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DEVELOPMENT OF A STEADY STATE MODEL FOR FORECASTING U.S. NAVY NURSE CORPS PERSONNEL

by

Gary Deen
Glenn G. Buni

March 2004

Thesis Advisor:	Anke Richter
Associate Advisor:	Stephen Mehay

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This thesis developed a deterministic Markov state model to provide the U.S. Navy Nurse Corps a tool to more accurately forecast recruiting goals and future years force structure. Nurse Corps data was provided by the Nurse Corps Community Manager's office covering fiscal years 1990 to 2003. The probabilities used in the Markov model were derived from the fiscal year data. Transitions used in this model were stay at present grade, move up one grade or exit the system. Backward movement was not allowed and individuals could only move up one grade per year. The model was limited to eleven years and focused primarily on the ranks of O-1 to O-3. O-4's and O-5's that appeared in the data were allowed to flow through the system. Logistic regression was then used to investigate the probability of "staying" in the Nurse Corps to certain career decision points. Nurse Corps cohort data files for fiscal years 90 through 94 were merged for analysis, as was cohort data for fiscal year 96 through 98. Results of the markov model show that the O-1's and O-2's reach a steady state at the eight-year mark while the O-3's reach a steady state at the seventeen-year mark (based on provided data). The steady state values are compared to actual Nurse Corps goals. Results of the logistic regression show that Recalls, Medical Enlisted Commissioning Program and Nurse Candidate Program were all significant at increasing the probability of staying in the Nurse Corps. Males were more likely than females to stay in the Nurse Corps and changes in education levels decreased the probability of staying in the Nurse Corps.

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Glenn G. Buni
Lieutenant, United States Navy
B.S., Saint Mary's College, 1993
M.S., Saint Mary' College, 1999

Gary T. Deen
Lieutenant, United States Navy
B.S.N., Georgia State University, 1994

Submitted in partial fulfillment of the
requirements for the degree of

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NAVAL POSTGRADUATE SCHOOL
March 2004

Authors: Glenn G. Buni

Gary T. Deen

Approved by: Anke Richter
Thesis Advisor

Stephen Mehay
Associate Advisor

Douglas A Brook
Dean, Graduate School of Business and Public Policy

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ABSTRACT

This thesis developed a deterministic Markov state model to provide the U.S. Navy Nurse Corps a tool to more accurately forecast recruiting goals and future years force structure. The nurse corps personnel were categorized by length of service and paygrade. The focus of this research was paygrades O-1 to O-3, which required lengths of service up to eleven years for aging through the system. O-4's and O-5's that appeared in the data were allowed to flow through the system. Nurse Corps data was provided by the Nurse Corps Community Manager's office covering fiscal years 1990 to 2003. The transition probabilities used in the Markov model were derived from the fiscal year data. Personnel stay at present grade, move up one grade or exit the system within each year of the model. Backward movement was not allowed and individuals could only move up one grade per year. Logistic regression was then used to investigate the probability of "staying" in the Nurse Corps to certain career decision points. Nurse Corps cohort data files for fiscal years 90 through 94 were merged for analysis, as was cohort data for fiscal year 96 through 98. Results of the markov model show that the O-1's and O-2's reach a steady state at the eight-year mark while the O-3's reach a steady state at the seventeen-year mark (based on provided data). Comparing to nurse corps goals, the current accession plans result in a severe shortage of Lieutenants. There is an overabundance of Ensigns so the overall size of the Nurse Corps is as desired; it is just a more junior corps. Scenarios were developed to ascertain the best mix of accessions to attain Nurse Corps goals as well as to examine scenarios for downsizing. Results of the logistic regression show that Recalls, Medical Enlisted Commissioning Program and Nurse Candidate Program were all significant at increasing the probability of staying in the Nurse Corps. Males were more likely than females to stay in the Nurse Corps and a change in education levels decreased the probability of staying in the Nurse Corps.

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TABLE OF CONTENTS

I. INTRODUCTION 1
- **A. BACKGROUND 1**
- **B. OBJECTIVES 5**
- **C. SCOPE 5**
- **D. ORGANIZATION OF STUDY 6**

II. THE NAVAL NURSE CORPS 7
- **A. STRUCTURE OF THE NAVAL NURSE CORPS 7**
- **1. Overview of the Naval Nurse Corps 7**
- **2. Establishing Manpower Authorizations for the Navy Nurse Corps 7**
- **3. Defense Officer Personnel Management Act (DOMPA) 8**
- **4. Accession Sources 9**
  - ***a.Nurse Candidate Program (NCP)* 16**
  - ***b.Direct Accessions* 17**
  - ***c.Recalls* 17**
  - ***d.Full Time Outservice Training (FTOST)* 17**
  - ***e.Seaman-To-Admiral (STA-21)* 18**
- **5. Related Studies 18**
  - ***a.Manpower Modeling used in Government and Armed Forces* 19**
  - ***b.Accession Sources for the U.S. Nurse Corps* 21**

III. METHODOLOGY 23
- **A. MARKOV MODEL FORMULATION 23**
- **1. Data Set 23**
- **2. Fiscal Year Matrices 23**
- **3. Required Statistics 24**
  - ***a.Defining The Transition* 24**
  - ***b.Stocks* 25**
  - ***c.Input* 26**
  - ***d.Predicted Years Output* 27**
  - ***e.Summary Output* 27**
- **B. LOGISTIC REGRESSION 27**
- **1. Data Set 27**
- **2. Descriptive Variables 28**
- **3. Constructed Variables 29**
- **4. Logistic Regression Model 31**

IV. RESULTS 33
- **A. MARKOV MODEL 33**
- **1. Model Validation 33**
  - ***a.Base Case Scenario* 34**
  - ***b.Steady State Scenario* 37**
  - ***c.Optimal Mix Of Accessions* 38**
  - ***d.Two-Thirds/One-Third Mix* 40**

e.50% Reduction In Accessions Scenario 43
B. DESCRIPTIVE STATISTICS....48
1. FY 90-94 Data Set 48
2. FY 96-98 Data Set 50
C. REGRESSION ANALYSIS 51
1. Data Analysis, Logit Stay = 4 Years....51
2. Data Analysis, Logit Stay = 5 Years....54
3. Data Analysis, Logit Stay = 7 Years....57
4. Data Analysis, Logit Stay = 10 Years....60
5. Data Analysis, Logit Stay = 5 Years, Fy 96-98 Data....63

V. CONCLUSIONS AND RECOMMENDATIONS....67
A. MARKOV MODEL....67
1. Lesson Learned 67
B. REGRESSION ANALYSIS 68
C. RECOMMENDATIONS....70
1. Considerations for Future Studies 70
D. SUMMARY 72

APPENDIX A – YEAR 1 MATRIX FY 02 (BASE CASE)....75

APPENDIX B – INPUTS FY 02 (BASE CASE) 77

APPENDIX C – PREDICTED YEARS OUTPUT 79

APPENDIX D – SUMMARY OUTPUT (BASE CASE) 81

APPENDIX E – O-1 TO O-5 OUTPUT....83

APPENDIX G – TWO THIRDS/ONE THIRD MIX (INPUT AND SUMMARY OUTPUT)....87

APPENDIX H – 50% CUT IN ACCESSIONS (INPUT AND SUMMARY OUTPUT)....89

LIST OF REFERENCES....91

INITIAL DISTRIBUTION LIST....93

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I. INTRODUCTION

A. BACKGROUND

Naval medicine provides high quality and cost-effective health care to approximately 700,000 active duty Navy and Marine Corps members, as well as 2.6 million retirees and their family members while at the same time supporting contingency, humanitarian, and joint operations around the world. A health care team consisting of highly trained and dedicated health care professionals accomplishes this mission (Ref 1: 2004 JAN 15). The Navy Nurse Corps is a vital member of this team and its complex role is described below:

> The Navy Nurse Corps actively supports the Navy and Marine Corps Team and Navy Medicine with a community of active and reserve component professionals focused on accomplishing the readiness and health benefit missions. Navy Nursing is unique in its responsibility for professional nursing care in peacetime and wartime. Nurse Corps officers share an historical camaraderie of caring for others under ordinary, extraordinary, and often unusual circumstances. As professional registered nurses, they voluntarily assume an additional role as Naval officers which mandates the successful integration of compassion with discipline, individuality with conformity, and wellness promotion with wartime readiness. As collaborative participants on the health care team, they freely share nursing expertise to accomplish the health services mission. Navy Nurses are life-long learners, dedicated to pursuing quality education and training to foster personal and professional excellence. Leadership is every Nurse Corps officer's responsibility. As role models and mentors for other nurses and Hospital Corpsmen, Navy Nurses must apply their experience, education, and training to be both military and nursing leaders (Ref. 2: 2004 Jan 15).

The U.S. Navy Nurse Corps (NC) must compete with the civilian community and other agencies, including the U.S. Army and the U.S. Air Force, in its quest to maintain an adequate supply of nurses for meeting the mission of Navy medicine.

The Navy NC relies on several training programs to produce new graduate nurses to meet the NC's end-strength (authorized number of nurses). Some of these programs select qualified candidates from the enlisted ranks and provides an opportunity for sailors

to obtain a Bachelor's of Science in Nursing (BSN) degree and to receive a commission into the Nurse Corps [through the Medical Enlisted Commissioning Program (MECP) and Seaman to Admiral (STA-21) programs].

Some programs provide scholarships for educational expenses [Naval Reserve Officer Training Corps (NROTC) and Nurse Candidate Program (NCP)] and then provide a commission into the Navy upon completion of the BSN. These programs are considered primary sources for entry into the NC and the candidates will enter the Navy at the rank of Ensign (O-1) for a contractual period of four years.

When the training pipeline does not provide an adequate input into the NC, the Navy recruits in the open market for nurses who have graduated from an accredited School of Nursing with a minimum education requirement of a BSN. These acquisitions are called "direct accessions" (with or without a sign-on bonus) and are considered secondary sources for accessioning.

Qualified candidates who enter the NC as direct accessions may receive an entry grade credit for approved civilian job experience. Based on previous job experience, this entry grade job credit could allow the candidate to enter the NC up to the rank of Lieutenant (O-3). Direct accessions that receive a bonus upon entering the Navy commit to four-year contracts, while those who do not receive bonuses are obligated to three-year terms. (Ref.3)

In November of 1999 the Congressional Budget Office (CBO) released its analysis of the drawdown of the military officer corps. The analysis showed that the Department of Defense (DoD) reduced the number of officers on active duty by about 23 percent between 1989 and 1996 as part of the post-Cold War drawdown in U.S. military forces (Ref. 4: p.1). The Navy achieved its reductions using a selective early retirement (SER) program, cuts in accessions, and the up-or-out provisions of the promotion system (Ref. 4: p. 13).

However, this drawdown only affected officers in combat-related occupations. Support occupations, which include the Nurse Corps, actually increased during the same time period. In the Navy, combat-related occupations decreased by about five percent,

while health support occupations increased by about 26 percent (Ref. 4: p.34). The NC was able to remain at stable levels during the drawdown and data from the NC Community manager's office show that end strength targets for the NC remained around the level of 3300 for nurses on active duty between FY92 to FY 95. NC targets for end strength show a decline between FY1996 to FY2003 to a current level of 3168 nurses for active duty.

Not only was DoD mandated a reduction in the force structure, but the services have also been constrained by the Defense Officer Personnel Management Act (DOPMA) of 1980. (Ref. 4: p.3) DOPMA controls specific inventory numbers in the pay grades O-4 thru O-6, and dictates the opportunity for promotion (the proportion of those officers competing for a higher grade who are in fact promoted) as well as "flow-points"(the number of years and months of service at which officers may typically expect promotions) to promotion (Ref. 4: p.5). This act was designed to bring about "stability and interservice equity to the management of the officer corps" (Ref. 4: p.5).

The Navy reduced the flow of officers into the general officer corps (accessions) as the primary means for reducing its force. The CBO study identified the following problems with reducing the flow of accessions:

- Separation rates of officers remained unchanged and some groups of officers even displayed lower than expected separation rates during the drawdown even though accessions were being cut;
- The cuts in the number of accession has created a more senior officer corps with respect to time in service and rank, and could also include age of officers;
- This older corps would have to develop new ways of training the new accession, since the junior (middle grade) officers would be more scarce;
- The smaller cohorts entering the service through the reduced accession pipeline would eventually result in a shortage of experienced officers in the mid to upper pay grades. This shortage could possibly require more incentives to maintain the corps. (Ref.4: p. 2-4)

In the future, if the NC were tasked with reducing its active duty nurses end strength, the NC could expect the same types of problems that were identified in the CBO study above. The options available for reducing its force would be to cut the accessions entering the NC, enforcing the up-or-out rules of DOPMA, or enticing early separation or retirement from the NC. The easiest of the three listed options would be for the NC to cut accessions into the system. However, even without a mandated drawdown of the NC, other problems exist within the current officer structure and promotion process.

Promotions from the grade of O-3 to O-4 within the NC occur only when there are vacancies at the O-4 level. Higher than normal retention rates being experienced by NC officers in pay grades at or above the O-4 level, are expected to create a blockage of promotions between the ranks of O-3 and O-4. With this backlog in place, nurses in the paygrade of O-3 will have less opportunity for advancing and likely will exit the system. With mid-grade nurses leaving the NC and accessions for entry being reduced, the NC will be creating a more senior force and can expect shortages in the lower to mid pay grades in the future.

The creation of a deterministic Markov state model will provide the NC a tool to more accurately forecast recruiting goals and future year force structure. The study of these results should enable NC manpower planners to decrease the variance of personnel influx within the Navy Nurse Corps' accession pipelines. By decreasing this variance, the NC can be better prepared to meet the mandated requirements from within its existing stock of personnel. In addition, the reduction in variance should improve the opportunities for promotion by ensuring that there are sufficient numbers of nurses needed for system continuity.

In the Chief of Naval Operations (CNO) guidance for 2004, he challenges each and every member of the navy to be more efficient and find ways to reduce wasteful spending within the fleet. He wants a smaller, more educated and productive fleet that can take advantage of new and developing technologies. He wants the leaders in the fleet to improve efficiencies by using metrics and modeling. He states that, "we must improve our use of modeling, develop and improve output matrices to better define our requirements and resource needs and instill a culture of improved productivity in

everything we do." (Ref. 5, 2004 Jan 15) Having a Navy NC manpower model will improve on the "best guess estimates" currently used in the decision making process for annual NC accession goals and will more closely align NC business practices of force management with the goals of the CNO by relying more on predictive models.

B. OBJECTIVES

This thesis will use Markov modeling to develop a steady state representation of personnel and personnel progression within the NC. By developing this model, we propose to answer the following questions:

- How many nurses must the Navy gain and lose each year to maintain the Nurse Corps?
- What pay grade do these losses need to be in to ensure adequate promotion opportunity?
- What number of nurses should come from each accession source program?
- What policy guidance can be learned/observed from the model?

