2005	3	7	5.47		1974

Figure A.2: *DRDC CORA OR Scientist Career Progression Dataset (Cont'd)*

1-May-2006	4	1	5.89		1974
30-Nov-1997	5	8	30.48		1946
30-Nov-1998	5	8	31.48		1946
30-Nov-1999	5	8	32.48		1946
30-Nov-2000	5	8	33.48		1946
30-Nov-1999	2	4	0.32		1975
30-Nov-2000	2	5	1.32		1975
30-Nov-2001	3	2	2.32		1975
30-Nov-2002	3	3	3.32		1975
30-Nov-2003	3	4	4.32		1975
30-Nov-2004	3	5	5.32		1975
30-Nov-2005	3	6	6.32		1975
1-May-2006	3	7	6.74		1975
30-Nov-2002	3	2	0.31		1972
30-Nov-2003	3	3	1.31	LWOP	1972
30-Nov-2004	3	4	2.31		1972
30-Nov-2005	3	6	3.31		1972
1-May-2006	4	1	3.74		1972
30-Nov-1997	4	5	15.42		1958
30-Nov-1998	4	6	16.42		1958
30-Nov-1999	4	7	17.42		1958
30-Nov-2000	4	8	18.42		1958
30-Nov-2001	4	8	19.42		1958
30-Nov-2002	5	1	20.42		1958
30-Nov-2003	5	2	21.42		1958
30-Nov-2004	5	3	22.42		1958
30-Nov-2005	5	4	23.42		1958
1-May-2006	5	4	23.85		1958
30-Nov-1997	4	11	23.19		1951
30-Nov-1998	4	11	24.19		1951
30-Nov-1999	5	4	25.19		1951
30-Nov-2000	5	5	26.19		1951
30-Nov-2001	5	6	27.19		1951
30-Nov-2002	5	7	28.19		1951
30-Nov-2003	5	8	29.19		1951
30-Nov-2004	5	8	30.19		1951
30-Nov-2005	5	8	31.19		1951
1-May-2006	5	8	31.61		1951
30-Nov-2002	2	4	0.43		1975
30-Nov-2003	2	5	1.43		1975
30-Nov-2004	3	2	2.43		1975
30-Nov-2005	3	3	3.43		1975
1-May-2006	3	4	3.85		1975
30-Nov-2004	3	1	0.49		1973
30-Nov-2005	3	2	1.49		1973
1-May-2006	3	3	1.92		1973
30-Nov-2005	3	2	0.16		1975
1-May-2006	3	3	0.75		1975
30-Nov-2000	3	3	0.52		1968
30-Nov-2001	3	4	1.52		1968
30-Nov-2002	3	5	2.52		1968
30-Nov-2003	3	6	3.52		1968
30-Nov-2004	3	7	4.52		1968
30-Nov-2005	3	7	5.52		1968
1-May-2006	4	1	5.94		1968
30-Nov-2005	3	1	0.42		1978
1-May-2006	3	1	0.84		1978
30-Nov-1997	4	13	29.26		1941
30-Nov-1998	4	13	30.26		1941
30-Nov-1999	4	13	31.26		1941
30-Nov-2000	4	13	32.26		1941
30-Nov-2001	4	13	33.26		1941
30-Nov-1997	4	2	15.65		1956
30-Nov-1998	4	3	16.65		1956

Figure A.3: *DRDC CORA OR Scientist Career Progression Dataset (Cont'd)*

30-Nov-1999	4	4	17.65		1956
30-Nov-2000	4	4	18.65		1956
30-Nov-2003	5	3	20.24		1953
30-Nov-2004	5	4	21.24		1953
30-Nov-2005	5	5	22.24		1953
1-May-2006	5	6	2.66		1953
30-Nov-1997	4	7	19.09		1957
30-Nov-1998	4	8	20.09		1957
30-Nov-1999	5	1	21.09		1957
30-Nov-2000	5	2	22.09		1957
30-Nov-2001	5	3	23.09		1957
30-Nov-2002	5	4	24.09		1957
30-Nov-2003	5	5	25.09		1957
30-Nov-2004	5	6	26.09		1957
30-Nov-2005	5	7	27.09		1957
1-May-2006	5	8	27.52		1957
30-Nov-2000	3	6	0.71		1958
30-Nov-2001	3	7	1.71		1958
30-Nov-2002	4	1	2.71		1958
30-Nov-2003	4	2	3.71		1958
30-Nov-2004	4	3	4.71		1958
30-Nov-2005	4	4	5.71		1958
1-May-2006	4	5	6.13		1958
30-Nov-1997	4	3	10.15		1960
30-Nov-1998	4	5	11.15		1960
30-Nov-1999	4	7	12.15		1960
30-Nov-2000			13.15	LWOP	1961
30-Nov-2001			14.15	LWOP	1962
30-Nov-2002			15.15	LWOP	1963
30-Nov-2003	5	4	16.15		1960
30-Nov-2004	5	5	17.15		1960
30-Nov-2005	5	6	18.15		1960
1-May-2006	5	7	18.57		1960
30-Nov-2001	4	13	20.33		1961
30-Nov-2002	4	13	21.33		1961
30-Nov-2003	4	13	22.33		1961
30-Nov-2004	4	13	23.33		1961
30-Nov-2005	4	13	24.33		1961
1-May-2006	4	13	4.75		1961
30-Nov-1999	3	4	0.23		1963
30-Nov-2000	3	5	1.23		1963
30-Nov-2001	3	6	2.23		1963
30-Nov-2002	3	7	3.23		1963
30-Nov-2003	4	1	4.23		1963
30-Nov-2004	4	2	5.23		1963
30-Nov-2002	3	5	0.24		1970
30-Nov-2003	3	6	1.24		1970
30-Nov-2004	3	7	2.24		1970
30-Nov-2005	4	1	3.24		1970
1-May-2006	4	2	3.66		1970
30-Nov-2000	2	4	0.45		1973
30-Nov-2001	2	5	1.45		1973
30-Nov-2002	3	2	2.45		1973
30-Nov-2003	3	3	3.45		1973
30-Nov-2004	3	4	4.45		1973
30-Nov-2005	3	5	5.45		1973
1-May-2006	3	6	5.87		1973
30-Nov-2000	2	4	0.40		1974
30-Nov-1997	5	4	15.49		1952
30-Nov-1998	6	1	16.49		1952
30-Nov-1999	6	2	17.49		1952
30-Nov-2000	6	3	18.49		1952
30-Nov-2001	6	4	19.49		1952
30-Nov-2002	6	5	20.49		1952

Figure A.4: *DRDC CORA OR Scientist Career Progression Dataset (Cont'd)*

30-Nov-2003	6	6	21.49	1952
30-Nov-2004	6	7	22.49	1952
30-Nov-2005	6	7	23.49	1952
1-May-2006	6	7	23.92	1952
30-Nov-2001	3	3	0.51	1977
30-Nov-1997	5	3	15.99	1954
30-Nov-1998	5	4	16.99	1954
30-Nov-1999	5	5	17.99	1954
30-Nov-1997	2	4	0.09	1962
30-Nov-1998	2	5	1.09	1962
30-Nov-1999	3	2	2.09	1962
30-Nov-2000	3	3	3.09	1962
30-Nov-2001	3	4	4.09	1962
30-Nov-2002	3	6	5.09	1962
30-Nov-2003	3	7	6.09	1962
30-Nov-2004	4	1	7.09	1962
30-Nov-2005	4	2	8.09	1962
1-May-2006	4	3	8.51	1962
30-Nov-1997	4	1	4.29	1963
30-Nov-1998	4	3	5.29	1963
30-Nov-1999	4	5	6.29	1963
30-Nov-2000	4	7	7.29	1963
30-Nov-2001	4	8	8.29	1963
30-Nov-2002	5	1	9.29	1963
30-Nov-2003	5	2	10.29	1963
30-Nov-2004	5	3	11.29	1963
30-Nov-2005	5	4	12.29	1963
1-May-2006	5	5	12.71	1963
30-Nov-2005	3	5	0.38	1975
1-May-2006	3	6	0.81	1975
30-Nov-2005	3	4	0.38	1972
1-May-2006	3	5	0.67	1972
30-Nov-1997	5	10	23.90	1942
30-Nov-1998	5	10	24.90	1942
30-Nov-1999	5	10	25.90	1942
30-Nov-2000	5	10	26.90	1942
30-Nov-2001	5	10	27.90	1942
30-Nov-2002	5	10	28.90	1942
30-Nov-2003	5	10	29.90	1942
30-Nov-2004	5	10	30.90	1942
30-Nov-2005	5	10	31.90	1942
1-May-2006	5	10	32.32	1942
30-Nov-2005	2	4	0.40	1979
1-May-2006	2	5	0.83	1979
30-Nov-2005	3	3	0.17	1976
1-May-2006	3	4	0.59	1976
30-Nov-1997	4	12	27.53	1948
30-Nov-1998	4	12	28.53	1948
30-Nov-1999	4	13	29.53	1948
30-Nov-2000	4	13	30.53	1948
30-Nov-2001	4	13	31.53	1948
30-Nov-2002	4	13	32.53	1948
30-Nov-2003	4	13	33.53	1948
30-Nov-2004	4	13	34.53	1948
30-Nov-2005	4	13	35.53	1948
1-May-2006	5	6	35.95	1948
30-Nov-1997	3	6	11.53	1964
30-Nov-2000	3	4	0.24	1973
30-Nov-2001	3	5	1.24	1973
30-Nov-2002	3	6	2.24	1973
30-Nov-2003	4	1	3.24	1973
30-Nov-2004	4	2	4.24	1973
30-Nov-2005	4	3	5.24	1973
1-May-2006	4	4	5.67	1973