C. SCOPE

The scope of this research will include: (1) an overview of the Navy NC structure; (2) a summary of current business practices used for personnel forecasting in the Navy; (3) identification of policies that govern end-strength; (4) development of progression rates by grade and years in service; (5) exploration of impact of accession sources on progression/retention rates at career decision points; and (6) development of a model incorporating the information detailed in the above items.

The model will be developed for the pay grades of Ensign (O-1) through Lieutenant (O-3), and will exclude the pay grades of Lieutenant Commander (O-4) thru Captain (O-6). Promotion rates obtained for the different pay grades will be derived from historical data gathered from the Bureau of Medicine (BUMED) Manpower Information System (BUMIS) as provided by the NC Community Manager's office. Retention rates at career

decision points will be investigated by using logistic regression methods to predict and/or identify significant factors (with particular focus on accession sources) that explain retention rate differences.

D. ORGANIZATION OF STUDY

Chapter II discusses the structure of the Navy NC, details the current manpower planning policies and procedures, and describes the effect that DOPMA has on the Navy Nurse Corps. This chapter also provides a summary of prior studies relating to nursing manpower issues. Chapter III describes the methodology used to predict various statistical rates, Markov modeling formulation, and introduces logistic regression (LOGIT) models for data analysis. Chapter IV provides results from sample scenario runs using the Markov model and provides results of the logistic regression analysis. Chapter V presents our conclusions and recommends possible further areas of investigation needed to extend this study.

II. THE NAVAL NURSE CORPS

A. STRUCTURE OF THE NAVAL NURSE CORPS

1. Overview of the Naval Nurse Corps

The U.S. Naval officer corps consists of approximately 55,638 officers and can be broken down into the Unrestricted Line (URL), Restricted Line (RL), and Staff officer communities. The NC is aligned with the RL and Staff officer communities and comprises approximately 5.57 percent of the total officer corps (Ref. 15: slide 3). The current (05Sep03) breakdown of the NC has a beginning balance for FY03 of 3157 nurses distributed through the pay grades of O-1 to O-7. Predicted gains for FY03 include 67 nurses from direct accession, six nurses from recalls, 42 nurses from NROTC, 55 nurses from NCP, and 53 nurses from MECP for a total of 224 gains.

Projected losses by types for FY03 are the following: 137 will retire, ten will resign, 108 will be Released from Active Duty (RAD), 16 will be administratively discharged, and seven will be lost for 'other' reasons for a total of 278 losses in FY03. Target end strength (equivalent to Officer Programmed Authorizations) for FY03 is 3,168, but the predictions show that actual end strength will be 3,103, a shortfall of 65 nurses.

The NC has approximately 3,176 billets. About 3,136 of these are Nurse Corps "specific" billets, with the remaining 40 being "shared" (or serving in a capacity other than nursing). The target end strength numbers reflect "funded" (or "subsidized") billets, which results in the NC having 8 "unfunded" billets (the original 3,176 billets *minus* 3,168 of the authorized end strength). (Ref. 3)

2. Establishing Manpower Authorizations for the Navy Nurse Corps

The community manager for the NC develops an annual accession plan based on guidance from the Chief of Naval Personnel (CNP), which determines the recruiting goals for the next fiscal year. The community manager and planner work together to develop the accession plan. The planner starts out with a beginning inventory balance (end of previous fiscal year inventory) and projects losses for the current year. This loss

projection determines the needed gains for the upcoming fiscal year and these gains are adjusted up or down depending on which way the inventory target is moving. This inventory target is billet authorizations (or "end strength").

In addition to adjusting the gains, the planner must also consider the various entries that will come into the NC through its accession programs. Direct accessions are the only source that can be "manipulated" up or down as needed by the planner/community manager to meet accession shortfalls. Currently, the NC does not recruit by specialty.

Once the accession plan is complete, it is then submitted to CNP for approval. If approved, a goaling letter is completed to direct NC recruiting in meeting its targets for the coming fiscal year. This process has a mid-year review to allow for any adjustments in the plan. Any changes to this plan must be approved by the CNP.

CNP directives and NC goal requirements can differ due to initiatives that may propose cutting total end-strength in the overall Naval officer corps. This could result in the Nurse Corps accession plan being returned with reduced targets and goals. (Ref. 3)

3. Defense Officer Personnel Management Act (DOMPA)

In November 1980, Congress amended United States Code Title 10 to "make uniform the provisions of law relating to the appointment, promotion, separation and retirement of regular commissioned officers of the Army, Navy, Air Force and Marine Corps." Thus began the onset of the Defense Officer Personnel Management Act (or "DOPMA"), which gave the services direction for managing its officer corps. (Ref. 6: p.1)

For the first time in history, DOPMA established "uniform" laws for all four military services governing original appointment of commissioned officers (both regular and reserve officers on extended active duty), rules governing promotion, and standards for the mandatory separation and retirement of officers (including separation pay for those separated involuntarily short of retirement) (Ref. 6: p.1).

DOPMA established officer inventories in the controlled grades of O-4 to O-6, dictates opportunity for promotion, and specifies the flow points of the promotion process. Not only did DOPMA continue such policies as "up-or-out", but it reformed

the system of active and reserve officer commissions and grade controls that were originally envisioned as a temporary measure to facilitate a peacetime military that was larger than the historical norm (Ref. 6: p.7).

Annually, Congress authorizes total officer strength for each military service by considering the historical relationship between officer and enlisted personnel (otherwise known as the "enlisted-officer ratio"), specific military branch personnel requirements, and the achievement of other manpower goals (Ref. 6: p.7).

Congress specifies in DOPMA the number of officers it will allow in each field grade rank above O-3 in the *officer grade distribution* (and published in the "DOPMA grade table"). The Officer grade distribution varies as a function of total officer end-strength rather than as a fixed percentage of total military end-strength. (Ref. 6: p.7-8)

Unique to its controlled promotion system, physicians and dentists are excluded from the DOPMA promotion grade table, giving those community managers more freedom in regulating its officer corps. The non-inclusion of nurses to this exception has lead to the services advocating for other creative parameters to allow their advancement in rank (namely at the O-4 level), *without* counting against DOPMA-restricted promotion mandates.

This so-called "relief" in DOPMA addresses the problem of removing nurses from the DOPMA grade table (in the same way medical and dental officers are excluded) or providing some form of separate grade table(s) or some grade table relief to bring the nurse competitive category promotions into line with DOPMA norms, now and for the future, without "taking" more field grades from the line (Ref. 6: p.45).

4. Accession Sources

The Navy NC relies on three main commissioning programs to support its staffing needs. These are NROTC, MECP and NCP. These programs are the primary sources of entry for nurses into the Navy NC. When these pipelines do not provide adequate accessions to meet end strength, the NC must recruit nurses in the open market via direct accession. Direct accessions is the only program that the NC can manually adjust throughout the year to correct for shortfalls in the training pipeline.

The NC can also use the Recall program to bring nurses back onto active duty from Reserve status to fill critical specialty shortage billets. If used, Recalls return to active duty in rank up to the level of Lieutenant (O-3) and can serve out their career, assuming they do not "fail-to-select" twice, where the "up-or-out" rule of service separation would apply.

NROTC, MECP and NCP have averaged about 61 percent of the accession gains for the NC since FY2000. Direct accessions and Recalls have accounted for approximately 36 percent of nurse accessions during the same time period. The NC has no forecasted Recall quotas for FY 2004 and beyond. (Ref.3)

Seaman-to-Admiral (STA-21) is a new accession program for the NC and will allow eligible enlisted members to apply for and receive a BSN along with a commission into the NC. Entry into the NC will be at the paygrade of Ensign (O-1). Current projections for the NC are that one or two candidates will enter the NC through the STA-21 in FY04 and FY05 but the output of this program is scheduled to reach 10 nurses per year after FY05. (Ref. 7)

U.S. Navy Corps' nurse accession sources are summarized in Table 1 below. Table 1 also displays historical accession programs that were used by the NC prior to FY 1995, which include FTOST and BDCP.

Table 1 - Nurse Corps Accession Programs (From U.S. Navy Nurse Corps - May 2002)

Program	Age Requirement	Education	Prof. Qual.	Service Obligation	Special Notes
2905 (Direct) (091)	Complete 20 years active commissioned service by age 55. Waivers for goaled specialties only.	Graduate from an accredited U.S. bachelor's or master's nursing program. Prior to FY90, accepted Diploma (108 weeks) and Associates Degree with BS in related field (Chemistry, Biology,etc)	Must be a currently licensed registered nurse.	3 years active duty. If accepts accession bonus, obligation is 4 years.	$5,000 accession bonus. Entry grade credit for experience. Appt as ENS, LTjg, LT.
Recall (029)	Must be able to complete 20 years by age 55.	Graduate from an accredited U.S. bachelor's or master's nursing program.	Must be a currently licensed registered nurse.	**Allowed to serve out career (provided no "Up-or-Out" applied).**	
NCP- Nurse Candidate Program (092) Subsidized program	Complete 20 yrs active commissioned service by age 55. Must report to OIS before 35th birthday.	Must have completed 2nd yr of accredited BSN prog; GPA must be 3.0/4.0 scale.	High school graduate (See Education)	1 yr school - 4 yrs ACS 2 yrs school - 5 yrs ACS Total 8 yrs mil service (SELRES or IRR)	$5000 access bonus; monthly stipend of $500/mon; No tuition or fees. Max of 24 months. Not eligible 6 months from graduation. Counts as inactive reserve end strength; commissioned (inactive) at graduation.
NROTC (004) Scholarship program	Commission before age 27, unless prior AD; Waive to 30.	Selected by CNET GPA; Must be 3.0 overall & "C" average in related sciences; Outputs change with 4 yr prog	High School graduate (See Education)	4 yrs AD; Total of 8 yrs mil service (SELRES or IRR)	Tuition (up to 4 years) plus books; Subsistence of $150/mon. Not to exceed 4 years of school/maximum of 40 academic months. Summers are training periods. Counts as NROTC midshipman while in school. Commissioned at time of graduation. May request voluntary delay for AD up to 12 months. Does not attend OIS.
MECP - Medical Enlisted Commissioning Program (103)	Commission prior to 35th birthday.	Graduate from an accredited U.S. bachelor's or master's nursing program.	High school graduate; Complete 30 semester credit hours of undergraduate courses to transfer; 2.5 GPA for undergraduate courses.	4 yrs AD; Total of 8 yrs mil service (SELRES or IRR)	Receive full pay and allowances for their enlisted pay grades; Eligible for advancement; Student pays tuition, fees, and books. Required to complete bachelors in 36 months. May obtain masters degree within this time period.
STA-21 – "Seaman to Admiral" Enlisted-to-Officer Commissioning Program	Commission prior to 35th birthday	Graduate from an accredited U.S. bachelor's or master's nursing program.	High school graduate; Maintain 2.5 or better GPA while enrolled in STA-21.	5 yrs AD; Total of 8 yrs mil service (SELRES or IRR)	The STA-21 Nurse Corps Option is available only at specially identified NROTC affiliated colleges or universities with nursing programs.

Historical Accession Programs

BDCP - Bachelors Degree Completion Program (090)	Commission prior to 35th birthday.	Graduate from an accredited U.S. bachelor's nursing program.	Enrolled or accepted to upper division college or university.	4 yrs AD; Total of 8 yrs mil service (SELRES or IRR)	Baccalaureate degree requirements required to be completed within 24 months; Receive full pay and allowances; Student pays tuition, fees, and books. Enlisted as E-3 in an active status in the reserves. FY95 was the last yr BDCP accepted students.
FTOST – Full Time Outservice Training (093)					In the early 1990s there was difficulty recruiting to specific specialties (CRNAs and Family Nurse Practitioners). This was a result of the late 1980's nursing shortage. Began in FY91: 10 - CRNAs and 4 - Family NPs; FY92: 5 - CRNAs; FY93: 1 - CRNA. FY93 was the last yr for FTOST.

a. Naval Reserve Training Corps (NROTC)

NROTC provided the Navy NC with its first accessions in Fiscal Year 1992. The NC community manager derives the quotas for this program, while the Chief of Naval Education and Training (CNET) and the Naval School of Health Sciences (NSHS) manage the program. The quota has been set at 60 candidates per year, but current output (FY-04) has been lowered to 39 due to attrition from the program. (Ref. 3)

Selection for this program is managed by CNET. Candidates must be commissioned before age 27, unless the candidate has prior active duty service, then a waiver may be granted to age 30. The candidate must maintain a 3.0 overall grade point average (GPA) with at least a "C" average in related sciences. Candidates must be high school graduates.

If accepted, candidates will have a four-year service obligation on active duty with a total commitment of eight years military service. This time will be served on active duty or in the Selective Reserves (SELRES) or Individual Ready Reserves (IRR). Candidates receive tuition plus books for 4 years or maximum of 40 academic months and also collect $150.00/month as subsistence.

Summers are considered training periods and while enrolled in school the candidate accrues time in service as a midshipman. The candidate is commissioned at graduation, but may request a voluntary delay for active duty for up to 12 months. Once commissioned, the candidate does not attend Officer Indoctrination School (OIS) (Ref 3 and Ref. 8: p.11-12).

b. Medical Enlisted Commissioning Program (MECP)

MECP is available to all enlisted personnel in the Navy and the Marine Corps, active and reserve. (Ref. 9) The NC community manager sets the quotas for the program, while NSHS manages the program. The quota for MECP is set at 150 enlisted personnel. However, this number varies based on the yearly graduation rates enrolled in school. Current projections (FY-04) are around 67 candidates. Eligible candidates must be high school graduates and have completed at least 30 hours of undergraduate course work that is transferable towards a nursing degree. Eligible candidates must then be commissioned prior to their 35th birthday, and must graduate from an accredited U.S.

bachelor's of nursing program. Once in the program candidates must maintain a 2.5 GPA.

Upon graduation, the candidate is commissioned as an Ensign with an obligation of four years active duty and eight total years of military service (SELRES or IRR). Once selected, the candidate receives full pay and allowances for their enlisted pay grades and remains eligible for advancement. The candidate pays tuition, fees and books and is required to complete their bachelor's degree within 36 months (Ref. 3 and Ref. 8: p-14).

a. Nurse Candidate Program (NCP)

NCP delivered its first accessions into the NC in FY 1993. The NC community manager develops quotas for this source and the program is managed by NSHS. The quota for this program is 55 per year. Individuals that make up the pool of candidates for NCP have no prior military experience and if selected must report to OIS prior to their 35th birthday and must be able to complete 20 years of active service by age 55.

Candidates must be high school graduates and have completed their second year of an accredited Bachelors of Science Nursing (BSN) program with at least a 3.0 GPA prior to acceptance into the program. If candidates are accepted, their payback is as follows; one year to complete the BSN; four years of active duty and a total of eight years of military service (SELRES or IRR). Two years to complete the BSN will require the candidate to payback five years of active service with eight total years of military service (SELRES or IRR).

Candidates receive a $5,000 accession bonus, a monthly stipend of $500 a month for a maximum of 24 months. The candidate is responsible for tuition, fees, and textbooks. During completion of course work, the candidate is considered as inactive reserve end strength. At graduation, the candidate is commissioned as an Ensign (O-1) into the NC and required to attend OIS (Ref. 3 and Ref. 8: p-13).

b. Direct Accessions

Direct Accessions are the primary supplements to the training pipeline. Individuals that make up the pool of candidates for direct accessions have no prior military experience and if selected must be able to complete 20 years of active service by age 55. Waivers for age can be granted for certain critical specialties.