Figure A.5: *DRDC CORA OR Scientist Career Progression Dataset (Cont'd)*

30-Nov-1997	3	4	5.17		1965
30-Nov-1998	3	5	6.17		1965
30-Nov-1999	4	1	7.17		1965
30-Nov-2000	4	2	8.17		1965
30-Nov-2001	4	3	9.17		1965
30-Nov-2002	4	4	10.17		1965
30-Nov-2003	4	5	11.17		1965
30-Nov-2004	4	6	12.17		1965
30-Nov-2005	3	2	0.25		1973
1-May-2006	3	3	0.67		1973
30-Nov-1997	4	3	25.89		1954
30-Nov-1998	4	4	26.89		1954
30-Nov-1999	4	5	27.89		1954
30-Nov-2000	4	6	28.89		1954
30-Nov-2001	5	1	29.89		1954
30-Nov-2002	5	2	30.89		1954
30-Nov-2003	5	3	31.89		1954
30-Nov-2004	5	4	32.89		1954
30-Nov-2005	5	5	33.89		1954
1-May-2006	5	6	34.32		1954
30-Nov-1997	3	5	7.24		1962
30-Nov-1998	4	1	8.24		1962
30-Nov-1999	4	2	9.24		1962
30-Nov-2000	4	3	10.24		1962
30-Nov-2001	4	4	11.24		1962
30-Nov-2002	4	5	12.24		1962
30-Nov-2003	4	6	13.24		1962
30-Nov-2004	4	7	14.24	LWOP	1962
30-Nov-2005	4	7	15.24		1962
1-May-2006	4	8	15.66		1962
30-Nov-1997	4	13	21.29		1941
30-Nov-1998	4	13	22.29		1941
30-Nov-1999	4	13	23.29		1941
30-Nov-2000	4	13	24.29		1941
30-Nov-2001	4	13	25.29		1941
30-Nov-2002	4	13	26.29		1941
30-Nov-2003	4	13	27.29		1941
30-Nov-2004	4	13	28.29		1941
30-Nov-2005	4	13	29.29		1941
1-May-2006	4	13	29.71		1941
30-Nov-2001	2	5	1.66		1975
30-Nov-2002	3	2	2.66		1975
30-Nov-2003	3	3	3.66		1975
30-Nov-2004	3	5	4.66		1975
30-Nov-2005	3	7	5.66		1975
1-May-2006	4	1	6.08		1975
30-Nov-2000	3	5	0.57		1965
30-Nov-2001	3	6	1.57		1965
30-Nov-2002	3	7	2.57		1965
30-Nov-2003	4	1	3.57		1965
30-Nov-2004	4	2	4.57		1965
30-Nov-2005	4	3	5.57		1965
1-May-2006	4	4	5.99		1965
30-Nov-2004	5	1	0.23		1957
30-Nov-2005	5	2	1.23		1957
1-May-2006	5	3	1.65		1957
30-Nov-2002	3	5	0.24		1970
30-Nov-2003	3	6	1.24		1970
30-Nov-2004	3	7	2.24		1970
30-Nov-2005	4	1	3.24		1970
1-May-2006	4	2	3.66		1970
30-Nov-1997	4	2	9.48		1963
30-Nov-1998	4	3	10.48		1963
30-Nov-1999	4	4	11.48		1963

Figure A.6: *DRDC CORA OR Scientist Career Progression Dataset (Cont'd)*

30-Nov-2000	4	5	12.48		1963
30-Nov-2001	4	6	13.48		1963
30-Nov-2002	4	7	14.48		1963
30-Nov-2003	4	8	15.48		1963
30-Nov-2004	4	8	16.48		1963
30-Nov-2005	4	9	17.48		1963
1-May-2006	4	9	17.90		1963
30-Nov-2001	4	7	25.53		1951
30-Nov-2002	4	8	26.53		1951
30-Nov-2003	4	8	27.53		1951
30-Nov-2004	4	9	28.53		1951
30-Nov-1997	4	6	14.38		1961
30-Nov-1998	5	1	15.38		1961
30-Nov-1999	5	2	16.38		1961
30-Nov-2000	5	3	17.38		1961
30-Nov-2001	5	4	18.38		1961
30-Nov-2002	5	5	19.38		1961
30-Nov-2003	5	6	20.38		1961
30-Nov-2004	5	7	21.38		1961
30-Nov-2005	5	8	22.38		1961
1-May-2006	5	8	22.81		1961
30-Nov-2003	3	1	0.49		1972
30-Nov-2004	3	2	1.49		1972
30-Nov-2005	3	3	2.49		1972
1-May-2006	3	4	2.91		1972
30-Nov-1997	4	11	22.99		1950
30-Nov-1998	4	11	23.99		1950
30-Nov-1999	4	12	24.99		1950
30-Nov-2000	4	12	25.99		1950
30-Nov-2001	4	13	26.99		1950
30-Nov-2002	4	13	27.99		1950
30-Nov-2003	4	13	28.99		1950
30-Nov-2004	4	13	29.99		1950
30-Nov-2005	4	13	30.99		1950
1-May-2006	4	13	31.41		1950
30-Nov-1997	5	8	22.15		1951
30-Nov-1998	5	8	23.15		1951
30-Nov-1999	5	9	24.15		1951
30-Nov-2000	5	9	25.15		1951
30-Nov-2001	5	10	26.15		1951
30-Nov-2002	5	10	27.15		1951
30-Nov-2003	5	10	28.15		1951
30-Nov-2004	5	10	29.15		1951
30-Nov-2005	5	10	30.15		1951
1-May-2006	5	10	29.58		1951
30-Nov-1998	2	5	0.90		1971
30-Nov-1999	3	2	1.90		1971
30-Nov-2000	3	3	2.90		1971
30-Nov-2001	3	4	3.90		1971
30-Nov-2002	3	5	4.90		1971
30-Nov-2003	3	7	5.90		1971
30-Nov-2004	4	1	6.90		1971
30-Nov-2005	4	2	7.90		1971
1-May-2006	4	4	8.32		1971
30-Nov-2003	3	2	0.51		1972
30-Nov-2004	3	3	1.51		1972
30-Nov-2005	3	4	2.51		1972
1-May-2006	3	6	2.93		1972
30-Nov-2005	3	2	0.20		1977
1-May-2006	3	3	0.62		1977
30-Nov-2001	4	6	0.43		1967
30-Nov-2002	4	7	1.43	LWOP	1967
30-Nov-2003	4	8	2.43		1967
30-Nov-2004	4	8	3.43		1967

Figure A.7: *DRDC CORA OR Scientist Career Progression Dataset (Cont'd)*

30-Nov-2005	4	9	4.43	LWOP	1967
1-May-2006	4	9	4.85	LWOP	1967
30-Nov-1997	2	5	0.07		1968
30-Nov-1998	3	2	1.07		1968
30-Nov-1997	4	11	21.40		1952
30-Nov-1998	4	12	22.40		1952
30-Nov-1999	4	12	23.40		1952
30-Nov-2000	4	13	24.40		1952
30-Nov-2001	4	13	25.40		1952
30-Nov-2002	4	13	26.40		1952
30-Nov-2003	4	13	27.40		1952
30-Nov-2004	4	13	28.40		1952
30-Nov-2005	4	13	29.40		1952
1-May-2006	4	13	29.82		1952
30-Nov-1997	5	9	35.10		1943
30-Nov-1998	5	9	36.10		1943
30-Nov-1997	4	11	28.56		1945
30-Nov-1998	4	11	29.56		1945
30-Nov-1999	4	11	30.56		1945
30-Nov-2000	4	11	31.56		1945
30-Nov-2001	4	11	32.56		1945
30-Nov-2002	4	11	33.56		1945
30-Nov-2003	4	11	34.56		1945
30-Nov-1997	5	7	29.54		1944
30-Nov-1998	6	2	30.54		1944
30-Nov-1999	6	3	31.54		1944
30-Nov-1997	5	8	31.54		1940
30-Nov-1998	5	8	32.54		1940
30-Nov-1999	5	9	33.54		1940
30-Nov-1997	4	1	15.40		1960
30-Nov-1998	4	2	16.40		1960
30-Nov-1999	4	3	17.40		1960
30-Nov-2000	4	4	18.40		1960
30-Nov-2001	4	5	19.40		1960
30-Nov-2002	4	6	20.40		1960
30-Nov-2003	4	7	21.40		1960
30-Nov-2004	4	8	22.40		1960
30-Nov-2005	4	8	23.40		1960
1-May-2006	4	9	23.82		1960
30-Nov-1997	4	2	8.39		1963
30-Nov-1998	4	3	9.39		1963
30-Nov-1999	4	4	10.39		1963
30-Nov-2000	4	5	11.39		1963
30-Nov-2001	4	6	12.39		1963
30-Nov-2002	4	7	13.39	LWOP	1963
30-Nov-2003	4	7	14.39	LWOP	1963
30-Nov-2004	4	7	15.39	LWOP	1963
30-Nov-2005	4	7	16.39	LWOP	1963
1-May-2006	4	7	16.81	LWOP	1963
30-Nov-1997	6	3	24.26		1950
30-Nov-1998	6	4	25.26		1950
30-Nov-1999	6	5	26.26		1950
30-Nov-2000	6	6	27.26		1950
30-Nov-2001	6	7	28.26		1950
30-Nov-2002	6	7	29.26		1950
30-Nov-2003	6	7	30.26		1950
30-Nov-2004	6	7	31.26		1950
30-Nov-2005	6	7	32.26		1950
1-May-2006	6	7	32.68		1950
30-Nov-2001	4	13	25.22		1957
30-Nov-2002	4	13	26.22		1957
30-Nov-2003	4	13	27.22		1957
30-Nov-2004	4	13	28.22		1957
30-Nov-2005	4	13	29.22		1957