The NC community manager develops quotas and Chief Naval Recruiting Command (CNRC) manages the program.

Applicants must be graduates of an accredited U.S. Bachelor's or Master's nursing program. Applicants must also have a current registered nursing license. Service obligation for successful applicants is three years of active duty or four years of active duty if accession bonus is accepted. In addition to an accession bonus, entry grade credit is given for nursing experience and accessions may enter into the pay grades of Ensign (O-1), Lieutenant Junior Grade (O-2), or Lieutenant (O-3). (Ref. 3 and Ref. 8: p-14-15)

c. Recalls

Recalls are another supplement to the training pipeline that has been used to fill critical needs in the NC. Eligible candidates for recall are drawn from the Naval Reserve Force and returned to active duty. If recalled, applicants must enter into the NC in the pay grades of Ensign (O-1), Lieutenant Junior Grade (O-2) or Lieutenant (O-3) and can continue to serve as long as not failed to select twice as per the normal "up or out" program. Also the candidate must be able to complete 20 years of service prior to age 55, and must be licensed as a registered nurse. (Ref. 3)

d. Full Time Outservice Training (FTOST)

FTOST has not been used since fiscal year 1993. Its primary purpose was to fill critical specialties such as Nurse Anesthesia or Family Nurse Practitioners that resulted from the nursing shortages of the 1980's (Ref. 3).

e. Seaman-To-Admiral (STA-21)

STA-21 is a recent accession program that was structured to combine previous enlisted commissioning sources into one category. This program allows the candidates to pick between career fields within the Navy or to let the Navy decide his or her career path. The candidate requests a career field at the time of the application process and is selected into programs based on the needs of the Navy.

The primary difference between STA-21 and MECP is that MECP candidates apply for commission only into the NC, whereas the STA-21 candidate may or may not go into nursing based on the needs of the Navy. Other differences between STA-21 and MECP are that candidates who are chosen for STA-21 receive full pay and benefits in addition to receiving $10,000 annually to cover tuition and books. If candidates are chosen for NC career path via the STA-21 program, the individual must attend a college with an affiliated NROTC unit. (Ref. 7)

5. Related Studies

In an attempt to locate prior studies with relevance to developing a steady state/Markov type model for the NC, a literature search was conducted. This search for literature used several electronic databases that included *Proquest, Ingentia, Defense Technical Information Center* or "*DTIC*" and *BOSUN.*

Proquest yielded 7069 Manpower articles, four manpower-modeling articles, and 36 Markov-modeling articles. Ingentia yielded 13 Nursing manpower articles, 16 manpower-modeling articles, 453 Markov-modeling articles, and six manpower and markov articles. DTIC yielded 25 Nursing manpower articles, 22 Markov modeling, 22 manpower modeling articles, and 20 Markov and manpower articles.

There were no articles that applied a Markov model to a manpower-planning question for the Nurse Corps. However, 76 articles used Markov models in manpower planning; 38 articles focused on the NC and manpower planning. All articles prior to 1980 were excluded from the analysis. Additional exclusion criteria included articles that pertained to processes that used modeling to control inventories, scheduling, and/or enlisted career-type forecasting.

This left us with 4 articles on manpower modeling used in government and armed forces and 2 articles on accession sources used for the U.S. Nurse Corps which are summarized in the following sections:

a. Manpower Modeling used in Government and Armed Forces

In 1977, Glenn published "Length of Service Distributions in Markov Manpower Models". This work explained the ease and functionality of using Markov models to manage manpower systems. He identifies the "main flows of staff within a manpower system as recruitment, promotion (including internal transfers), and wastage." He shows that the system can be managed by changing any of the flows, but recommends the most desirable method for control is recruiting. Changes to promotion will give immediate predictable control to the system but will have long term, unpredicted consequences that can have negative affects on the staff. (Ref. 10)

The Navy NC uses the same flows as described by Glenn and the most likely lever for control on the NC manpower system will be recruitment. Promotion timing and opportunity are set by DOPMA and are not flexible. "Wastage" or leaving the system is a personal issue and is usually affected by events or procedures outside the control of the NC. Identifying events, which cause nurses to leave the system, will provide the NC with information to address and correct to create a more stable force.

In 1987, Kalamatianou published "Attainable and Maintainable structures in Markov Manpower Systems with Pressure in the Grades". This work considered the problem where promotion pressure is exerted on the manpower structure. This idea is described below:

> Pressure in a grade is the result of delays in expected promotions and is measured by the proportion of people in those length-of-service categories of a grade from which promotees are chosen. High values of pressure would tend to make the system unstable with respect to promotions. A high proportion of unpromoted employees could a have serious effect on the efficiency of the organization.

The study gives examples of relieving this pressure by modeling the force to give program managers the ability to accurately forecast the force structure. (Ref. 11)

In the Navy NC, promotions into the control grades happen when vacancies at the O-4 grade and higher occur, essentially pulling from the lower grades for promotion. The model being constructed for this thesis will allow manpower staff to shape the force structure of the NC to avoid unnecessary pressure at certain levels or pay grades, in particular at the O-3 level. This will allow the NC planners to become more proactive and less reactive to managing the force.

In 1991, Raghavendra published "A Bivariate Model for Markov Manpower Planning Systems", which described the various uses that Markov type models play in large organizations, especially governments. He notes that most work done with this type of modeling centers around "estimating the future manpower structure, given the policies towards promotion and recruitment, or else round deriving these polices to attain a desired future structure". (Ref. 12)

In 1990, Suryadi published his Master's thesis titled *A Manpower Planning Model for the Composition of Officers of the Indonesian Army Personnel System*. This thesis developed a "grade/time in grade model for controlling the composition of Indonesian Army officers' corps". Suryadi created a discrete two-dimensional state model where backward movement (demotion) could not occur and individuals can only advance one grade per fiscal year. Also covered in the thesis was the fact that the Indonesian Army only accesses its' officers from three sources and wanted to provide policy makers a tool that would allow them to predict and analyze the effects of certain policy changes to recruiting, promoting, and separation.

Suryadi states that:

> In an organization such as the TNI-AD (Indonesian Army) where the manpower flow is continuous and dynamic, it becomes extremely difficult to determine the impact of policy changes. Experts have found that an effective method of studying a system as this is to assume a state of equilibrium (in steady-state). (Ref. 13: p.4)

Suryadi's thesis has a direct relevance to developing a Markov type model for the Navy's NC because of the manpower management parallels between the U.S.

Nurse Corps and the Indonesian Army. The NC accesses its new officers through several training pipelines and the NC community managers can benefit by using the model to examine policy changes and their affects on the Corps.

b. Accession Sources for the U.S. Nurse Corps

In 1998, Jonak and Paradis completed their Master's thesis titled *An Analysis of the Effects of Accession Sources as a Predictor of Navy Nurse Corps Officers.* This thesis looked at the accession sources used by the Navy NC and attempted to identify accession source as a good predictor for career behavior. Analysis of the data used a multivariate logit regression to investigate the relationship between accession source and career success measures. This thesis also identified threats in the external environment that affects the accession rate for the Navy Nurse Corps, which includes external labor market problems (civilian nursing shortages), and competition with the US Air Force, and US Army Nurse Corps.

The methodology for the Jonak and Paradis study looked at various career points in the Nurse's career and used multivariate logistic regression to describe the success of completing their first obligated service commitment in addition to investigating other factors that could affect success. Conclusions of this study are difficult to interpret because of problems identified with the model and the small sample sizes.

It was noted, however, that some commissioning programs rely on enlisted personnel as a primary source for its candidates. Candidates from this pool may not have enough time left in service to be described as a success by this study when in fact these enlisted candidates are quite successful and their behavior should be investigated further. (Ref. 14)

In 1999 Maeder completed her Master's thesis *The Costs and Benefits of the Navy Nurse Corps Accession Sources*. She took the recommendations of the Jonak and Paradis thesis and investigated the costs and benefits of the various accession sources used by the Navy NC. This study was similar to the Jonak and Paradis study of 1998, except Maeder used nursing cohorts that entered the navy during 1992, 1993, and 1994.

She changed the definition of success and used logistic regression to develop predictors to explain the differences between accession sources.

In addition to identifying successful accession programs, costs for each source were analyzed to compare the effectiveness of each program. For example, it was estimated that NROTC costs per accession was about $86,000 and this source had a 41.7 percent retention rate. MECP on the other hand cost about $74,781 per accession but yielded a 90.2 percent retention rate. (Ref. 8)

This thesis will attempt to identify anomalies in retention rates that are noted at various junctures in nurses' careers by modeling a logistic regression similar to the one used in Maeder's thesis. This thesis will also use some variables that were found useful in describing successful accessions in the Nurse Corps as described by Jonak and Paradis and Maeder's thesis work.

III. METHODOLOGY

A. MARKOV MODEL FORMULATION

This chapter introduces a Markov modeling method, which can be used to forecast manpower requirements. Data used in the modeling process were obtained from BUMIS courtesy of the Nurse Corps' Community Manager's office. Current officer data for the ranks of Ensign through Lieutenant (O-1 to O-3) are used in this study. The ranks of Lieutenant Commander and Commander (O-4/O-5) are included in the model to allow for system flow; however, these grades are not the focus of analysis.

The NC personnel Flow Recalculation Cycle model (or "*FLORENCE*") is a deterministic Markov-state model used to calculate future personnel force structure. Named after the pioneer of modern day nursing, "*FLORENCE*" is a forecasting tool that will allow a nurse manager to predict future stocks of personnel by adjusting the flow of nurses into the model (accessions).

1. Data Set

The Nurse Corps data was received as yearly Excel files. Each file contained one record for all Navy officers in the Nurse Corps who were on active duty anytime in that fiscal year. By merging the files, individual records could be grouped together and ordered by fiscal year (1990 through 2003). This succession of records portrays each individual's career.

2. Fiscal Year Matrices

FLORENCE is designed to predict manpower stocks by paygrade and years of service (YOS) over a ten-year period. Within each year, stocks of personnel are categorized by YOS and paygrades. The model is restricted to 11 years of service, which allows for personnel flow to the O-4 level based on constraints that DOPMA places on opportunity and flowpoints for promotion. (Ref. 4, p.8)

The main body of the transition matrix is composed of a series of submatrices by years of service. Each submatrix is composed of a set of rows and columns, containing

paygrades O-1 through O-5. The row provides the stock of personnel at a given rank (and given year of service) at the beginning of the year. Each row consists of probabilities of personnel moving from one paygrade to another paygrade in the model. Personnel will stay at current rank, move up one rank, or exit the system based on calculated probabilities.

3. Required Statistics

This section discusses how the calculating probabilities of grade change as a function of years of service were obtained. From the Nurse Corps data, we calculated for each year of service (YOS) between one and 11 and each grade between O-1 and O-4 the probability that the individual would be promoted, remain at the same grade, demoted (highly unlikely), or exit the Nurse Corps.

To calculate these probabilities, we counted the number of instances we observed an individual at a particular YOS and grade. For these individuals, we count up how many nurses were promoted, remained at the same grade, demoted, or exited. Dividing by the sum of these four groups gives us the probabilities we are interested in.

a. Defining The Transition

There are several ways of defining who will be counted at each combination of YOS and grade change. The method used must provide statistics that fit the expected input for the manpower-staffing model. The following definitions were used:

YOS - An individual was given credit for one YOS if this person served on active duty at anytime during the fiscal year. In the extreme, if the person came on active duty on September 30, the last day of the fiscal year, this person was credited with one year-of-service.

PAYGRADE/GRADE – Military paygrade structure consists of ranks from O-1 to O-10. The provided data used the following codes for paygrades:

L = Ensign = O-1

K = Lieutenant junior grade = O-2

J = Lieutenant = O-3

I = Lieutenant Commander = O-4

H = Commander = O-4

GRADE CHANGE - Each person's grade is determined as the individual's grade at the end of the fiscal year (**from**). The following fiscal year was scanned for any changes and this would determine end grade (**to**). For example, a person was an O-1 at the end of the first FY and promoted to O-2 by end of second FY (thus transition would equal "**from**" O-1 "**to**" O-2. The final changes (promote, same, demote, leave) were counted to determine which outcome category people fell into. Dividing these four groups by the total yields the probabilities.

Using the above definitions of YOS and grade change, if a person is promoted in the same year that the individual exits the system, the promotion is ignored. For example: if a person is an 0-2 at the start of the FY year, is promoted to O-3, and exits before the end of the FY, this person is counted in the "O-2 to Exit" group. The promotion to lieutenant is ignored because the Markov model allows only one progression per model cycle time (1-year).

For the first year-of-service, the initial grade is the same as the ending grade. For the first YOS, the only outcomes are that individuals stay in their initial grade ("O-1 to O-1") or exit the Navy ("O-1 to Exit"). This approach was taken because the Excel files only contain one record per person. Each record only allowed for one grade variable. If someone were promoted twice in one year, only the second grade would be shown on the person's Excel record. Additionally, backward flow ("demotion") is not permitted to take place from a higher to a lower rank in the model since this occurrence was only observed twice in the historical Nurse Corps data.

b. Stocks

The initial stock values were developed for each paygrade and YOS by using the BUMIS data as provided in Excel spreadsheets for FY 2002. The first step was to ensure that each record had a year group value. If the value was missing, the Active Commission Base Date (ACBD) was used to create the year group variable. If ACBD was missing, the Reported to Nurse Corps Date (RPD) was used to create the year group

variable. A new column was created for YOS. Therefore, the conversion to YOS was calculated by subtracting the given 2-character year group number from 100 plus data FY+1.

For example:

If year group = 02, then 103 – 02 = 10<u>1</u> (or 1 YOS).

The goal was to ensure that the FY-02 year group reflects 1 YOS.

In creating a new manpower model, current year stocks were derived and placed in appropriate YOS and paygrade categories. The current year stock, S(0), for each YOS and paygrade category, is multiplied by the transpose matrix to yield an end of year stock, S(1)=(M^t*Stock (0)), where M^t= transpose of the transition matrix. S(1) stock becomes the beginning stock for year two, S(2), while increasing YOS by one year. Accessions from Year One are added into the model at the beginning of Year Two as individuals with YOS 1. This process is repeated for each predicted year. The model time horizon is ten years. This means that for each year of service and grade category, ten predicted years are calculated using the matrix. Accession source values and yearly targets for the respective paygrades used in the model were obtained from the NC Community Manager's office. The NC Community Manager's office projects the targeted stock values that are based on projected end strength numbers from BUMED and are projected out to FY 08.