Figure A.8: *DRDC CORA OR Scientist Career Progression Dataset (Cont'd)*

1-May-2006	4	13	29.64		1957
30-Nov-2005	2	4	0.23		1979
1-May-2006	2	5	0.65		1979
30-Nov-1997	4	2	7.90		1957
30-Nov-1998	4	3	8.90		1957
30-Nov-1999	4	4	9.90		1957
30-Nov-2000	4	5	10.90		1957
30-Nov-2001	4	6	11.90		1957
30-Nov-2002	5	1	12.90		1957
30-Nov-2003	5	2	13.90		1957
30-Nov-2004	5	3	14.90		1957
30-Nov-2005	5	4	15.90		1957
1-May-2006	5	5	16.32		1957
30-Nov-2002	3	2	0.19		1969
30-Nov-2003	3	3	1.19		1969
30-Nov-2004	3	4	2.19		1969
30-Nov-2005	3	5	3.19		1969
1-May-2006	3	5	3.61		1969
30-Nov-1997	5	3	21.24		1947
30-Nov-1998	5	4	22.24		1947
30-Nov-1999	5	5	23.24		1947
30-Nov-2000	5	6	24.24		1947
30-Nov-2001	5	7	25.24		1947
30-Nov-2002	5	8	26.24		1947
30-Nov-2003	5	8	27.24		1947
30-Nov-2004	6	3	28.24		1947
30-Nov-2005	6	4	29.24		1947
1-May-2006	6	5	29.67		1947
30-Nov-1997	3	5	5.24		1965
30-Nov-1998	3	6	5.24		1965
30-Nov-1999	4	1	6.24		1965
30-Nov-2000	4	2	7.24		1965
30-Nov-2001	4	3	8.24		1965
30-Nov-2002	4	4	9.24		1965
30-Nov-2003	4	6	10.24		1965
30-Nov-2004	4	7	11.24		1965
30-Nov-2005	4	8	12.24		1965
1-May-2006	4	8	12.67	LWOP	1965
30-Nov-1999	2	4	0.24		1972
30-Nov-2000	2	5	1.24		1972
30-Nov-2001	3	2	2.24		1972
30-Nov-2002	3	3	3.24		1972
30-Nov-2003	3	5	4.24		1972
30-Nov-2004	3	7	5.24		1972
30-Nov-2005	4	1	6.24	LWOP	1972
1-May-2006	4	1	6.67	LWOP	1972
30-Nov-2004	2	4	0.23		1979
30-Nov-2005	2	5	1.23		1979
1-May-2006	3	2	1.65		1979
30-Nov-1997	5	1	12.49		1954
30-Nov-1998	5	1	13.49		1954
30-Nov-1999	5	2	14.49		1954
30-Nov-2000	5	2	15.49		1954
30-Nov-2001	5	2	16.49	LWOP	1954
30-Nov-1997	4	2	12.47		1959
30-Nov-1998	4	3	13.47		1959
30-Nov-1999	4	4	14.47		1959
30-Nov-2000	4	5	15.47		1959
30-Nov-2001	4	6	16.47		1959
30-Nov-2002	5	1	17.47		1959
30-Nov-2003	5	2	18.47		1959
30-Nov-2004	5	3	19.47		1959
30-Nov-2005	5	4	20.47		1959
1-May-2006	5	5	20.89		1959

Figure A.9: *DRDC CORA OR Scientist Career Progression Dataset (Cont'd)*

30-Nov-2004	2	4	0.25		1982
30-Nov-2005	2	5	1.25		1982
1-May-2006	3	2	1.67		1982
30-Nov-1997	4	6	15.23		1959
30-Nov-1998	4	7	16.23		1959
30-Nov-1999	4	8	17.23		1959
30-Nov-2000	4	8	18.23		1959
30-Nov-1997	4	3	9.42		1959
30-Nov-1998	4	4	10.42		1959
30-Nov-1999	5	1	11.42		1959
30-Nov-2000	5	2	12.42		1959
30-Nov-2001	5	3	13.42		1959
30-Nov-2003	3	1	0.19		1975
30-Nov-2004	3	2	1.19		1975
30-Nov-2005	3	3	2.19		1975
1-May-2006	3	4	2.61		1975
30-Nov-2000	2	4	0.49		1965
30-Nov-2001	2	5	1.49		1965
30-Nov-2002	3	2	2.49		1965
30-Nov-2003	3	3	3.49		1965
30-Nov-2004	3	4	4.49		1965
30-Nov-1997	5	6	21.57		1954
30-Nov-1998	5	7	22.57		1954
30-Nov-1999	5	8	23.57		1954
30-Nov-2000	5	8	24.57		1954
30-Nov-2001	5	9	25.57		1954
30-Nov-2002	5	9	26.57		1954
30-Nov-2003	5	10	27.57		1954
30-Nov-2004	5	10	28.57		1954
30-Nov-2005	5	10	29.57		1954
1-May-2006	5	10	29.99		1954
30-Nov-1997	5	5	22.55	LWOP	1952
30-Nov-1998	5	6	23.55		1952
30-Nov-1999	5	7	24.55		1952
30-Nov-2000	5	8	25.55		1952
30-Nov-2001	5	8	26.55		1952
30-Nov-2002	5	9	27.55		1952
30-Nov-2003	5	9	28.55		1952
30-Nov-2004	5	10	29.55		1952
30-Nov-2005	5	10	30.55		1952
1-May-2006	6	5	30.97		1952
30-Nov-2004	2	4	0.65		1977
30-Nov-2005	2	5	1.65	LWOP	1977
1-May-2006	2	5	2.07		1977
30-Nov-2002	4	4	0.52		1961
30-Nov-2003	4	5	1.52		1961
30-Nov-2004	4	6	2.52		1961
30-Nov-2005	4	7	3.52		1961
1-May-2006	4	8	3.94		1961
30-Nov-2003	3	2	0.23		1975
30-Nov-2004	3	3	1.23		1975
30-Nov-2005	3	4	2.23		1975
1-May-2006	3	5	2.65		1975
30-Nov-1997	4	8	18.62		1955
30-Nov-1998	4	8	19.62		1955
30-Nov-1999	4	9	20.62		1955
30-Nov-2000	4	9	21.62		1955
30-Nov-2001	4	10	22.62		1955
30-Nov-2002	4	10	23.62		1955
30-Nov-2003	4	11	24.62		1955
30-Nov-2004	4	11	25.62		1955
30-Nov-2005	4	12	26.62		1955
1-May-2006	4	12	27.04		1955
30-Nov-2002	3	3	0.41		1960

Figure A.10: *DRDC CORA OR Scientist Career Progression Dataset (Cont'd)*

30-Nov-2003	3	4	1.41		1960
30-Nov-2004	3	5	2.41		1960
30-Nov-2005	3	6	3.41		1960
1-May-2006	3	7	3.83		1960
30-Nov-1997	2	4	0.07		1967
30-Nov-1998	2	5	1.07		1967
30-Nov-1999	3	2	2.07	LWOP	1967
30-Nov-2000	3	3	3.07		1967
30-Nov-2001	3	4	4.07		1967
30-Nov-2002	3	5	5.07		1967
30-Nov-2003	3	6	6.07		1967
30-Nov-2004	3	7	7.07		1967
30-Nov-2005	4	1	8.07		1967
1-May-2006	4	2	8.49		1967
30-Nov-2002	2	3	0.08		1977
30-Nov-2003	2	4	1.08		1977
30-Nov-2004	2	5	2.08		1977
30-Nov-2005	3	2	3.08		1977
1-May-2006	3	3	3.50		1977
30-Nov-1997	5	8	23.37		1948
30-Nov-1998	5	8	24.37		1948
30-Nov-1999	5	9	25.37		1948
30-Nov-2000	5	9	26.37		1948
30-Nov-2001	5	10	27.37		1948
30-Nov-2002	5	10	28.37		1948
30-Nov-2003	5	10	29.37		1948
30-Nov-2004	5	10	30.37		1948
30-Nov-2005	5	10	31.37		1948
1-May-2006	5	10	31.80		1948
30-Nov-1997	5	1	18.51		1957
30-Nov-1998	5	2	19.51		1957
30-Nov-1999	5	3	20.51		1957
30-Nov-2000	5	4	21.51		1957
30-Nov-2001	5	5	22.51		1957
30-Nov-2002	5	6	23.51		1957
30-Nov-2003	5	7	24.51		1957
30-Nov-2004	5	8	25.51		1957
30-Nov-2005	5	8	26.51		1957
1-May-2006	5	9	26.93		1957
30-Nov-1997	3	4	7.05		1954
30-Nov-2005	2	4	0.40		1977
1-May-2006	2	5	0.83		1977
30-Nov-2000	3	6	0.60		1962
30-Nov-2001	3	7	1.60		1962
30-Nov-2002	4	1	2.60		1962
30-Nov-2003	4	2	3.60		1962
30-Nov-2004	4	3	4.60		1962
30-Nov-2005	4	4	5.60		1962
1-May-2006	4	5	6.02		1962
30-Nov-2000	2	4	0.17		1975
30-Nov-2001	2	5	1.17		1975
30-Nov-2002	3	2	2.17		1975
30-Nov-2003	3	3	3.17		1975
30-Nov-1997	2	3	0.02		1972
30-Nov-1998	2	4	1.02		1972
30-Nov-1999	2	5	2.02		1972
30-Nov-1997	3	6	9.24		1962
30-Nov-1998	3	7	10.24		1962
30-Nov-1999	3	4	2.72		1972
30-Nov-2000	3	5	3.72		1972
30-Nov-2001	3	6	4.72		1972
30-Nov-2002	3	7	5.72		1972
30-Nov-2003	3	7	6.72		1972
30-Nov-2004	3	7	7.72		1972