A summary is provided for each year in the model, which shows totals for beginning-of-the-year stock and end-of-the-year stock by paygrade. The end-of-year stock is then compared to target stocks that are set annually by the NC Community Mangers office, with direction from BUMED and BUPERS. A difference between actual and targeted levels is shown for each year in the model. (See Appendix A)

c. Input

For ease of use, an INPUT worksheet was added to the model to allow for direct data entry. Users can enter or change values for current year stocks. Accessions can be manipulated for any or all of the ten years covered by the model. These entries

are linked into their corresponding positions within the model and produce changes based on data manipulation. (See Appendix B)

d. Predicted Years Output

The PREDICTED YEARS OUTPUT worksheet in the model presents results for forecasted values that were derived for personnel flows through the model. The values produced in the output section are end-of-year/beginning-of-next-year stock values for each paygrade and YOS. These results are further summarized at the bottom of the worksheet and only show totals for individual paygrades per Predicted Year (**PY**).

PY is defined in this matrix as the beginning-of-year (BOY) stock for the future year and covers the ten-year projected period. (See Appendix C) For Example, if the initial stocks used in the matrix are for FY-02, then **PY**-2 values will represent the beginning stock for FY-03 by paygrade. **PY**-3 will then represent FY-04 stock, and so on.

e. Summary Output

The SUMMARY OUTPUT worksheet displays end-of-year stocks as compared to targeted stock values and a section displaying the difference between actual and targets. The SUMMARY OUTPUT worksheet only displays results for Ensign (O-1) to Lieutenant (O-3) categories because these are the primary focus paygrades for this study. (See Appendix D) An alternative OUTPUT sheet (O-1 to O-5 OUTPUT) is available, which displays an overall officer corps of Ensign (O-1) to Commander (O-5). (See Appendix E)

B. LOGISTIC REGRESSION

1. Data Set

The data used to analyze retention in this thesis was obtained from BUMIS and was provided by the NC Community Manager's office. The files consisted of data for all Nurses on active duty between the fiscal years of 1991 through 2003 and contained professional data including items such as commissioning dates, source of commission, subspecialty codes, education levels, and gender.

The files were provided as Excel spreadsheets, which were then converted into SAS format for this analysis. Attempts were made to match Social Security Numbers of the Nurse cohort data to demographic data that is contained in DMDC's Active Duty Military Master and Loss Edit Files. This merged data set would have allowed this thesis to analyze variables that were identified in prior work as affecting retention rates. This includes variables such as prior military service, and family or dependent status. However, after many unsuccessful attempts at getting the data sets matched and merged, it was decided to analyze only the BUMIS data, which was readily available.

The first data set was created by merging files that contained nurses who entered the Navy NC during FY 1990, FY 1991, FY 1992, FY1993 and FY1994. Nurses who entered the NC in FY 1996, FY 1997 and FY 1998 comprise the second data set. The FY90 to FY94 date set contains 1,607 nurses and the FY96 to FY98 data set contains 711 nurses.

Analysis of cohort group data allows for observing events that happen over a period of time. The regressions used in this analysis cover retention at four, five, seven and ten years of service using the FY90, FY91, FY92, FY93, and FY94 data sets and at five years of service using the FY96, FY97 and FY98 data sets. These time periods were selected because most initial obligations are for four years with a follow-on assignment of three years, which presents nurses with career decisions as to stay or go at each mark. The five-year mark was chosen to allow for analysis of the later data sets that include FY96, FY97, and FY98.

2. Descriptive Variables

The variables in Table 2 were derived from the BUMIS data or were constructed for use in the logistic regression model. Table 2 provides variable names and definitions of each variable.

Table 2 – Variable Descriptions

VARIABLE NAMES	DEFINITION OF VARIABLES
AGE	Age at entry into the Nurse Corps
AGESQ	Age at entry into the Nurse Corps squared
EDCHANGE	1 = Highest education level (EDLEV1) changed during the time of reference (STAY = 4, 5, 7, or 10 year mark); otherwise = 0
BDCP_HSCP	1 = Baccalaureate Degree Completion Program and Health Services Commissioning Program; otherwise = 0
DIRECT	1 = Direct accession without bonus; otherwise = 0
DIRECTBON	1 = Direct accession with sign-on bonus; otherwise = 0
FTOST	1 = Full Time Out Service Training; otherwise = 0
MECP	1 = Medical Enlisted Commissioning Program; otherwise = 0
NCP	1 = Nurse candidate Program; otherwise = 0
NROTC	1 = Naval Reserve Officer Training Corps; otherwise = 0
RECALL	1 = Recalled to active duty; otherwise = 0
PHD	1 = Doctorate degree; otherwise = 0
MS	1 = Masters degree; otherwise = 0
BSN	1 = Bachelors Science Nursing; otherwise = 0
DIP	1 = Diploma Graduate Nurse; otherwise = 0
ASSOC	1 = Associate Degree Nurse; otherwise = 0
DFY90	1 = Fiscal year 1990; otherwise = 0
DFY91	1 = Fiscal year 1991; otherwise = 0
DFY92	1 = Fiscal year 1992; otherwise = 0
DFY93	1 = Fiscal year 1993; otherwise = 0
DFY94	1 = Fiscal year 1994; otherwise = 0
DFY95	1 = Fiscal year 1995; otherwise = 0
DFY96	1 = Fiscal year 1996; otherwise = 0
DFY97	1 = Fiscal year 1997; otherwise = 0
DFY98	1 = Fiscal year 1998; otherwise = 0
DFY99	1 = Fiscal year 1999; otherwise = 0
DFY00	1 = Fiscal year 2000; otherwise = 0
DFY01	1 = Fiscal year 2001; otherwise = 0
DFY02	1 = Fiscal year 2002; otherwise = 0
DFY03	1 = Fiscal year 2003; otherwise = 0
STAY	1 = Nurse remained on active duty to a specified time (4, 5 7 or 10 years); otherwise = 0
MALE	1 if sex "M", otherwise = 0

3. Constructed Variables

The variable **STAY** was chosen for the dependent variable and was constructed by identifying nurses in the data set who had declared (**DELCD**) they were exiting the NC. If a nurse decided to exit the NC, DELCD was coded as a "1" in the NC file. This file was then flagged by SAS and checked to ensure that if DELCD was coded as a "1" it was also the last record to show up in the files for that particular nurse. If a record was

coded with two DELCD's the record used for determining whether a nurse stayed or exited the NC was the DELCD that preceded the final record for that nurse.

YRGRP was a variable in the original files for the initial commissioning year group. It was converted to **FY** (fiscal year) if the YRGRP variable was present. However, many observations for YRGRP were missing. To remedy this situation, SAS code was written to construct a FY variable by taking the **RPD** (reported to the Nurse Corps) variable and converting it to FY. The RPD date was chosen because it mirrored the ACBD (Active Commissioning Base Date) in the original Excel files and was consistently available.

EDCHANGE was created by comparing **EDLEV1** (highest level of education) across the FY files and determining if there were any changes in the variable EDLEV1. If the EDLEV1 variable changed during the time period being investigated for the retention decision, EDCHANGE was coded as "1", or coded "0" otherwise. This variable was created to investigate whether gaining higher education affects one's decision to stay on active duty.

GRADE2 was created to convert the paygrades from character to numeric values. For example if grade = "L", then GRADE2 = 1; otherwise GRADE2 = O.

Dummy Variables for each Fiscal Year were created and labeled as **DFY90**, **DFY91**, etc. These variables are created to take into account any extraneous events or other unobserved factors relating to a particular FY that would affect voluntary separation behavior.

Dummy Variables for each of the **GCAT** (gain categories) were created to allow for analysis of the effect of accession source on staying in the NC. That is, if GCAT = 004 then NROTC = 1; otherwise NROTC = 0. This process is repeated on all GCAT categories used in this analysis.

The **SEX** variable was changed from a character to a binary variable representing a **MALE**. The SAS code will make male a "1" if sex = "M" and male a "0" if sex = "F". This will allow for analyzing the effects of being either male or female on the decision to STAY in the NC.

Attempts were made to create a variable that would capture the effects that prior service has on staying in the NC. Earlier studies have shown that prior enlisted service leads to higher retention rates than non-prior service, and this effect should captured to explain the differences between the accession sources. (Ref. 8) However, to build a variable would require manipulation of entry dates and it was considered that this technique would be unreliable due to anomalies between the dates within the data. Therefore, prior service was left out of the model. It is suggested that an accurate variable be constructed for use in future studies of accession sources.

4. Logistic Regression Model

The Logit model is used here to analyze the probability that a NC officer will STAY in the NC to a specified time, (4, 5, 7 or 10 years) and to interpret the partial effects of each explanatory variable on the probability of staying in the NC, with particular interest in the effect of accession source. The model used for the regression on the FY90, 91, 92, 93, and 94 data sets is presented below:

STAY= f (*AGE AGESQ DFY91 DFY92 DFY93 DFY94 RECALL BDCP_HSCP MECP NCP NROTC DIRECTBON FTOST MALE EDCHANGE*)

This model specification was used due to the limited availability of demographic data, such as prior military service, dependents and family status. Age is included because older entrants into the NC usually have a better understanding of the economics involved of the job market and are more inclined to stay on active duty to reap the benefits.

The dummy fiscal year variables (DFY91) are in the model to capture any unobserved (unmeasured) events during the course of a given fiscal year. Accessions sources are in the model to investigate whether each accession source has different probabilities for staying in the NC. The education level variables (PhD, MS, BSN etc.) were investigated but were omitted from the model due to insignificance at all important levels (.01, .05 and .10). There were very few observations in some categories, and prior studies having demonstrated that the education level does not vary enough to be useful in explaining career point decisions. (Ref. 7, p.28)

MALE was entered into the model to predict retention differences between males and females. **EDCHANGE** was entered into the model to investigate whether increasing one's education affects that person's probability of staying in the NC.

IV. RESULTS

The following sections provide the quantitative results of this study. These results are based on scenarios developed for use in this thesis only and do not represent current Nurse Corps business practices.

A. MARKOV MODEL

1. Model Validation

To validate this model, NC data for FY2002 was used to construct beginning stock values. The beginning stock values were developed using the NC Excel files as explained earlier in this thesis and showed there were 441 Ensigns, 443 Lieutenant Junior Grades, and 1143 Lieutenants. The actual numbers that were provided by the NC Community Manger's office show that there were actually 440 Ensigns, 444 Lieutenant Junior Grades and 1185 Lieutenants or a difference of 42 nurses short (one too many Ensigns and one too few Lieutenant Junior Grades) between the beginning FY2002 stock values obtained from the NC Excel files and actual stocks provided by the NC Community Manger's office. These figures are shown below in Table 3.

Table 3 – Model Validation Values

Paygrade	Developed stock values	Actual NC data	Difference b/w Developed and Actual
Ensigns	441	440	1
Lieutenant Junior Grades	443	444	-1
Lieutenants	1,143	1,185	-42
TOTALS	**2,027**	**2,069**	**-42**

The model was run using the stock values obtained from the Excel file for FY 2002 (beginning FY 03 stock) as 459 Ensigns, 487 Lieutenant Junior Grades, and 1084 Lieutenants. The model predicted actual numbers calculated from the Excel files for FY 2003 show that there were 438 Ensigns, 446 Lieutenant Junior Grades and 1161 Lieutenants. This produced 22 too many Ensigns, 41 too many Lieutenant Junior Grades,

and 77 too few Lieutenants for an overall difference of 14 nurses short between the ending FY 02 stock values and actuals. These model values are within reasonable variances with regard to actual staffing. Therefore, the model properly replicates staffing and promotion within the NC.

As shown in Table 4, checking the model against the targeted goals as provided by the NC Community Managers office, the model's total sum was only three short of predicted target values but there was larger variation within the grades. However, this is to be expected given that actual NC staffing is similarly different as compared to targets.

Table 4 – Beginning of FY 03 Values

Paygrade	NC Data	Model Predicted values	NC Targets	Difference b/w Predicted and Targets
Ensigns	438	459	301	158
LTJG	446	487	592	-105
Lieutenants	1,161	1,084	1140	- 56

Below are some forecasting runs obtained by implementing the prediction model:

a. Base Case Scenario

For the base case use of this model, the FY2002 data was allowed to progress through a ten-year period by only adding the expected yearly accessions values into the system. The NC Community Mangers office provided these accession values. They ranged from 224 to 296 but after year five were a constant 263. No grade information was provided, so all entries are assumed to be at the O-1 level. (Table 5 and Appendix B) Results are provided in Appendix D. Trends that were noted from this model were that Ensigns were overestimated while Lieutenant Junior Grades and Lieutenants were underestimated. With this trend, the overall totals appear acceptable. However, it masks the discrepancies in the individual paygrade stock values. Table 5 displays accession source per grade in the matrix.

Table 5 – Accessions (Base Case)

ACCESSIONS

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
ENS	**1**	268	224	267	296	261	263	263	263	263	263	**2631**
LTJG	**2**	0	0	0	0	0	0	0	0	0	0	**0**
LT	**3**	0	0	0	0	0	0	0	0	0	0	**0**
LCDR	**4**	0	0	0	0	0	0	0	0	0	0	**0**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**268**	**224**	**267**	**296**	**261**	**263**	**263**	**263**	**263**	**263**	**2631**

Table 6 displays initial staffing patterns in paygrades O-1 to O-4 for FY02 (Base Case). These staffing patterns were developed using the method described earlier by creating the YOS variable in Excel.