Figure A.11: *DRDC CORA OR Scientist Career Progression Dataset (Cont'd)*

30-Nov-2005	3	7	8.72		1972
1-May-2006	3	7	9.14		1972
30-Nov-2004	3	3	0.40		1975
30-Nov-2005	3	4	1.40		1975
1-May-2006	3	5	1.82		1975
30-Nov-1997	5	8	20.56		1943
30-Nov-1998	5	8	21.56		1943
30-Nov-1999	5	9	22.56		1943
30-Nov-2000	5	9	23.56		1943
30-Nov-2001	5	10	24.56		1943
30-Nov-2000	2	4	0.39		1975
30-Nov-2001	2	5	1.39		1975
30-Nov-1997	4	4	10.41		1957
30-Nov-1998	4	6	11.41		1957
30-Nov-1999	5	1	12.41		1957
30-Nov-2000	5	2	13.41		1957
30-Nov-2001	5	3	14.41		1957
30-Nov-2002	5	4	15.41		1957
30-Nov-2003	5	5	16.41		1957
30-Nov-2004	5	6	17.41		1957
30-Nov-2005	5	7	18.41		1957
1-May-2006	5	8	18.83		1957
30-Nov-1997	4	7	17.24		1953
30-Nov-1998	4	8	18.24		1953
30-Nov-1999	4	9	19.24		1953
30-Nov-2000	4	9	20.24		1953
30-Nov-2001	4	10	21.24		1953
30-Nov-2002	4	10	22.24	LWOP	1953
30-Nov-2003	4	10	23.24	LWOP	1953
30-Nov-2004	4	10	24.24		1953
30-Nov-2005	4	10	25.24		1953
1-May-2006	4	10	25.66		1953
30-Nov-2004	2	4	0.40		1978
30-Nov-2005	2	5	1.40	LWOP	1978
1-May-2006	3	2	1.82		1978
30-Nov-2002	4	8	0.41		1959
30-Nov-2003	4	8	1.41		1959
30-Nov-2004	4	9	2.41		1959
30-Nov-2005	4	9	3.41		1959
1-May-2006	4	10	3.83		1959
30-Nov-2003	3	2	0.33		1977
30-Nov-2004	3	3	1.33		1977
30-Nov-2005	3	4	2.33		1977
1-May-2006	3	5	2.75		1977
30-Nov-1997	4	2	8.20		1961
30-Nov-1998	4	3	9.20		1961
30-Nov-1999	4	4	10.20		1961
30-Nov-2000	4	5	11.20		1961
30-Nov-2001	4	6	12.20		1961
30-Nov-2002	4	7	13.20		1961
30-Nov-2003	4	8	14.20		1961
30-Nov-2005	3	3	0.44		1971
1-May-2006	3	4	0.86		1971
30-Nov-2002	2	4	6.66		1976
30-Nov-2003	2	5	7.66		1976
30-Nov-2004	3	2	8.66		1976
30-Nov-2005	3	3	9.66		1976
1-May-2006	3	4	10.08		1976

Annex B
A Summary of the Career Progression Model's Assumptions

B.1 Career Advancement

Normal Progression

From the analysis of the historical trends (Section 2.2), it was found that the majority of the DS population stepped predictably along a *normal* career path as described in Table 5 and Figure 12. At the DS-4 double barrier, it was assumed that 25% of individuals were promoted while the remainder received a single step. At the DS-5 double barrier a 10% probability of promotion was assumed. These percentages were arrived at via a blend of few observed events in the 10 year dataset and expert opinion as offered by D(J&SA), Mr. Bob Dickinson.[12]

As an aside, it is noted that to model the career paths of the entire DS population as *normal* would not reflect individual variance in progression rates. On the other hand, to translate the historical promotion data (Table 7) into probabilities for promotion, single step, double step and no step at each step of the Pay Plan in a memory-less "Markov chain" model would not take into account the tendency for some individuals to consistently progress faster or slower than *normal*. Therefore, the present entity-based modeling approach was chosen in which a large fraction of DS's followed the *normal* progression for the entirety of their careers, while a smaller fraction follow an *accelerated* or *delayed* progression for part of their careers.

The following sections describe *accelerated* and *delayed* progression, and the way in which DS's changed from *normal* to abnormal (*accelerated* or *delayed*) career progression.

Accelerated progression

Based on the historical trends (Section 2.2.5), it was assumed that some DS's who progressed along the *normal* career path would be identified as having met (or quickly approaching) the requirements for the next DS level, and were therefore *accelerated* through the remainder of their current level. The accelerated progression scheme was also used to account for cases where promotion occurred above the double barrier in DS-4 and DS-5 for which there is no mechanism built in to *normal* progression as has been defined here.

For DS level 3, 4, and 5, the following was assumed regarding *accelerated* progression:

- a DS followed *normal* progression for the first 2 years within any DS level;
- in each subsequent year, until they reached the natural promotion point for the level (top of the level for DS-3, and double barrier for DS-4 and DS-5), each DS had a 10%, 7.5%, and 5% annual chance of being identified as *accelerated* for DS-3, DS-4 and DS-5 respectively;

[12]Conversion of authors with Mr. Bob Dickinson, CORA D(J&SA), March 2006.

- after passing the natural promotion point (for DS-4 and DS-5), the annual probability of being identified as *accelerated* decreased by a factor of 4, until the end of the level was reached, after which time it was reduced by another factor of 4;
- once identified as *accelerated*, a DS was given an accelerated step, meaning a double step if they were more than 2 years from the natural promotion point, promotion if they were 1 year or less from the natural promotion point or beyond the promotion point (for DS-4 and DS-5), and a promotion or a double step (with 50% probability) if they were exactly 2 years from the natural promotion point;
- *accelerated* DS's who received a double increment one year doubled their chances of receiving an *accelerated* step in each subsequent year that they remained within the DS level in which they were identified as *accelerated*, and were automatically promoted upon reaching the natural promotion point of the level;
- *accelerated* DS's who were promoted to the next DS level were returned to *normal* career progression.

Delayed progression

Based on the historical dataset, it was assumed that DS's had a 5% chance of being delayed at the end of DS-3, and a 2% annual probability of delay above step 7 in DS-4 and anywhere in DS-5. Furthermore, given a delay one year, it was assumed that there was a 50% chance of delay the subsequent year. Lastly it was assumed that once back to *normal* progression, there was no memory of the individual having been delayed (i.e. no decreased chance of promotion, etc).

B.2 Hiring

As a baseline, it was assumed that 10 new recruits were hired annually. This baseline was slightly lower than the 10.9 hires per year average observed since 2000. As the organization grew, a progressively larger number of individuals were expected to retire annually, and more would have to be hired to replace them. Thus, 10 new recruits per year represented modest growth. In Annex C, 5 and 15 new recruits annually were considered.

The DS-level, pay step, and age of new recruits were modeled after historical trends. New recruits were randomly assigned a DS level based on the expected fraction of each, while age and pay step were assumed to be uniformly distributed within a certain range (see Table B.1). For simplicity, it was assumed that all new recruits were hired at the start of the fiscal year (April 1), and were included in the tally for that year.

Table B.1: *Statistical description of new recruits*

	Type of New Recruit		
	DS-2	DS-3	DS-4
Fraction of Recruits	40%	50%	10%
Min Age	25	27	36
Max Age	29	35	48
Min Pay Step	4	2	1
Max Pay Step	4	6	13

B.3 Attrition

Annual attrition probabilities were assumed to be a function of YOS and age (via YTR). The inclusion of age was necessary to accurately predict retirement for individuals hired at an advanced stage of their careers. YTR was calculated by:

$$YTR = \min\{60 - Age,\ \max\{55 - Age,\ 30 - YOS\}\},$$

and the annual probability that an individual retires[13] was assumed to be given by the following conditional statement:

if ($YTR \leq 5$) then

$$P_{\text{retire}} = \begin{cases} 1.35\,\% & YTR > 0 \\ 15.8\,\% & -10 < YTR \leq 0 \\ 100.0\,\% & YTR = -10 \end{cases}$$

else

$$P_{\text{retire}} = \begin{cases} 4.8\,\% & YOS < 5 \\ 7.4\,\% & 5 \leq YOS < 20 \\ 1.35\,\% & 20 \leq YOS < 30 \\ 15.8\,\% & 30 \leq YOS \end{cases}.$$

The annual attrition probability that results from these rules is plotted in Figure B.1.

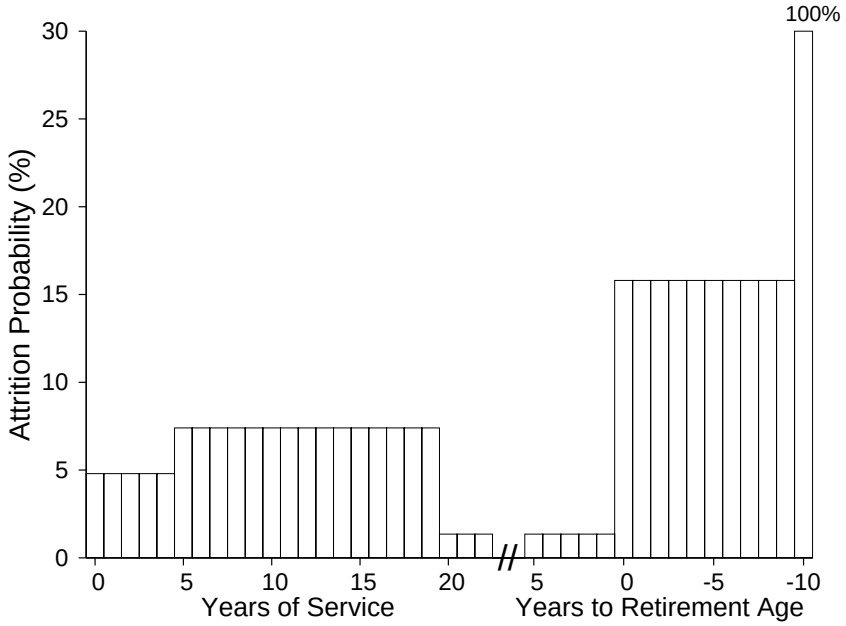


Figure B.1: *Annual attrition probability*

[13] In this context, retire could mean retire from the work force, leave CORA for other employment, or move from the scientific to managerial stream in DRDC.