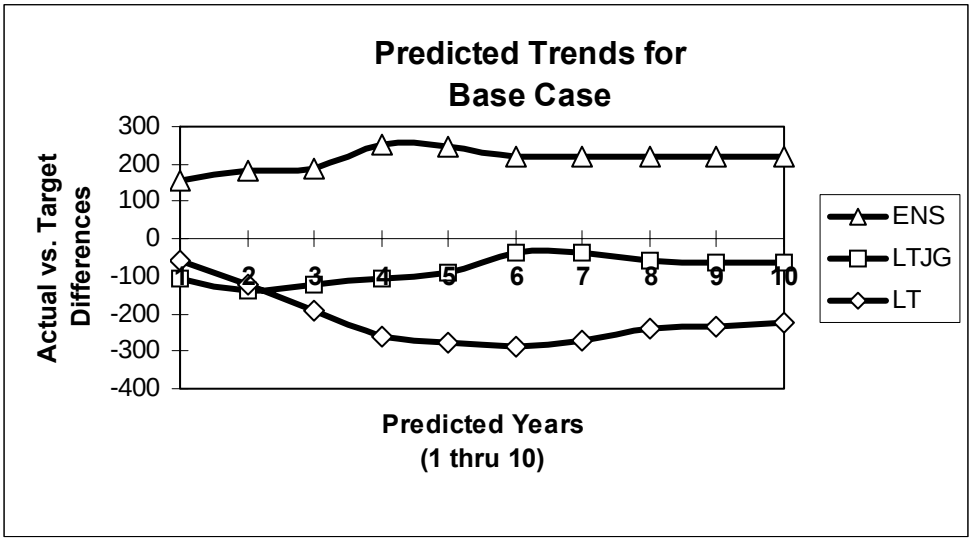
Table 6 – Initial Staffing (Base Case)

INITIAL STAFFING

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	**1**	194	239	8	0	0	0	0	0	0	0	0	**441**
LTJG	**2**	9	4	216	210	4	0	0	0	0	0	0	**443**
LT	**3**	7	10	18	29	176	189	183	211	130	136	54	**1143**
LCDR	**4**	0	1	7	3	1	2	2	0	0	2	103	**121**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**210**	**254**	**249**	**242**	**181**	**191**	**185**	**211**	**130**	**138**	**157**	**2148**

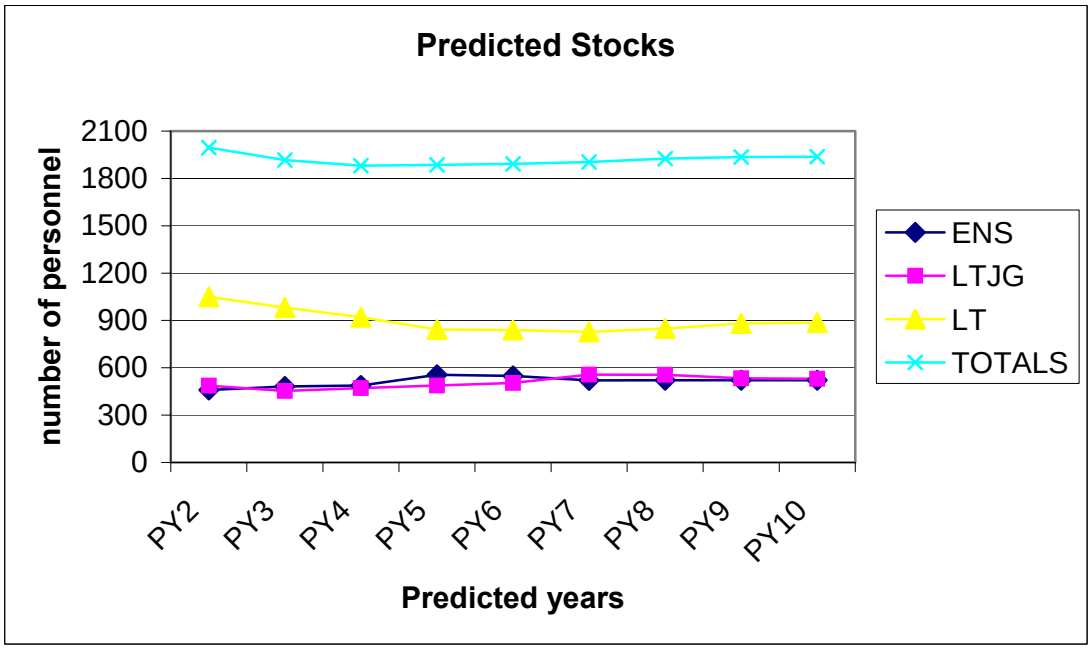
Graph 1 displays the differences between actual and target stock over the predicted periods. These differences are the result of the model predictions of personnel flow by year as compared to yearly NC targets.

Graph 1 – Predicted Trends (Base Case)



Graph 2 shows the predicted stocks of paygrades over time using the Base Case scenario in this model.

Graph 2 – Predicted Stocks



Over the years in the model, the shortage of Lieutenants are *increasing* and averages about 217 short of NC targets yearly. By removing the low year and high

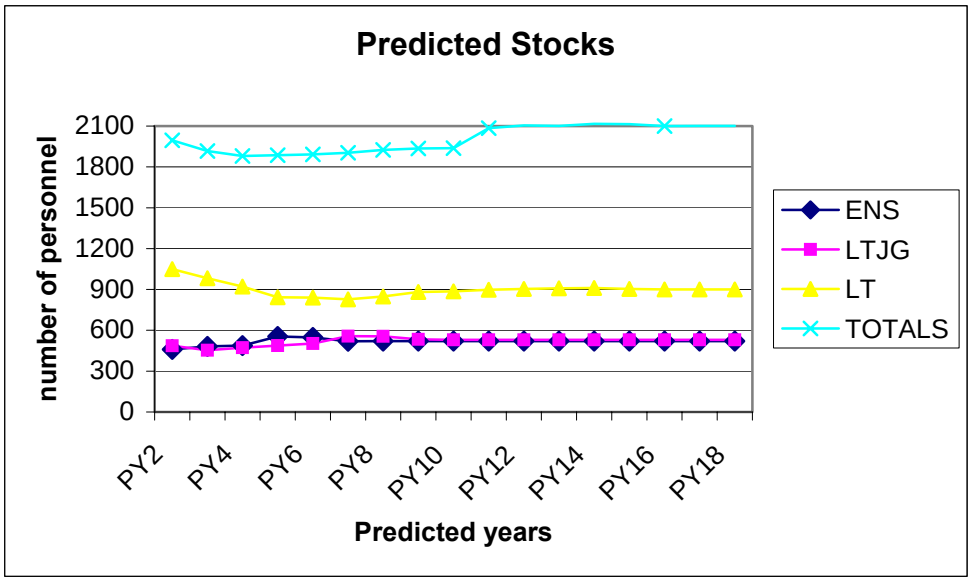
year differences in stock values for Lieutenants, the average is 228 short per year. The overabundance of Ensigns (typically around 220 over) balances the total NC staffing.

However, this indicates an increasingly junior corps, lacking much of the desired experience levels. This result is confirmed in the steady state analysis. (See Appendix B and D)

b. Steady State Scenario

By observing the model function over the ten-year period it was noted that the Ensigns and Lieutenant Junior grades reached a steady state at the nine-year mark, so the model was then extended out in an attempt to capture a steady state for Lieutenants. Lieutenants reached the steady state at the 17-year mark. The actual staffing by paygrade is shown in Graph 3.

Graph 3 – Predicted Stocks



At steady state, there are 521 Ensigns, 530 Lieutenant Junior Grades and 900 Lieutenants. These numbers will remain unchanged over time as long as no changes are made to the number and rank of accessions entering the NC. Comparing these values with the targets shows that Ensigns are 220 over, Lieutenant Junior Grades are 63 under, and Lieutenants are 220 under, which yields an overall shortage of 63 nurses. It should also be noted that during the first five years of the model, the number of accessions

entering the system varied but stabilized at 263 per year at the six-year mark and continued out to the 18-year mark. Based on this scenario, the current accession plan will consistently short the Lieutenant ranks and oversupply the Ensign ranks, yielding a shortage of mid-grade officers.

c. Optimal Mix Of Accessions

An attempt was made to optimize the accession sources by minimizing the difference between targets and actual stock numbers. This mix of accessions may or may not be a feasible solution to the NC but offers some interesting insights and results. In order to minimize the overage/underage for each year, all the accession numbers were zeroed out and each Ensign value was manipulated to ensure that the differences between target and actual stocks were minimized.

Once these values were set, adjusting the accession source for Lieutenant Junior Grade allowed for minimizing the difference between targets and actuals. Lieutenants required no accessions to minimize its stock value. Lieutenant stock values were negative at the beginning of the model and then their numbers steadily increased. By the end of year six, there was a *growing* average of Lieutenants. This highlights the blockage experienced by the Lieutenants when the Ensigns and Lieutenant Junior Grades are adjusted to exactly meet targets. Lieutenants do not have sufficient promotions and/or do not leave the service quickly enough to counter the influx of new Ensigns and Lieutenant Junior Grades required by the targets. Table 7 displays a mix of accession sources per paygrade to optimize the total stock of nurses.

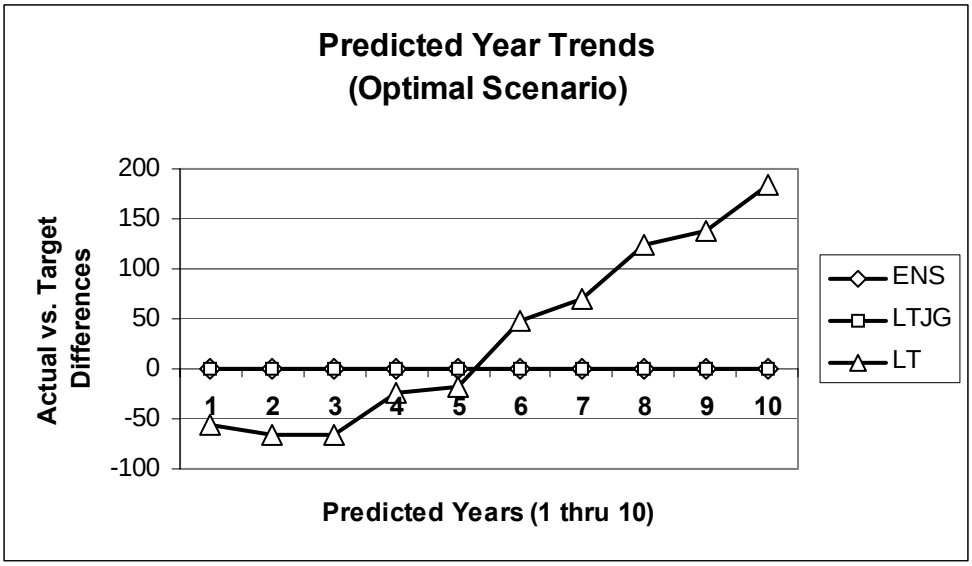
Table 7 – Accessions (Optimal Mix)

ACCESSIONS

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
ENS	**1**	110	187	121	179	128	173	134	168	138	164	**1502**
LTJG	**2**	105	104	195	147	147	135	151	145	149	143	**1421**
LT	**3**	0	0	0	0	0	0	0	0	0	0	**0**
LCDR	**4**	0	0	0	0	0	0	0	0	0	0	**0**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**215**	**291**	**316**	**326**	**275**	**308**	**285**	**313**	**287**	**307**	**2923**

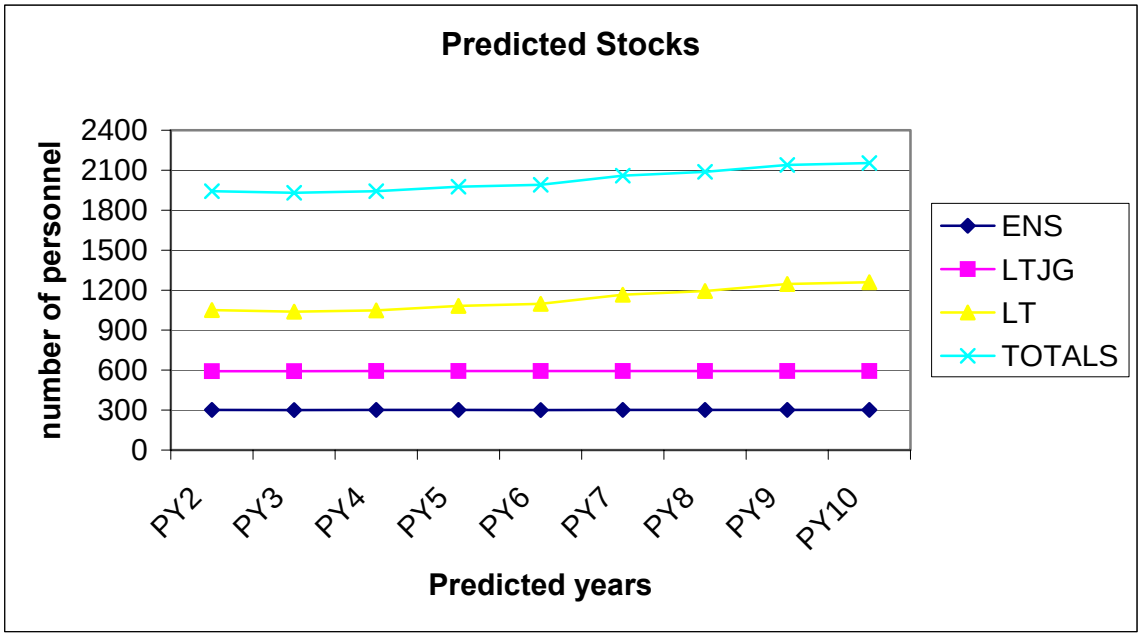
In addition to an oversupply of Lieutenants, this accession plan poses additional problems for the NC because the number of Ensigns varies at a minimum of 30 people each year. This fluctuating target would be very difficult to achieve within a schooling system. Graph 4 displays the differences between actual and target stock over the predicted periods.

Graph 4 – Predicted Trend (Optimal Mix)



Graph 5 shows the predicted stocks of paygrades over time.

Graph 5 - Predicted Stocks (Optimal Mix)



In order to maintain this optimal mix of accessions, the NC would have to recruit nurses with one or two years of experience in addition to new graduate nurses. If the NC felt that recruiting experienced nurses was infeasible, they could increase the quotas for RECALLS to supplement Lieutenant Junior Grade accessions. (See Appendix F)

d. Two-Thirds/One-Third Mix

This scenario was created to explore alternative methods of dividing the current expected accessions between Ensigns and Lieutenant Junior Grades. This scenario places two-thirds of the accessions going into the Ensign category, with the remaining one-third of the accessions being channeled into Lieutenant Junior Grades. By using this method of disproportionately dividing its inflow the NC still maintains its annual accession goals; however, they must recruit more Lieutenant Junior Grades. Table 8 displays the mix of accessions used for this scenario.

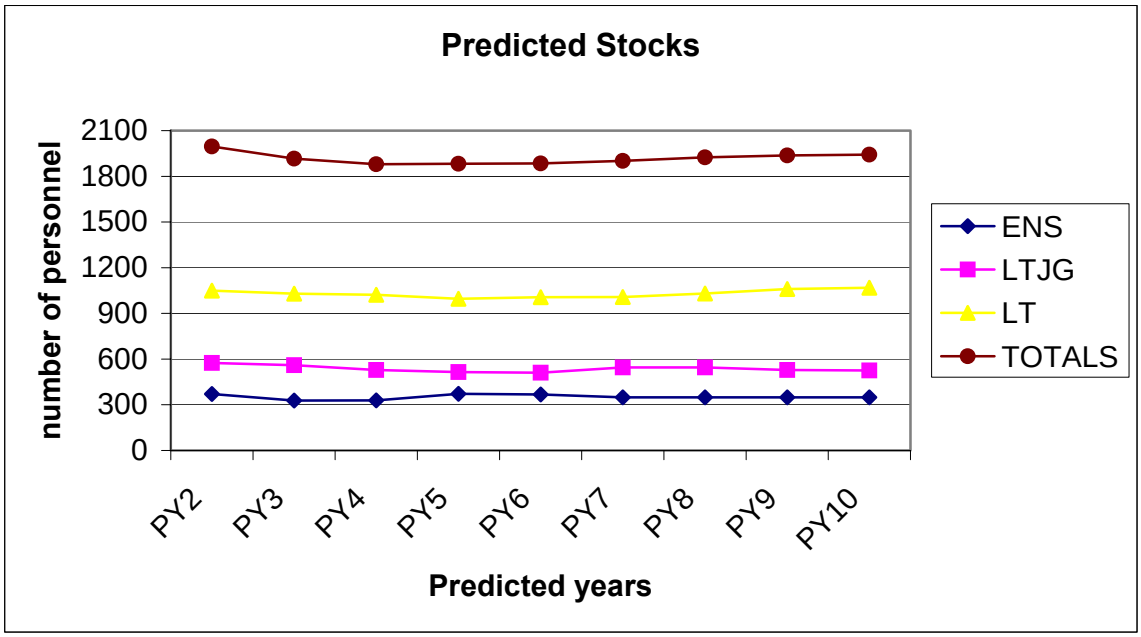
Table 8 – Accessions (Two-Thirds/One-Third Mix)

ACCESSIONS

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
ENS	**1**	180	150	179	198	175	176	176	176	176	176	**1762**
LTJG	**2**	88	74	88	98	86	87	87	87	87	87	**869**
LT	**3**	0	0	0	0	0	0	0	0	0	0	**0**
LCDR	**4**	0	0	0	0	0	0	0	0	0	0	**0**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**268**	**224**	**267**	**296**	**261**	**263**	**263**	**263**	**263**	**263**	**2631**

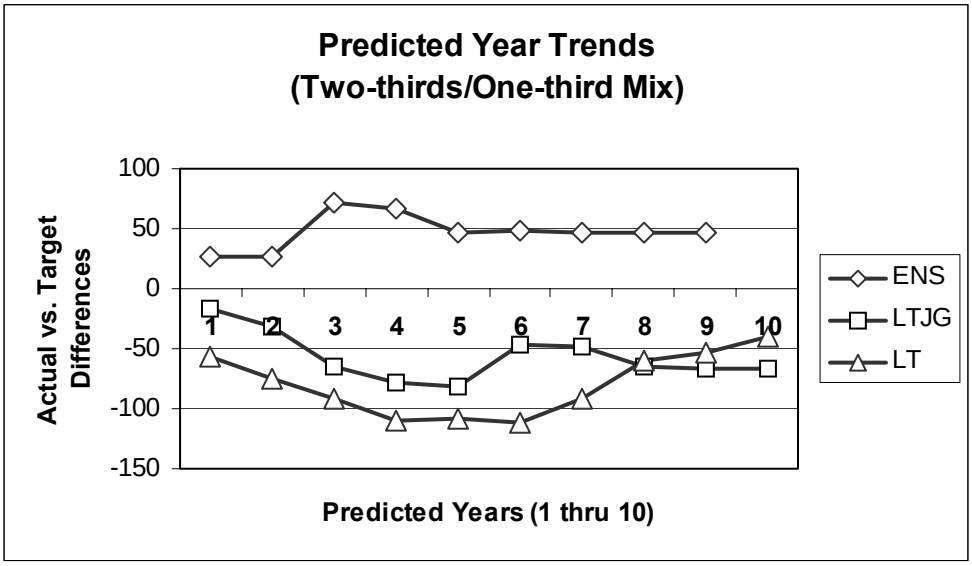
This model, along with the provided NC accession targets, demonstrates an average predicted total of 176 Ensigns and 87 Lieutenant Junior Grades over the ten year projected periods. By running this scenario and comparing the end of year stocks to NC targets, Ensigns remained on average 50 nurses *over* the targeted goals. Lieutenant Junior Grade's averaged 56 nurses short of targets and Lieutenants averaged 80 nurses short of the targets. The highest differences for Lieutenants occurred between the four and six-year mark. As compared to the base case, the Ensign overages are significantly reduced, as are the underages for Lieutenant Junior Grades and Lieutenants. The overall totals between this scenario and the base case are almost identical. The range of these differences is between zero and seven. Graph 6 shows the predicted stocks of paygrades over time.

Graph 6 - Predicted Stocks (Two-Thirds/One-Third Mix)



As noted in the optimal mix scenario, the same issues can be expected to occur with the Lieutenant promotions. However, distributing the inflow of Ensigns and Lieutenant Junior Grades as described in this scenario may *decrease* the pressure on the backlog for Lieutenants. Graph 7 displays the differences between actual versus target over the predicted periods.

Graph 7 – Predicted Trend (Two-Thirds/One-Third Mix)



This scenario appears feasible and produces the best results for stocks of Ensigns to Lieutenants as compared to the NC targets. A drawback to this scenario would be that the NC would have to recruit nurses with one or two years of experience in addition to new graduates to fill accessions for both Ensign and Lieutenant Junior Grade stocks. Again, the NC could use Recalls to supplement Lieutenant Junior Grade accessions. (See Appendix G)

e. 50% Reduction In Accessions Scenario

This scenario was investigated to uncover trends that are expected should the NC need to drastically reduce its end strength. As previously shown, the easiest way to reduce end strength is to cut accessions into the system. In this scenario, accessions for Ensigns were cut in half and averaged 132 nurses needed per year. Table 9 displays accessions per grade for the scenario where accession sources are cut by fifty percent. In comparison, Table 10 shows the accessions used for the Base Case.

Table 9 – Accessions (One-Half Accessions)

ACCESSIONS

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
ENS	1	135	112	134	148	130	132	132	132	132	132	1319
LTJG	2	0	0	0	0	0	0	0	0	0	0	0
LT	3	0	0	0	0	0	0	0	0	0	0	0
LCDR	4	0	0	0	0	0	0	0	0	0	0	0
CDR	5	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	135	112	134	148	130	132	132	132	132	132	1319

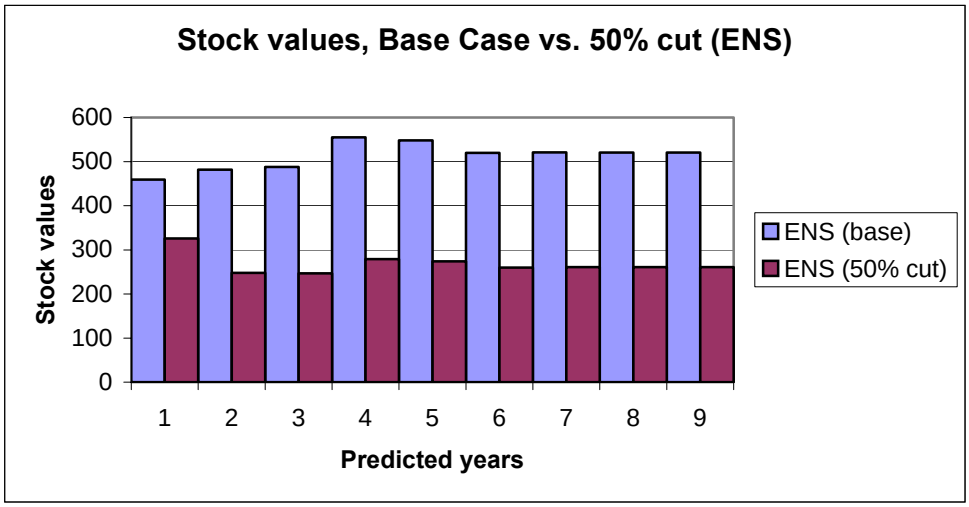
Table 10 – Accessions (Base Case)

ACCESSIONS

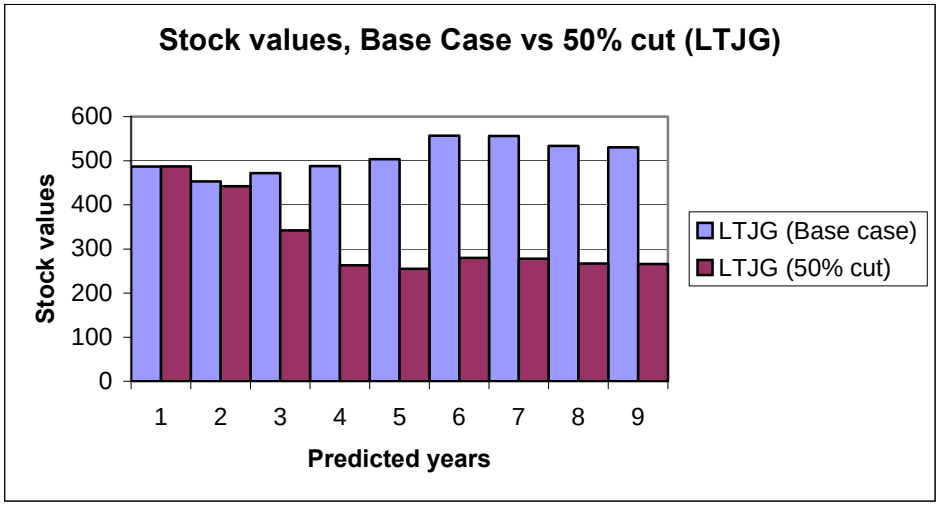
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
ENS	1	268	224	267	296	261	263	263	263	263	263	2631
LTJG	2	0	0	0	0	0	0	0	0	0	0	0
LT	3	0	0	0	0	0	0	0	0	0	0	0
LCDR	4	0	0	0	0	0	0	0	0	0	0	0
CDR	5	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	268	224	267	296	261	263	263	263	263	263	2631

An obvious result of this scenario was that Ensigns were decreased and turned to underages by the second year and steadied at minus 40, where the base case showed a steady state of 220 Ensigns in surplus. The underages for Lieutenant Junior Grades steadily *increased* to the steady state of minus 327, where the base case steady state for Lieutenant Junior Grades was minus 63. For Lieutenants, the effects were similar to the base case for the first four years; however, Lieutenant numbers drastically *decreased* as compared to the base case. At year ten, predictions show that this scenario yields a minus 657 of Lieutenants, where as the base case shows a minus 222. Graphs 6,7, and 8 demonstrate the differences between the Base Case Stocks from the fifty percent reduction scenario of Ensigns, Lieutenant Junior Grades, and Lieutenants:

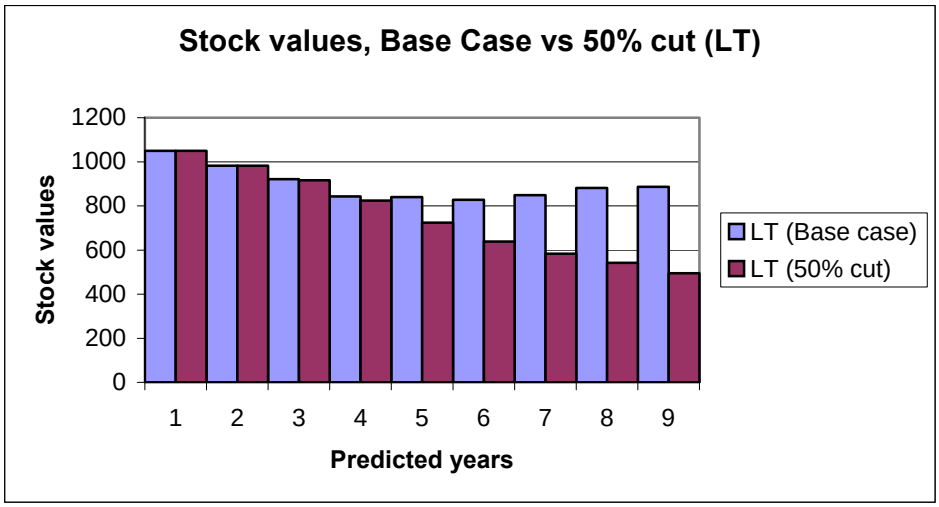
Graph 8 – Predicted Trend (Two-Thirds/One-Third Mix)



Graph 9 – Predicted Trend (Two-Thirds/One-Third Mix)

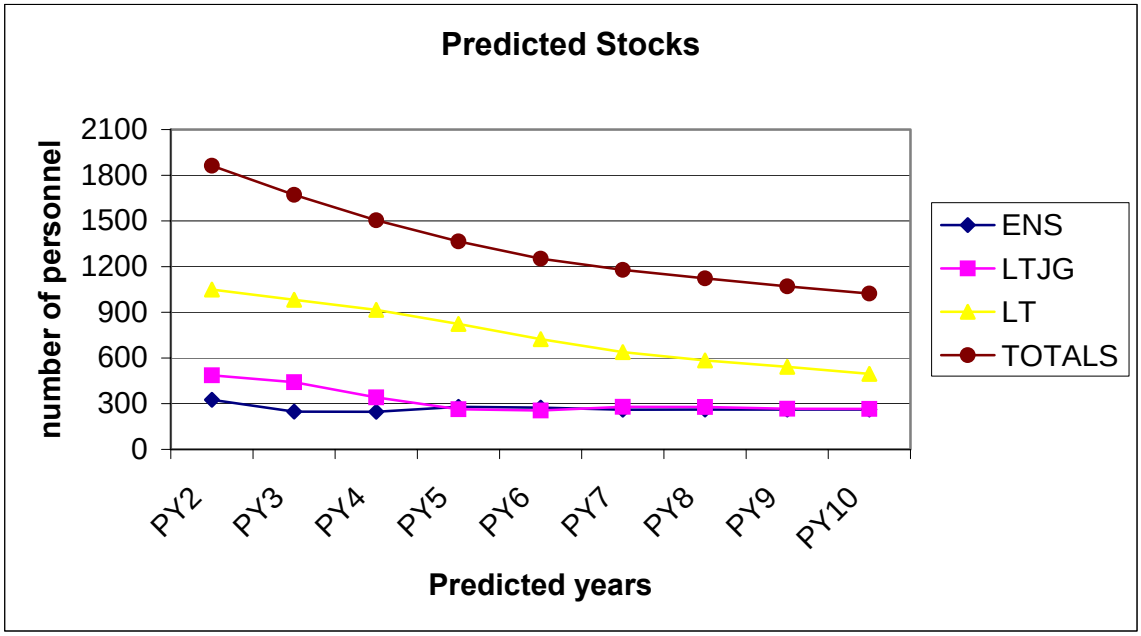


Graph 10 – Predicted Trend (Two-Thirds/One-Third Mix)



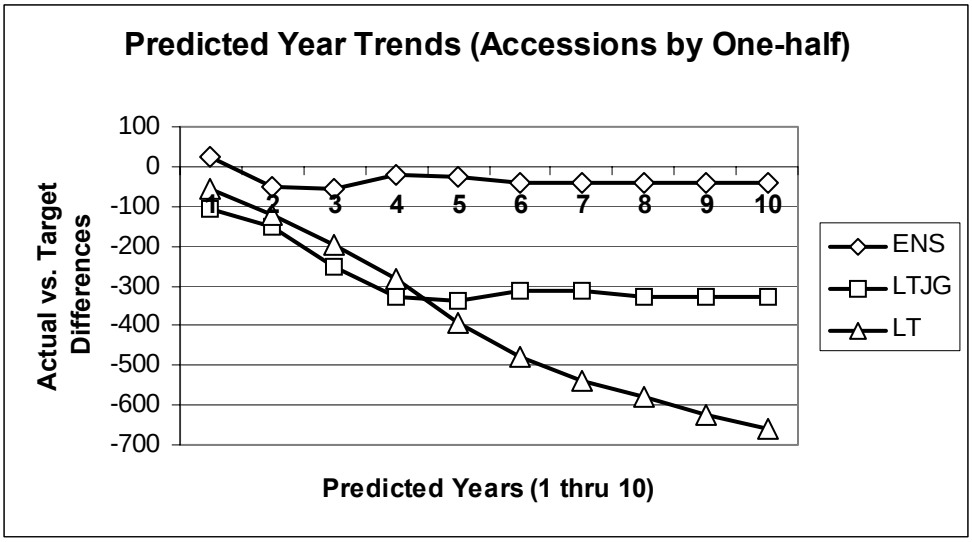
Graph 11 shows the predicted stocks of paygrades over time.