B.4 LWOP

It was assumed that individuals with less than 20 YOS (and more than 5 YTR) had a 2% annual chance of going on LWOP, while those closer to retirement do not go on leave. After each year on LWOP, return to work was assumed to occur with 50% probability, while remaining on leave occurred with 50% probability.

While on leave, individuals continued to increase in age and YOS, but did not undergo career advancement. Those on leave did not contribute to the total SWE while away, though they were included in annual tallies of the DS population.

B.5 Initialization of the Simulation with 2006 Data

In order to properly initialize the simulation, data for individual DS's as of the beginning of FY 06/07 was required. Specifically, the DS level, pay increment, age (as of the end of 2006), YOS (rounded to nearest year) and an identifier for those on LWOP were required and could be obtained directly from the 1 May 2006 dataset. Also required were the current progression rate, years within their current DS level (rounded down to the nearest integer – used to test for candidacy to *accelerated* progression), and years within their current pay step (rounded down to nearest integer – required for biannual increments). These inputs were all obtained from historical data for each individual. The current progression rate was set to *normal* for all individuals except those who had received an *accelerated* step within their current DS level and those that had been in their current pay step for longer than *normal*; these DS's were assigned *accelerated* and *delayed* progression rates respectively. Years spent on LWOP were not counted towards years in current level or years in current pay step. For individuals who had been in the same level since 1997, years in current DS level was counted back assuming normal progression to the beginning of the DS level (this did not affect results as the parameter was only required by the model for the first 2 years in a DS level).

For the 17 new recruits hired in 2006, their DS Level was known (six DS-2's, nine DS-3's and two DS-4's) while their ages, and steps were initialized with the statistical distribution used for all new recruits as described in Section B.2 .

The data used to initialize the model is shown in Figure B.2.

Figure B.2: *Input to career progression model*

	DS level	Step	Years of Service	Age	Progression Rate	Years in Level	Years in Increment	LWOP Flag
1	4	2	5	35	2	1	0	0
2	4	2	5	33	2	1	0	0
3	4	3	5	39	2	2	0	1
4	4	13	4	51	2	4	3	0
5	2	5	1	26	2	1	0	0
6	5	10	25	48	1	10	0	0
7	3	7	6	32	1	5	0	0
8	4	5	5	37	1	3	0	0
9	4	1	6	32	2	0	0	0
10	3	7	7	31	2	5	0	0
11	4	1	4	34	2	0	0	0
12	5	4	24	47	3	4	1	0
13	5	8	32	55	3	7	3	0
14	3	4	4	31	2	2	0	0
15	3	3	2	33	2	2	0	0
16	3	3	1	31	2	1	0	0
17	4	1	6	38	2	0	0	0
18	3	1	1	28	3	1	1	0
19	5	6	3	53	2	3	0	0
20	5	8	28	49	2	7	0	0
21	4	5	6	48	2	4	0	0
22	5	7	19	46	2	3	0	0
23	4	13	5	45	2	5	5	0
24	4	2	4	36	2	1	0	0
25	3	6	6	33	2	4	0	0
26	6	7	24	54	2	8	2	0
27	4	3	9	44	2	2	0	0
28	5	5	13	43	2	4	0	0
29	3	6	1	31	2	1	0	0
30	3	5	1	34	2	1	0	0
31	5	10	32	64	2	20	9	0
32	2	5	1	27	2	1	0	0
33	3	4	1	30	2	1	0	0
34	5	6	36	58	2	1	0	0
35	4	4	6	33	2	3	0	0
36	3	3	1	33	2	1	0	0
37	5	6	34	52	2	5	0	0
38	4	8	16	44	2	7	0	0
39	4	13	30	65	2	26	9	0
40	4	1	6	31	2	0	0	0
41	4	4	6	41	2	3	0	0
42	5	3	2	49	2	2	0	0
43	4	2	4	36	2	1	0	0
44	4	9	18	43	2	10	1	0
45	5	8	23	45	2	8	1	0
46	3	4	3	34	2	3	0	0
47	4	13	31	56	2	22	5	0
48	5	10	30	55	2	16	5	0
49	4	4	8	35	1	2	0	0
50	3	6	3	34	1	3	0	0
51	3	3	1	29	2	1	0	0
52	4	9	5	39	2	5	1	1
53	4	13	30	54	2	23	6	0
54	4	9	24	46	2	9	0	0
55	6	7	33	56	2	11	5	0
56	4	13	30	49	2	5	5	0
57	2	5	1	27	2	1	0	0
58	5	5	16	49	2	4	0	0
59	3	5	4	37	3	4	1	0
60	6	5	30	59	2	2	0	0
61	4	8	13	41	1	7	1	1
62	4	1	7	34	2	1	0	1
63	3	2	2	27	2	0	0	0
64	5	5	21	47	2	4	0	0
65	3	2	2	24	2	0	0	0
66	3	4	3	31	2	3	0	0
67	5	10	30	52	2	14	3	0
68	6	5	31	54	2	0	0	0
69	2	5	2	29	2	1	0	0
70	4	8	4	45	2	4	0	0
71	3	5	3	31	2	3	0	0
72	4	12	27	51	2	16	1	0
73	3	7	4	46	2	4	0	0
74	4	2	8	39	2	1	0	0
75	3	3	4	29	2	1	0	0
76	5	10	32	58	2	16	5	0
77	5	9	27	49	2	9	0	0
78	2	5	1	29	2	1	0	0
79	4	5	6	44	2	4	0	0
80	3	7	9	34	3	7	4	0
81	3	5	2	31	2	2	0	0
82	5	8	19	49	2	7	0	0
83	4	10	26	53	2	13	3	0
84	3	2	2	28	2	0	0	0
85	4	10	4	47	2	4	0	0
86	3	5	3	29	2	3	0	0
87	3	4	1	35	2	1	0	0
88	3	4	10	30	2	2	0	0

Annex C
Alternate Scenarios

The results presented in Section 3.3 reflect the baseline scenario which uses model parameters based on historical trends. Since historical trends do not necessarily reflect future trends, it was prudent to consider alternate scenarios using other parameters. These alternate scenarios also constitute a crude sensitivity analysis, as they show to what extent the results depend on the input parameters.

Two sets of alternate scenarios were considered: variations in hiring rates, and in attrition rates.

C.1 Alternate Hiring Rates

The number of new recruits hired annually was varied to determine the effects of hiring strategy on CORA's growth. This was important because annual hiring rates are something that can be controlled by management to shape the size of the organization.

In the baseline scenario, it was assumed that 10 new recruits joined DRDC CORA annually, representing moderate growth of the organization. It was found that at its current size, CORA would lose 5-6 OR DS's annually, and so in the first alternate scenario, 5 new recruits per year were considered. The resulting size of CORA's OR DS population is shown in Figure C.1, and reveals that indeed the total population decreased slightly to 90% of its current size within a decade. Thus, as claimed previously, hiring approximately 6 new OR scientists were required annually to maintain CORA's size and therefore its capacity to perform OR.

Figure C.2 shows the results of the simulation assuming 15 new recruits annually. CORA's size would be expected to increase by 50% by 2012 and double by 2020 under such an aggressive recruiting schedule.

C.2 Alternate Attrition Rates

There are a variety of reasons why past attrition trends may not reflect future rates. These include changes in Canada's economic climate, particularly in the high-tech/knowledge sector, with a boom (or bust) giving scientists added incentive to leave (or stay). Given that the Defence Scientific Services Group's contract is set to expire in the fall of 2006, possible changes to the current retention bonus may affect attrition rates. These changes may affect attrition of junior DS's who are expected to be the most likely to leave because they have invested little time in the organization, little money into their pension fund, and who, oftentimes being fresh from school, may choose to pursue other career paths. More senior DS's may be less likely to leave due to factors such as job satisfaction, significant investment in the pension fund, and a level of seniority which they would not enjoy if they started with a new employer. Because of the demographics of its DS population (i.e

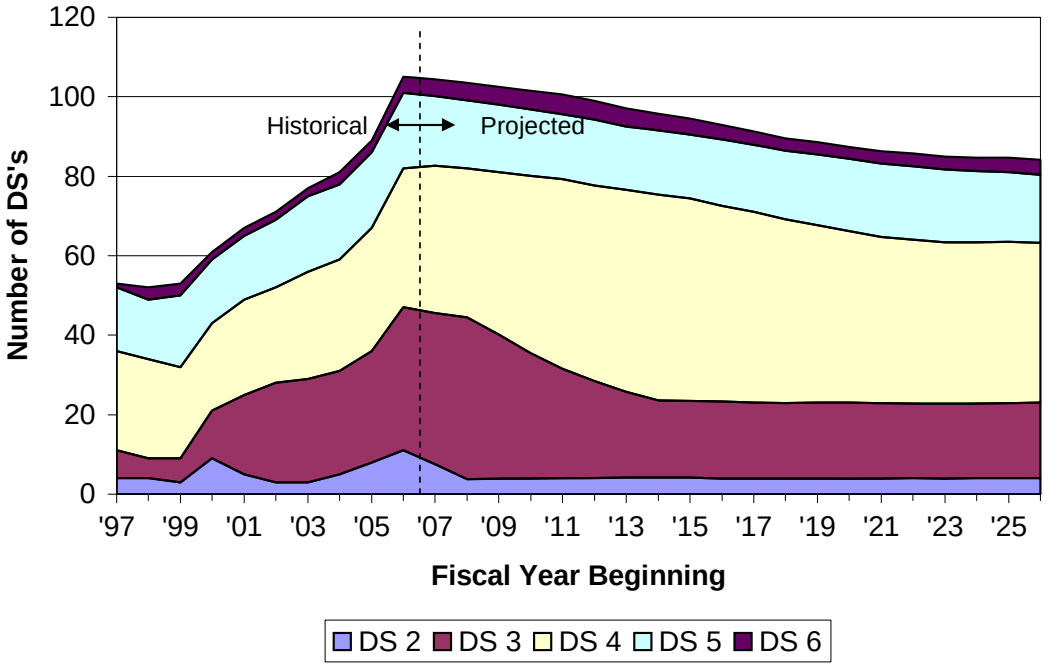


Figure C.1: *Projected DS population assuming 5 new recruits per year.*

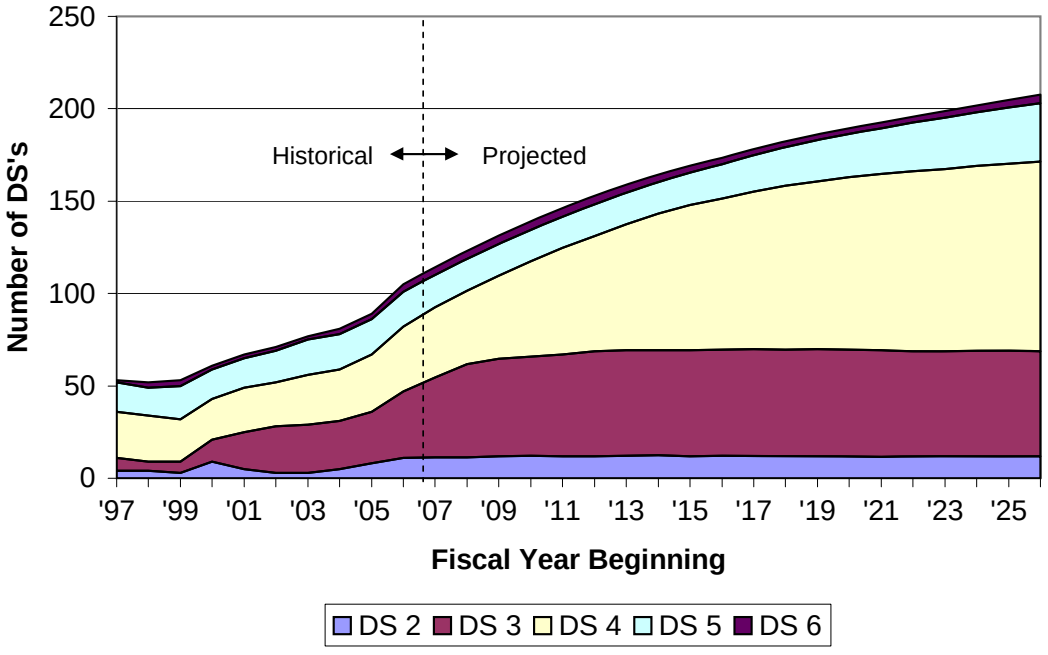


Figure C.2: *Projected DS population assuming 15 new recruits per year.*

its current population is skewed towards junior DS's), CORA's rate of growth and future size of its DS population is particularly sensitive to changes in the attrition rates of junior scientists.

Alternately, even if economic factors don't affect attrition rates, due to the limited size of the 1997-2006 dataset and the statistics of small sample sizes, it is possible that the measured attrition probabilities (used in the baseline scenario) do not reflect the true attrition probabilities. The error bars on Figure 10 and 11 reflect this uncertainty. For these reasons, alternate attrition probabilities were considered.

Figure C.3 shows the projected number of OR scientists assuming annual attrition probabilities that were 50% higher than in the baseline scenario. This scenario represented a significant change in attrition rates towards the upper range of what was likely to occur in the future. Thus, even in this worst case scenario, CORA was still expected to grow slowly ($\sim$ 2 DS's per year) with 10 new recruits per year.

Alternately, if attrition rates were halved compared to the baseline scenario (representing the lower range of what is likely), CORA's would grow by 7 DS's per year assuming 10 new hires annually (Figure C.4).

In this last scenario, the total number of DS's increased at about the same rate as it did assuming 15 hires per year and baseline attrition rates (Figures C.4 and C.2). However, the relative number of DS-5 and DS-6 were higher in this scenario, due to a longer average career length. Thus, in order to grow, CORA's management can work with two strategies: minimizing attrition, or increasing hiring. Both strategies can result in similar growth, though the first strategy results in a healthier mix of junior and senior scientists.

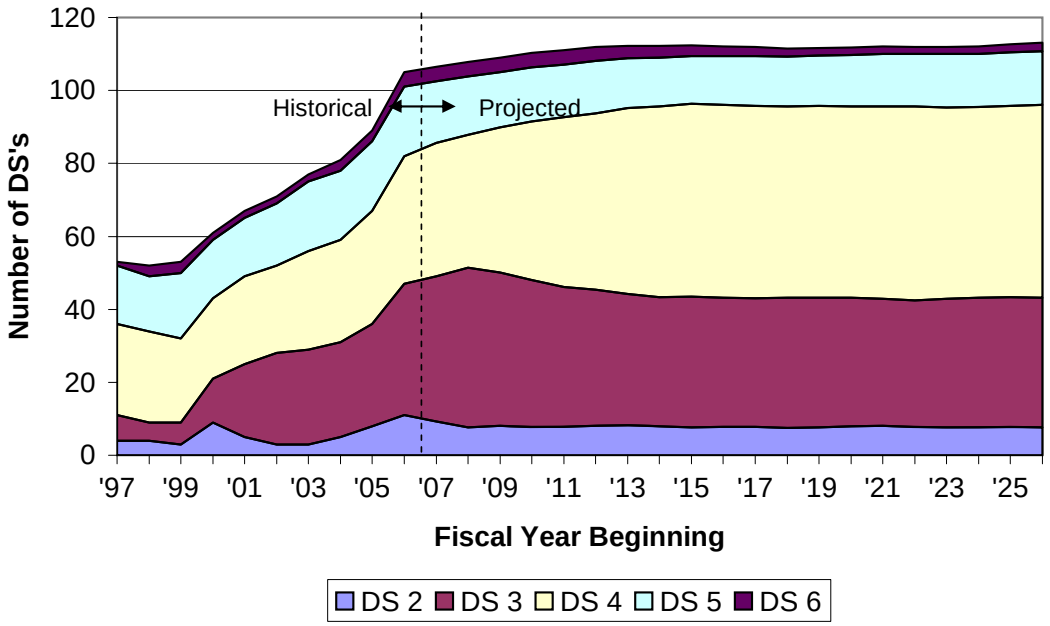


Figure C.3: *Projected DS population assuming attrition rates increased by 50%.*

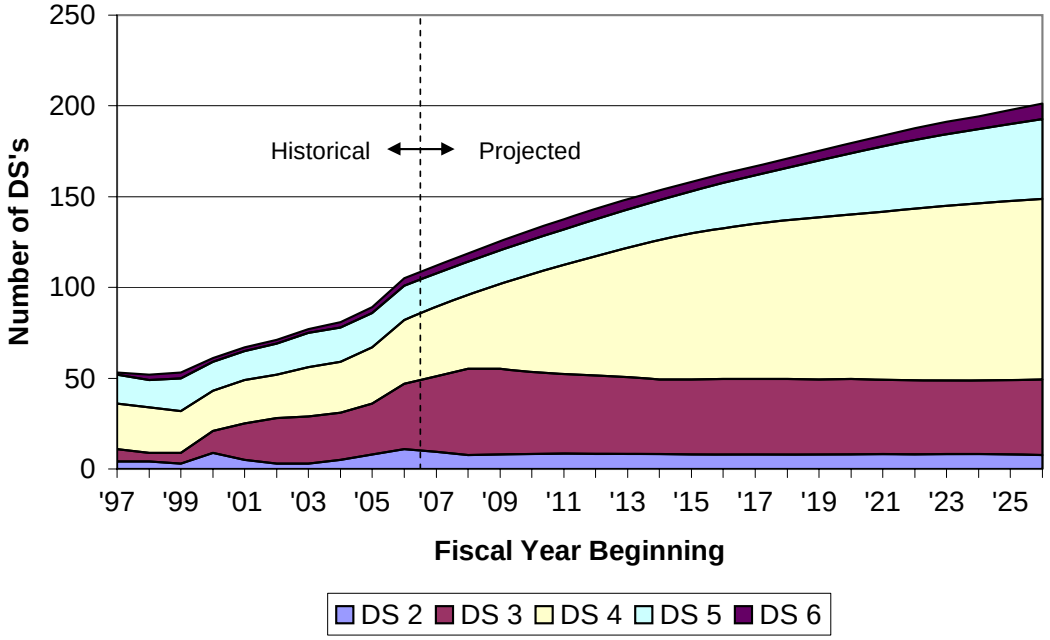


Figure C.4: *Projected DS population assuming attrition rates halved.*

Annex D
Demographics of Other Defence Scientist Subpopulations

In addition to OR scientists, CORA's DS community also includes social scientists, strategic analysts, and intelligence analysts. As shown in Figure D.1, these subpopulations make up a minority of DS's in CORA. The hiring surge since 2000 has included significant growth of the social scientist and strategic analyst populations, as evidenced by the hiring trends shown in Figure D.2.

A breakdown by DS level of social scientist, strategic analyst and intelligence analyst populations are shown in Figures D.3, D.4, and D.5 respectively .

The complete historical dataset contained 106 person-years of data and 22 unique individuals in the social scientist subpopulation. For strategic analysts, 108 person-years were available for 16 individuals, while for intelligence analysts, 128 person-years were spread over 16 individuals. The small number of individuals in each subpopulation meant that promotion/pay increment data was available for only fragments of the Pay Plan, and the data was distributed too sparsely through the Pay Plan to obtain any meaningful statistics on promotion/pay increment probabilities.