Graph 11 - Predicted Stocks (One-Half Accessions)



Graph 12 displays the differences between actual and target stock over the predicted periods.

Graph 12 – Predicted Trend (One-Half Accessions)



This obviously is a feasible solution for the Nurse Corps should it choose to reduce its force structure. By reducing accessions by 50 percent, the total force structure in paygrade O-1 to O-3 is reduced by 12.4 percent at year one, 24.5 percent at year three, 36.9 percent at five years and 50.1 percent at ten years. The shortage of Lieutenant Junior Grade and Lieutenant stocks appear in the model at beginning of the 3-year mark, and continue throughout the 10-year predicted period. This delay in force reduction is expected when a reduction in force is accomplished by cutting the accessions in its system. A consequence of reducing the force with this method is that it gives rise to a more senior NC force, and therefore cause shortages in the mid-grade ranks (O-3) as referenced in the 1999 CBO military drawdown study. (Ref. 4) (See Appendix H)

B. DESCRIPTIVE STATISTICS

One of the original goals of this research was to differentiate the Markov model of personnel flow by each accession source. With the limited data available, we explored whether accession sources had an impact on retention rates (model probabilities for "exiting") at key junctures in length of service.

1. FY 90-94 Data Set

The descriptive statistics for the retention model at four years using the FY 90-94 data are described in Table 11:

Table 11 – Descriptive Statistics For 4-Year Retention Model

Variable	Mean	Min	Max
AGE	28.25	21.6	50.1
AGESQ	824.93	466.15	2506.16
DFY91	0.2204	0	1
DFY92	0.2654	0	1
DFY93	0.1840	0	1
DFY94	0.1696	0	1
RECALL	0.034440	0	1
BDCP_HSCP	0.507827	0	1
MECP	0.127740	0	1
NCP	0.030056	0	1
NROTC	0.026299	0	1
DIRECTBON	0.169067	0	1
FTOST	0.020038	0	1
MALE	0.259862	0	1
EDCHANGE	0.072636	0	1
STAY	0.9073	0	1

Note: Data is from FY 90-94. N = 1,607

The descriptive statistics for the Retention model at five years using the FY 90-94 data are described in Table 12:

Table 12 – Descriptive Statistics For 5-Year Retenition Model

Variable	Mean	Min	Max
AGE	28.25	21.6	50.1
AGESQ	824.93	466.15	2506.16
DFY91	0.2204	0	1
DFY92	0.2654	0	1
DFY93	0.1840	0	1
DFY94	0.1696	0	1
RECALL	0.034440	0	1
BDCP_HSCP	0.507827	0	1
MECP	0.127740	0	1
NCP	0.030056	0	1
NROTC	0.026299	0	1
DIRECTBON	0.169067	0	1
FTOST	0.020038	0	1
MALE	0.259862	0	1
EDCHANGE	0.117095	0	1
STAY	0.6857	0	1

Note: Data is from FY 90- 94. N = 1,607

The descriptive statistics for the Retention model at seven years using the FY 90-94 data are described in Table 13:

Table 13 – Descriptive Statistics For 7-Year Retention Model

Variable	Mean	Min	Max
AGE	28.25	21.6	50.1
AGESQ	824.93	466.15	2506.16
DFY91	0.2204	0	1
DFY92	0.2654	0	1
DFY93	0.1840	0	1
DFY94	0.1696	0	1
RECALL	0.034440	0	1
BDCP_HSCP	0.507827	0	1
MECP	0.127740	0	1
NCP	0.030056	0	1
NROTC	0.026299	0	1
DIRECTBON	0.169067	0	1
FTOST	0.020038	0	1
MALE	0.259862	0	1
EDCHANGE	0.4552	0	1
STAY	0.5408	0	1

Note: Data is from FY 90-94. N = 1,607

The descriptive statistics for the Retention model at ten years using the FY 90-94 data are described in Table 14:

Table 14 – Descriptive Statistics For 10-Year Retention Model

Variable	Mean	Min	Max
AGE	28.25	21.6	50.1
AGESQ	824.93	466.15	2506.16
DFY91	0.2204	0	1
DFY92	0.2654	0	1
DFY93	0.1840	0	1
DFY94	0.1696	0	1
RECALL	0.034440	0	1
BDCP_HSCP	0.507827	0	1
MECP	0.127740	0	1
NCP	0.030056	0	1
NROTC	0.026299	0	1
DIRECTBON	0.169067	0	1
FTOST	0.020038	0	1
MALE	0.259862	0	1
EDCHANGE	0.7407	0	1
STAY	0.4175	0	1

Note: Data is from FY 90-94. N = 1,607

2. FY 96-98 Data Set

The same rationale as explained above was used to develop the logit model to analyze retention for the FY96, 97, and 98 data sets. The model is specified as:

***STAY= f (AGE AGESQ DFY*97 DFY98 RECALL NROTC MECP NCP DIRECTBON MALE EDCHANGE)**

The descriptive statistics for the Retention model at five years using the FY 96-98 are described below in Table 15:

Table 15 – Descriptive Statistics For 5-Year Retention Model

Variable	Mean	Min	Max
AGE	28.02	21.6	46.57
AGESQ	814.244	466.985	2169.098
DFY97	0.3669	0	1
DFY98	0.27027	0	1
RECALL	0.00995	0	1
NROTC	0.3755	0	1
MECP	0.219	0	1
NCP	0.1891	0	1
DIRECTBON	0.1237	0	1
MALE	0.3911	0	1
EDCHANGE	0.0910	0	1
STAY	0.8101	0	1

Note: Data is from FY 96-98. N = 711

For the FY90-94 data set, the mean 4-year retention rate was .907, the mean 5-year retention rate was .685, the mean 7-year retention rate was .540, and the 10-year retention rate was .417. For the FY 96-98 data set the mean retention rate was .810.

For the FY90-94 data set, BDCP_HSCP made up the largest group of accession with a value of 50.8 percent and FTOST were the smallest group of accessions with a value of 2 percent.

For the FY96-98 data set, NROTC comprised the largest group of accessions with a value of 38 percent and DIRECTS were the smallest group of accessions with a value of 2 percent. MALES comprise 26 percent of the FY90-94 data and 39 percent of the FY96-98 data set. For the FY90-94 data set, the percentage of nurses that changed their education level was between 7 percent for STAY = 4 years to 74 percent for STAY = 10 years. For the FY96-98 data set, 9 percent of nurses changed their education level.

C. REGRESSION ANALYSIS

Logistic (LOGIT) regression is used on the NC data to predict if any variables, especially accession source, in this limited data set affect the probability of staying in the NC.

1. Data Analysis, Logit Stay = 4 Years

Goodness of Fit

For the FY 90-94 data and the 4-year retention model, the max-rescaled R-squared has a value of 0.4544 and the Likelihood ratio is significant and shows that at least one independent variable used in this model is different than zero. If this thesis were able to use other demographic data in this model, it may have been possible to increase the R-squared value. However, this model should have reasonable predictive power.

Estimated Coefficients

The results of the logistic regression are provided in Table 16, which displays parameter estimates, standard errors, and Chi- Square statistics.

Table 16 – Logit Retention Model Statistics (Retention = 4 Years)

Variable	Parameter est. (s.e.)	Chi-Square	Pr>Chi-Square
Intercept	-1.5003 (2.8798)	0.2714	0.6024
AGE	0.2377 (0.1906)	1.5555	0.2123
AGESQ	-0.00457 (0.00305)	2.2379	0.1347
DFY91	-0.7379 (0.3467)	4.5306	0.0333**
DFY92	0.3396 (0.3410)	0.9921	0.3192
DFY93	1.2543 (0.4544)	7.6207	0.0058***
DFY94	1.1271 (0.4761)	5.6044	0.0179**
RECALL	1.9443 (0.6541)	8.8362	0.0030***
BDCP_ HSCP	0.9413 (0.3440)	7.4866	0.0062***
MECP	2.1345 (0.6363)	11.2526	0.0008***
NCP	0.2071 (0.8007)	0.0669	0.7959
NROTC	0.9365 (0.9056)	1.0692	0.3011
DIRECTBON	1.0816 (0.3937)	7.5463	0.0060***
FTOST	5.2650 (0.8671)	36.8686	<.0001***
MALE	0.7148 (0.3311)	4.6616	0.0308**
EDCHANGE	-4.7200 (0.3360)	197.2916	<.0001***
Likelihood Ratio (DF= 15)	-	363.4666	<.0001***
Max-rescaled R-Square	0.4544	-	-
Sample Size (N)	1,607	-	-

Note: Retention is at 4-years for FY90-94
The base case for this data set is a female entering the NC in FY1990 as a Direct Accession
Entries with two asterisks are significant at the .05 level
Entries with three asterisks are significant at the.01 level

Table 17 displays the computed partial effects for each variable in the logit 4-year retention model.

Table 17 – Partial Effects For Logit Retention Model FY 90-94 (Retention = 4 Years)

Variable	Partial effect
AGE	0.03428
AGESQ	-0.00071
DFY91	0.09016**
DFY92	0.04738
DFY93	0.12878***
DFY94	0.12077**
RECALL	0.15946***
BDCP_HSCP	0.10738***
MECP	0.16501***
NCP	0.03015
NROTC	0.107
DIRECTBON	0.11768***
FTOST	0.1912***
MALE	0.08802**
EDCHANGE	-0.7715***

Note: Retention is at 4-years for FY90-94
The base case for this data set is a female entering the NC in FY1990 as a Direct Accession
Entries with two asterisks are significant at the .05 level
Entries with three asterisks are significant at the .01 level

The partial effects from Table 11 are compared to the base case of a female entering the NC in FY1990 as a Direct accession with no change in education level, using the FY 90-94 data and **STAY** = 4 years. The base case used in this scenario has a predicted probability of staying in the NC of 80.8 percent. The partial effects were obtained by subtracting the base case value from the retention probability when each explanatory variable is changed by one unit (from 0 to 1 for dummy variables).

The following accession sources are significant at all levels (alpha = 0.01 and 0.05) with FTOST showing a 19.1 point increase in probability of staying in the NC to the four-year mark. MECP accessions showed a 16.5 point increase in the probability of staying in the NC to the four-year mark. Accessions from the RECALL program have a higher probability of staying in the NC by 15.9 points. Directs with a sign on bonus had

a higher probability of staying in the NC by 11.8 points and accessions from BDCP_HSCP had a higher probability of staying by 10.7 points.

The variable MALE was significant at the 0.05 level and shows that males are 8.8 points more likely to stay in the NC than females to the four-year mark. The EDCHANGE variable was significant and shows a lower probability of staying in the NC to the four-year mark by 77.1 points.

2. Data Analysis, Logit Stay = 5 Years

Logistic (LOGIT) regression analysis is used on the NC data to predict if any variables in this data set, especially accession sources, affect the probability of staying in the NC for five years.

Goodness of Fit

For the FY90-94 data STAY = 5 years, the max-rescaled R-squared has a value of 0.3402 and the Likelihood ratio is significant and shows that at least one independent variable used in this model is different than zero. Again, the low R-squared could be raised by including other demographic variables. Nonetheless, this model should have reasonable predictive power.

Estimated Coefficients

The results of the logistic regression are provided in Table 18, which shows the parameter estimates, standard errors, and Chi- Square statistics.

Table 18 – Logit 5-Year Retention Model Statistics FY 90-94

Variable	Parameter est. (s.e.)	Chi-Square	Pr>Chi-Square
Intercept	-3.6201 (1.9074)	3.6020	0.0577
AGE	0.2558 (0.1310)	3.8147	0.0508
AGESQ	-0.00329 (0.00220)	2.2351	0.1349
DFY91	0.2986 (0.2097)	20275	0.1545
DFY92	0.2738 (0.2079)	1.7342	0.1879
DFY93	0.2611 (0.2305)	1.2832	0.2573
DFY94	0.3954 (0.2368)	2.7892	0.0949
RECALL	2.2824 (0.5811)	15.4286	<.0001***
BDCP_ HSCP	-0.4256 (0.2450)	3.0180	0.0823
MECP	1.5677 (0.4172)	14.1221	0.0002***
NCP	1.2305 (0.5687)	4.6821	0.0305**
NROTC	-0.5601 (0.4086)	1.8786	0.1705
DIRECTBON	0.0630 (0.2754)	0.0523	0.8190
FTOST	4.2607 (0.7247)	40.6482	<.0001***
MALE	0.4730 (0.1692)	7.8160	0.0052***
EDCHANGE	-3.9880 (0.3417)	136.2442	<.0001***
Likelihood Ratio (DF= 15)	-	441.7644	<.0001
Max-rescaled R-Square	0.3402	-	-
Sample Size (N)	1,607	-	-

Note: Retention is at 5-years for FY90-94
The base case for this data set is a female entering the NC in FY1990 as a Direct Accession
Entries with two asterisks are significant at the .05 level
Entries with three asterisks are significant at the .01 level

Table 19 displays the computed partial effects for each variable in the 5-year logit retention model.

Table 19 – Partial Effects For Logit Retention Model FY 90-94

Variable	Partial effect
AGE	0.0499
AGESQ	-0.00068
DFY91	0.05766
DFY92	0.05319
DFY93	0.05087
DFY94	0.07456
RECALL	0.25121***
BDCP_HSCP	-0.09489
MECP	0.21249***
NCP	0.1842**
NROTC	-0.12721
DIRECTBON	0.01284
FTOST	0.28747***
MALE	0.08744***
EDCHANGE	-0.66539***

Note: Retention is at 5-years for FY90-94
The base case for this data set is a female entering the NC in FY1990 as a Direct Accession
Entries with two asterisks are significant at the .05 level
Entries with three asterisks are significant at the .01 level

The partial effects from Table 19 are compared to the base case of a female entering the NC in FY1990 as a Direct accession with no change in education level, using the FY 90-94 data and STAY = 5 years. The base case used in this scenario has a predicted probability of staying in the NC of 70.9 percent.

The following accession sources are significant at all levels, FTOST, RECALL, and MECP. FTOST has a 28.7 point higher probability of staying in the NC to the five-year mark. RECALLS have a 25.1 point higher probability of staying in the NC to the five-year mark and MECP has a 21.2 point higher probability of staying to the five-year mark. NCP was significant at the 0.05 level and shows a higher probability of staying in the NC of 18.4 points. MALES are significant at all levels and increase the probability of staying in the NC by 8.7 points. EDCHANGE was significant at all levels and decreases the probability of staying in the NC by 66.5 points.

3. Data Analysis, Logit Stay = 7 Years

Logistic (LOGIT) regression analysis is used on the NC data to predict if any variables in the data set, especially accession sources, affect the probability of staying in the NC.

Goodness of Fit

For the FY 90-94 data with STAY = 7 years, the max-rescaled R-squared has a value of 0.7461 and the Likelihood ratio is significant and shows that at least one independent variable used in this model is different than zero. Therefore this model should have reasonable predictive power.