There was enough information to suggest that the career trends for these subpopulations did indeed differ from the OR scientist population. The expected differences in HR trends between OR scientists and these subpopulations is underlined by the fact that in the past decade no attrition was observed in the social scientist and strategic analyst populations, while only two intelligence analysts retired. This translates crudely into a 0.8% annual attrition rate for all DS's besides OR scientists (for whom the annual attrition rate was found to be 6.0%). Furthermore, strategic analysts and intelligence analysts tended to be hired into more senior positions (higher DS level and/or pay increment). Thus, it was concluded that it would be unreasonable to apply the trends observed for OR scientists to these subpopulations.

Lastly, the small size of the populations means that the results of any modeling efforts such as the one introduced in this report would be fairly unreliable. Given the small population size involved, the stochastic nature of the model would dominate the model results. These results would have very little predictive power, especially with respect to the DS level of the individuals within the subpopulations.

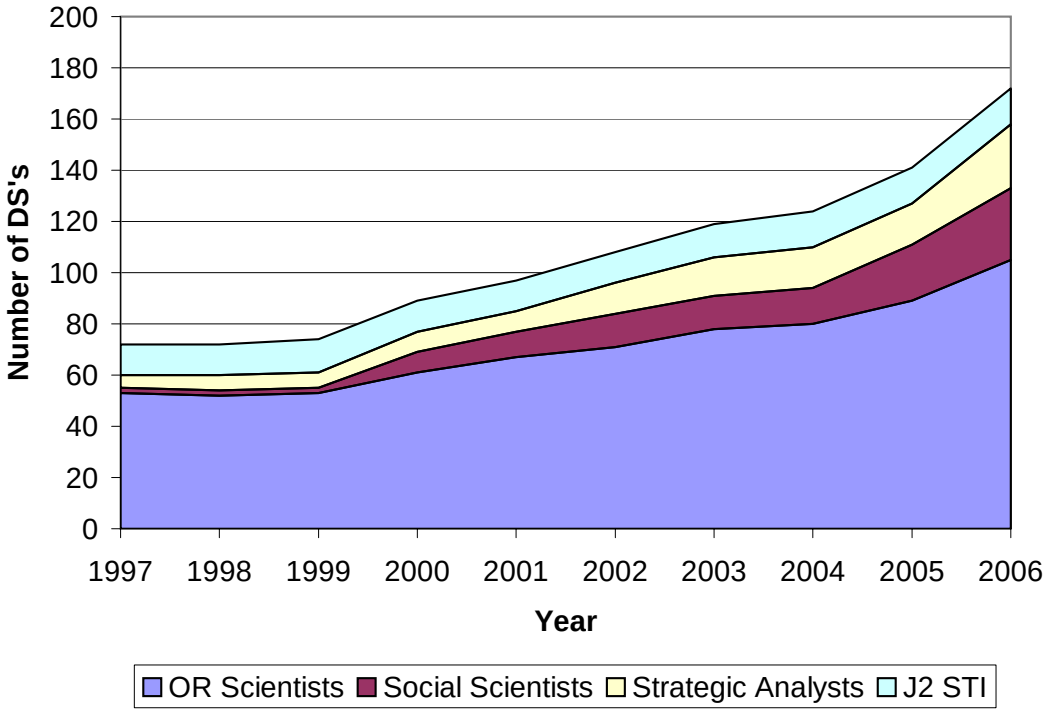


Figure D.1: *Historical size of all Defence Scientist groups currently under DRDC CORA.*

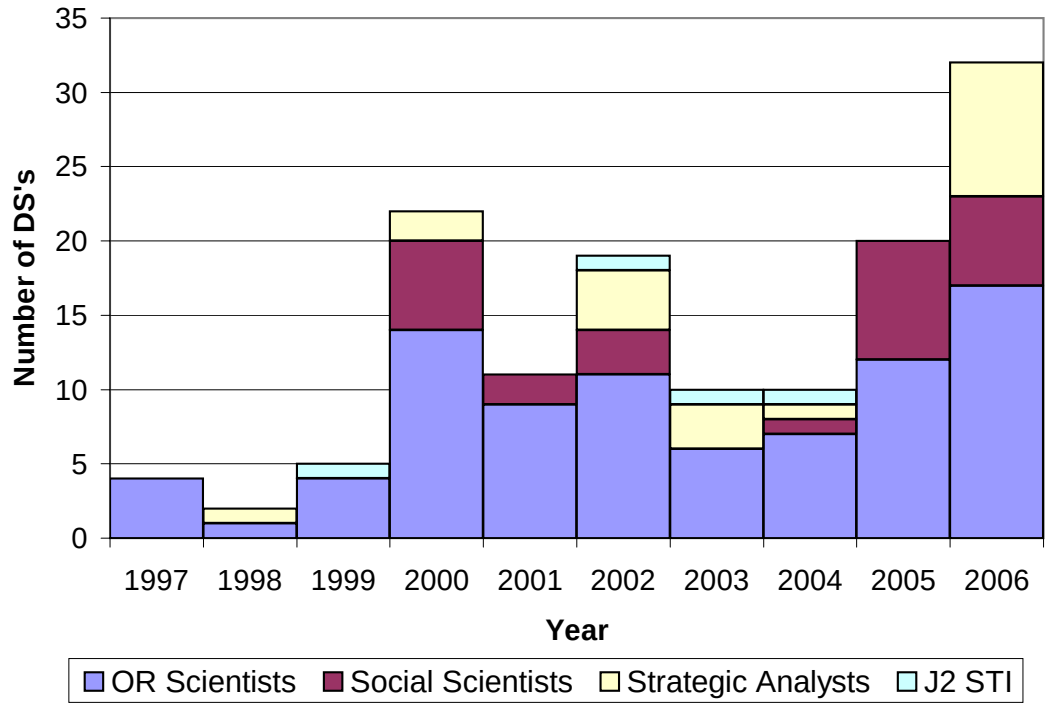


Figure D.2: *Hiring trends for all Defence Scientist groups currently under DRDC CORA.*

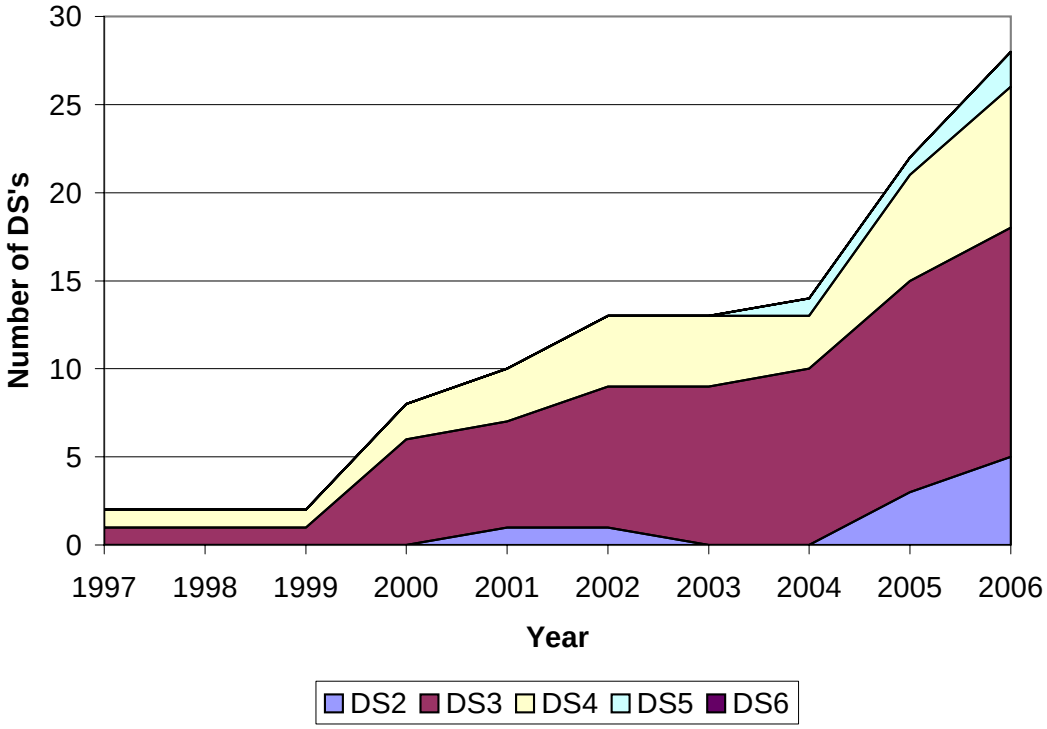


Figure D.3: *Historical size of Social Scientist population in DRDC CORA.*

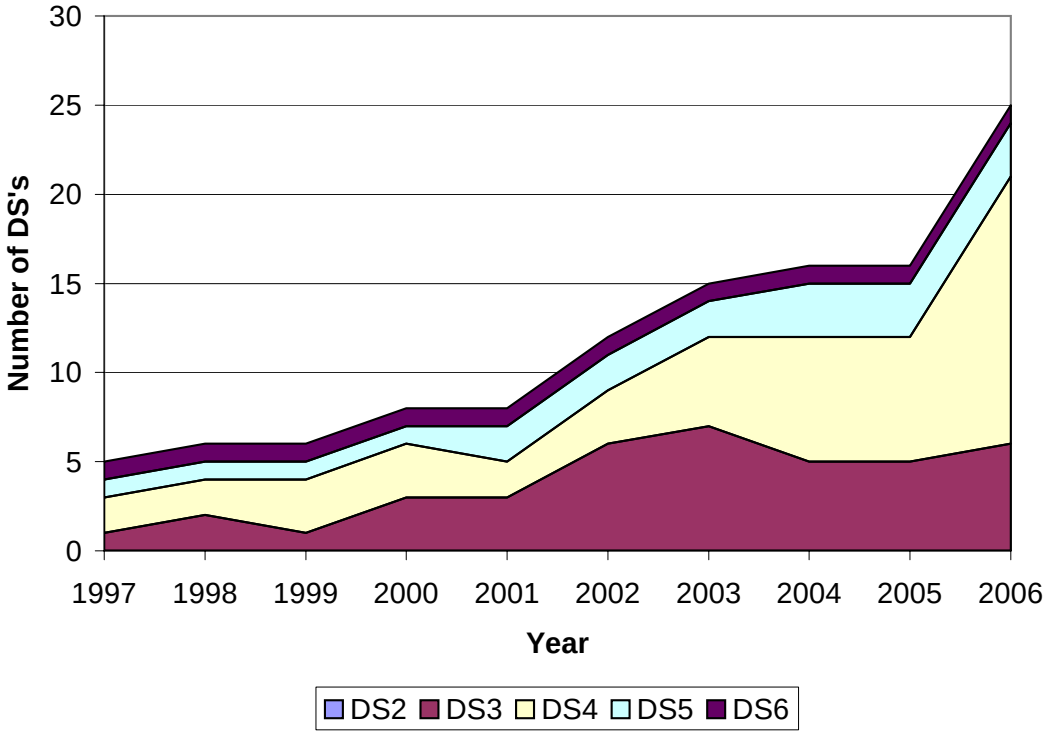


Figure D.4: *Historical size of Strategic Analyst population in DRDC CORA.*

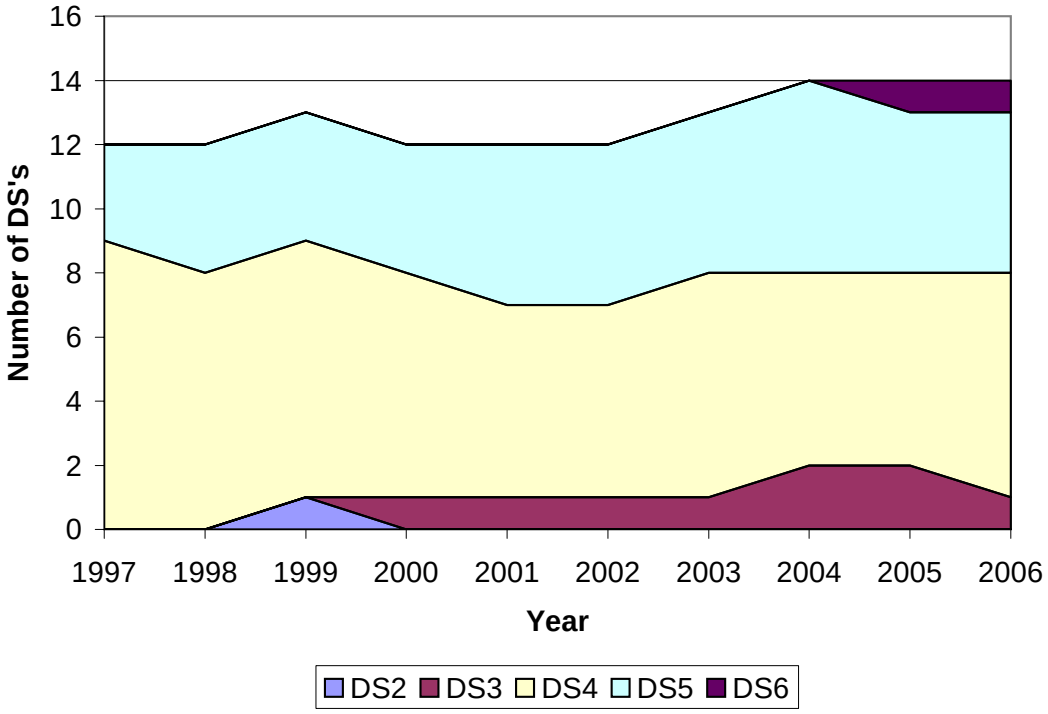


Figure D.5: *Historical size of Intelligence Analyst population.*

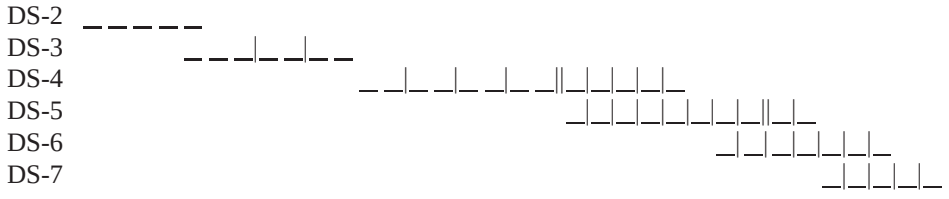
Annex E
The Defence Scientific Service Group Pay Plan

Members of the Defence Scientist (DS) Service Group are subject to the DS Pay Plan,[14] that defines the seven DS classification levels, and the pay steps within each level. Table E.1 summarizes the DS-levels, pay increments, and barriers as outlined in the Pay Plan. Double barriers are defined as natural points at which time a DS is normally considered for promotion, while single barriers represent points at which a scientist may be held back if sufficient progress is not observed.

The Pay Plan also: sets out the characteristics and expectations of a DS at each classification level (the "DS Classification Standard"); describes the merit-based system that dictates how individuals are promoted throughout their careers; and describes the normal rates of progression through the Pay Plan, including when individuals are to be considered for promotion, and the significance of single and double barriers. Specifically, under the section "DS Salary progression guidelines", the Pay Plan states:

> "The normal rates of salary progression within the levels will be as follows:
> - annual increments - DS-02, DS-03, DS-06 and DS-07
> - annual increments - below the double barriers in DS-04 and DS-05
> - biennial increments - crossing the double barrier in DS-04 and DS-05 and at each single barrier thereafter
>
> "Employees in DS-03, and below the double barriers in DS-04 and DS-05, may receive double increments if they are developing at a much faster rate than normal towards meeting the criteria for promotion to the next level.
>
> "Slower than normal rates of salary progression may also occur.
>
> "Employees will be considered for promotion after one year at the DS-01 level and after one year at the maximum of DS-02 and DS-03 levels, the double barrier in DS-04 and the sixth increment in DS-05. Consideration for promotion can occur at other points on the salary scale."

Table E.1: *DS Pay Plan: Levels, pay steps, and barriers (since 1997).*



[14] http://publiservice.tbs-sct.gc.ca/pubs_pol/hrpubs/compensation/dssg_e.asp

Table E.2: *DS compensation rates as of the beginning of FY 06/07*

Pay	DS Level					
Step	2	3	4	5	6	7
1	$ 37621	$ 51953	$ 67929	$ 83639	$ 97229	$ 106555
2	$ 41701	$ 54117	$ 69842	$ 85788	$ 99619	$ 108950
3	$ 48058	$ 56282	$ 71754	$ 87940	$ 102013	$ 111345
4	$ 49792	$ 58445	$ 73671	$ 90088	$ 104406	$ 113740
5	$ 51953	$ 60612	$ 75580	$ 92239	$ 106801	$ 116135
6		$ 62778	$ 77496	$ 94390	$ 109188	
7		$ 64941	$ 79410	$ 96789	$ 111579	
8			$ 81318	$ 99168		
9			$ 83238	$ 101509		
10			$ 85147	$ 103849		
11			$ 87063			
12			$ 88976			
13			$ 90890			

E.1 Retirement and Superannuation

As public service employees DS's are covered by the Public Service Superannuation Act,[15] and are entitled to:

- retire with full pension after 35 YOS, where full pension is 70% of their highest average salary over any 5 year window during their employment (typically the last 5 YOS);
- retire with no penalty on their accrued pension when they reach age 55 and 30 YOS; or age 60 and 2 YOS, accruing 2% towards their pension for each YOS;
- retire early incurring a 5% penalty on their pension for every year remaining before age 55 or 30 YOS (whichever is more), though they may only do this if they have reached age 55 and have $\geq$ 25 YOS or have reached 30 YOS and have are $\geq$ 50 years old,
- work indefinitely beyond retirement age.

[15] `http://laws.justice.gc.ca/en/p-36/`

List of symbols/abbreviations

CF	Canadian Forces
CORA	Centre for Operational Research and Analysis
DND	Department of National Defence
DRDC	Defence Research and Development Canada
DS	Defence Scientist
FY	Fiscal Year
HRMS	Human Resources Management System
LWOP	Leave Without Pay
OR	Operational Research
OR&A	Operational Research and Analysis
SWE	Salary Wage Envelope
YOS	Years of Service
YTR	Years to Retirement age

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September 2006

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This report documents the findings of a study on the demographics of DRDC CORA's operational research scientists. Based on data from 1997-2006, the report gives a breakdown of the DS population by DS level, age and seniority. Historical attrition, hiring and career progression trends are also presented. The report describes results of a model created to project current DS demographics into the future. The demographic data and the model will aid management in determining annual recruiting levels.

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4. AUTHORS
(Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.)

Eles, Philip T. ; Massel, Paul L.

5. DATE OF PUBLICATION (month and year of publication of document)	6a. NO. OF PAGES (total containing information. Include Annexes, Appendices, etc).	6b. NO. OF REFS (total cited in document)
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7. DESCRIPTIVE NOTES (the category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered).

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This report examines DRDC CORA's historical and future capacity to perform traditional (quantitative) operational research (OR) by examining the past, present, and future demographics of its OR defence scientists (DS's). Trends related to the demographics of CORA's OR DS's were analyzed with respect to the size of the population, its distribution with respect to DS level, age and experience based on data from 1997-2006. Past hiring, attrition and career progression trends were also examined. Historical trends were used to develop a career progression model to simulate the future demographics of the OR DS population out to 2025. Results were interpreted from a strategic HR planning perspective with recommendations made regarding future HR strategies.

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Defence Scientist, DS, Defence Scientific Services Group, Pay Plan, trends, hiring, attrition, career progression, demographics

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