Estimated Coefficients

The results of logistic regression are provided in Table 20, which shows the parameter estimates, standard errors, and Chi- Square statistics.

Table 20 – Logit 7-Year Retention Model Statistics FY 90-94

Variable	Parameter est. (s.e.)	Chi-Square	Pr>Chi-Square
Intercept	-7.2207 (2.4667)	8.5688	0.0034
AGE	0.5759 (0.1663)	11.9897	0.0005***
AGESQ	-0.00854 (0.00272)	9.8801	0.0017***
DFY91	0.6301 (0.2904)	4.7066	0.0300**
DFY92	-0.1556 (0.2908)	0.2864	0.5926
DFY93	-0.1306 (0.3240)	0.1624	0.6869
DFY94	0.2723 (0.3415)	0.6357	0.4253
RECALL	1.1623 (0.5570)	4.3540	0.0369**
BDCP_ HSCP	-0.1418 (0.3406)	0.1734	0.6771
MECP	1.6937 (0.4642)	13.3121	0.0003***
NCP	-1.1904 (0.5450)	4.7706	0.0290
NROTC	0.2605 (0.65100	0.1602	0.6890
DIRECTBON	-0.2057 (0.3778)	0.2964	0.5861
FTOST	2.4029 (0.5193)	21.4087	<.0001***
MALE	1.0506 (0.2282)	21.2019	<.0001***
EDCHANGE	-4.8394	0.2118	<.0001***
Likelihood Ratio (DF= 15)	-	1304.38	<.0001
Max-rescaled R-Square	0.7461	-	-
Sample Size (N)	1,607	-	-

Note: Retention is at 7-years for FY90-94
The base case for this data set is a female entering the NC in FY1990 as a Direct Accession
Entries with two asterisks are significant at the .05 level
Entries with three asterisks are significant at the .01 levels

Table 21 displays the computed partial effects for each variable in the 7-year logit retention model.

Table 21 – Partial Effects For 7-Year Logit Retention Model FY 90-94

Variable	Partial effect
AGE	0.04913***
AGESQ	-0.00092***
DFY91	0.05265**
DFY92	-0.01754
DFY93	-0.01458
DFY94	0.02608
RECALL	0.07965**
BDCP_HSCP	-0.01591
MECP	0.09623***
NCP	-0.19051
NROTC	0.02507
DIRECTBON	-0.02363
FTOST	0.1086***
MALE	0.075***
EDCHANGE	-0.82471***

Note: Retention is at 7-years for FY90-94
The base case for this data set is a female entering the NC in FY1990 as a Direct Accession
Entries with two asterisks are significant at the .05 level
Entries with three asterisks are significant at the .01 level

The partial effects from Table 21 are compared to the base case of a female entering the NC in FY1990 as a Direct accession with no change in education level, using the FY data for 90 to 94 and STAY = 7 years. The base case used in this scenario has a predicted probability of staying in the NC of 87.9 percent.

The accession sources FTOST and MECP are significant at all levels. FTOST has a higher probability of staying in the NC of 10.8 points and MECP shows a higher probability of staying in the NC of 9.6 points. The accession sources NCP and RECALL were significant at the 0.05 level with NCP lowering the probability of staying in the NC by 19 points where RECALL shows a higher probability of staying in the NC of 8.0 points.

MALES are significant at all levels and have a higher probability of staying in the NC of 7.5 points. EDCHANGE is significant at all levels and lowers the probability of staying in the NC by 82.4 points.

4. Data Analysis, Logit Stay = 10 Years

Logistic (LOGIT) regression analysis is used on the NC data to predict if any variables in the data set, especially accession sources, affect the probability of staying in the NC.

Goodness of Fit

For the FY90-94 data with STAY = 10 years, the max-rescaled R-squared has a value of 0.5269 and the Likelihood ratio is significant and shows that at least one independent variable used in this model is different than zero. Therefore this model should have reasonable predictive power.

Estimated Coefficients

The results of logistic regression are provided in Table 22 and will show the parameter estimates, standard errors, and Chi- Square statistics.

Table 22 – Logit 10-Year Retention Model Statistics FY 90-94

Variable	Parameter est. (s.e.)	Chi-Square	Pr>Chi-Square
Intercept	-4.0629 (1.9547)	4.3202	0.0377**
AGE	0.4329 (0.1298)	11.1266	0.0009***
AGESQ	-0.00673 (0.00212	10.1086	0.0015***
DFY91	0.2467 (0.2009)	1.5077	0.2195
DFY92	-0.7386 (0.2271)	10.5744	0.0011***
DFY93	-0.3650 (0.2399)	2.3142	0.1282
DFY94	-0.3739 (0.2515)	2.2107	0.1371
RECALL	0.8077 (0.4102)	3.8777	0.0489**
BDCP_ HSCP	0.2167 (0.2607)	0.6908	0.4059
MECP	0.7208 (0.3219)	5.0146	0.0251**
NCP	-0.3355 (0.5295)	0.4014	0.5264
NROTC	-0.4199 (0.5455)	0.5925	0.4414
DIRECTBON	0.1982 (0.2829)	0.4908	0.4836
FTOST	0.4586 (0.4689)	.09562	0.3281
MALE	0.9588 (0.1585	36.5831	<.0001***
EDCHANGE	-4.0449 (0.2353)	295.4693	<.0001***
Likelihood Ratio (DF= 15)	-	793.879	<.0001
Max-rescaled R-Square	0.5269	-	-
Sample Size (N)	1,607	-	-

Note: Retention is at 10-years for FY90-94
The base case for this data set is a female entering the NC in FY1990 as a Direct Accession
Entries with two asterisks are significant at the .05 level
Entries with three asterisks are significant at the .01 level

Table 23 displays the computed partial effects for each variable in the logit retention model.

Table 23 – Partial Effects For Logit 10-Year Retention Model FY 90-94

Variable	Partial effect
AGE	0.02312***
AGESQ	-0.00043***
DFY91	0.01425
DFY92	-0.06526***
DFY93	-0.02745
DFY94	-0.02823
RECALL	0.03699**
BDCP_HSCP	0.01268
MECP	0.03419**
NCP	-0.02491
NROTC	-0.03234
DIRECTBON	0.01169
FTOST	0.02423
MALE	0.04135***
EDCHANGE	-0.73983***

Note: Retention is at 10-years for FY90-94
The base case for this data set is a female entering the NC in FY1990 as a Direct Accession
Entries with two asterisks are significant at the .05 level
Entries with three asterisks are significant at the .01 level

The partial effects from Table 23 are compared to the base case of a female entering the NC in FY1990 as a Direct Accession with no change in education level, using the FY 90-94 data and STAY = 10 years. The base case used in this scenario has a predicted probability of staying in the NC of 93.1 percent.

The accession sources RECALL and MECP are significant at the 0.05 level with RECALLS showing a higher probability of staying in the NC by 3.7 points and MECP shows a higher probability of staying in the NC by 3.4 points. MALE and EDCHANGE were both significant at all levels with MALES showing a higher probability of staying in the NC of 4.1 points and EDCHANGE lowers the probability of staying in the NC by 74 points.

5. Data Analysis, Logit Stay = 5 Years, Fy 96-98 Data

Logistic (LOGIT) regression analysis is used on the NC data to predict if any variables in the data set, especially accession sources, affect the probability of staying in the NC for five years. The FY 96-98 data is used for this analysis.

Goodness of Fit

For the FY 96-98 data with STAY = 5 years, the max-rescaled R-squared has a value of 0.5539 and the Likelihood ratio is significant and shows that at least one independent variable used in this model is different than zero. Therefore this model should have reasonable predictive power.

Estimated Coefficients

The results of the 5-year logistic regression are provided in Table 24, which shows the parameter estimates, standard errors, and Chi- Square statistics.

Table 24 – Logit Retention Model Statistics Fy 96-98 (Where Retention = 5 Years)

Variable	Parameter est. (s.e.)	Chi-Square	Pr>Chi-Square
Intercept	17.8607 (6.7719)	6.9563	0.0084***
AGE	-1.2466 (0.4770)	6.8313	0.0090***
AGESQ	0.0230 (0.00832)	7.6723	0.0056
DFY97	-0.7707 (0.2805)	7.5469	0.0060***
DFY98	2.7572 (1.0349)	7.0982	0.0077***
RECALL	3.9607 (3.3570)	1.3921	0.2381
NROTC	0.2265 (0.3887)	0.3395	0.5601
MECP	0.9744 (0.5018)	3.7711	0.0521
NCP	1.9679 (0.5589)	12.3963	0.0004***
DIRECT	0.4365 (0.8378)	0.2715	0.6023
MALE	0.7671 (0.3255)	5.5529	0.0185**
EDCHANGE	-7.6978	1.1495	<.0001***
Likelihood Ratio (DF= 11)	-	294.4626	<.0001
Max-rescaled R-Square	0.5539	-	-
Sample Size (N)	711	-	-

Note: Retention is at 5-years for FY96-98
The base case for this data set is a female entering the NC in FY1996 as a Direct accession receiving the sign-on bonus.
Entries with two asterisks are significant at the .05 level
Entries with three asterisks are significant at the .01 level

Table 25 displays the computed partial effects for each variable in the logit 5-year retention model.

Table 25 – Partial Effects For 5-Year Logit Regression, FY 96-98 Data

Variable	Partial effect
AGE	-0.23499***
AGESQ	0.003
DFY97	-0.12921***
DFY98	0.146399***
RECALL	0.15205
NROTC	0.02748
MECP	0.09055
NCP	0.13045***
DIRECT	0.04916
MALE	0.07675**
EDCHANGE	-0.84199***

Note: Retention is at 5-years for FY96-98
The base case for this data set is a female entering the NC in FY1996 as a Direct accession receiving the sign-on bonus.
Entries with two asterisks are significant at the .05 level
Entries with three asterisks are significant at the .01 level

The partial effects from Table 25 are compared to the base case of a female entering the NC in FY1996 as a Direct accession with a sign on bonus and no change in education level, using the FY 96-98 data and STAY = 5 years. The base case used in this scenario has a predicted probability of staying in the NC of 84.4 percent.

The accession source NCP was significant at all levels and shows a higher probability of staying in the NC of 13 points. MALE and EDCHANGE were significant at all levels with MALES having a higher probability of staying in the NC by 7.7 points and EDCHANGE lowers the probability of staying in the NC by 84.1 points.

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V. CONCLUSIONS AND RECOMMENDATIONS

A. MARKOV MODEL

1. Lesson Learned

The Markov model was validated by processing FY 2002 data and comparing outputs to actual FY 2003 stock values provided by the NC. When our model was used, the output was within reasonable variances (<10 percent) with regard to actual staffing. Therefore, it is felt that this model accurately replicates staffing and promotion patterns within the Nurse Corps.

With our base case scenario, the model overstated Ensigns and understated Lieutenant Junior Grades and Lieutenants. This leads to a NC that is junior and lacking much of the desired experience levels in mid-grade officers. By allowing the model to continue out to the 18-year mark, we were able to obtain a steady state for the three (O-1, O-2, and O-3) paygrades. This resulted in a severe shortage of Lieutenants (220) in the model. This is the paygrade that we feel is critical in terms of experience and retention purposes for the beneficial longevity of the Nurse Corps.

When we attempted to optimize the mix of accessions while minimizing the differences between Ensigns and Lieutenants, our Markov model demonstrated that the Lieutenant values grew to over 183 by the end of predicted year ten. We believe that this blockage or growth is due to insufficient promotions for Lieutenants or they do not leave the service quickly enough to counter the inflow of Ensigns and Lieutenant Junior Grades required to attain target NC goals for these ranks.

The scenario where the currently planned accessions were split between Ensigns and Lieutenant Junior Grades by two-thirds and one-third respectively, revealed stocks that more closely reflected target stock values. Distributing the accessions between Ensigns and Lieutenant Junior Grades may actually decrease the pressure of the backlog for Lieutenants.

In the scenario examining force reduction where accessions are cut by fifty percent, the model demonstrated critical shortages for Lieutenant Junior Grades and Lieutenants. This should be expected when input into the system is reduced. It creates a shortage in mid-grade officers and results in a more senior force.

B. REGRESSION ANALYSIS

Based on the logistic regressions for the FY 90-94 data set, the following variables *increased* the probability of staying in the NC: **MECP** proved to be a significant (positive) accession source at all levels of retention (four, five, seven and ten years). **RECALLS** were also significant (positive) accession sources for retention at the four, five and seven- year marks. **MALES** were also significant (positive) at all levels, showing a greater propensity for staying in the NC than females.

EDCHANGE was significant at all levels and consistently *decreased* the probability of staying in the NC. Higher education levels lead to the potential for higher wages and other positions outside of the NC which reduces an individual's desire to remain. **NCP** showed a significant *decrease* in retention at the seven-year mark. Table 26 displays the probability of staying in the NC by accession and EDCHANGE using FY 90-94 data:

Table 26 - FY 90-94 Data Set

VARIABLE NAMES	**STAY=4**	**STAY = 5**	**STAY = 7**	**STAY = 10**
DIRECT	**80.8%**	**70.9%**	**87.9%**	**93.1%**
MECP	**97.3%**	**92.1%**	**97.5%**	**96.5%****
RECALLS	**96.7%**	**92.4%**	**95.5%****	**96.8%****
Directbon	**92.38%**	**n/s**	**n/s**	**n/s**
NCP	**n/s**	**89.3%****	**68.9%****	**n/s**
EDCHANGE	**3.7%**	**4.4%**	**5.5%**	**19.1%**

Unless specified, alpha = 0.01

** alpha = 0.05

n/s = NOT SIGNIFICANT

Table 27 displays the probability of stay rates by accession sources and EDCHANGE using the FY 96-98 data:

Table 27 - FY 96-98 Data Set

VARIABLES	**STAY = 5 Years**
Directbon	**84.4%**
NCP	**97.4%**
EDCHANGE	**0.3%**

For the FY 96-98 data set where STAY = 5 years, **NCP** was significant at all levels as was **MALES**. Both of these variables *increased* the probability of staying in the NC. EDCHANGE was significant at all levels and consistently *decreased* the probability of staying in the NC.

C. RECOMMENDATIONS

By evaluating the limited data set, we found that 10-years retention patterns for the FY 90-94 year groups showed that RECALLS and MECP consistently increase their probability of staying in the NC versus other accession sources. The NC should consider maximizing these sources given their history of prior service and their affinity for military service. Analysis of 5-year retention for the FY 96-98 year groups show that NCP is a significant accession source and increases probability in staying in the NC.

Another finding from the data is that when a nurse receives higher education (EDLEV1) his/her probability of staying in the NC decreases significantly. This effect should be evaluated further and the NC could consider other options to increase retention after postgraduate education.

Our base case Markov model shows a shortage of Lieutenants in the out years as do actual NC projections. Based on projected scenarios using this model, the most feasible option was the split of accessions entering the system (i.e. the "two-thirds/one-third" scenario). Based on this scenario, the NC could rely more on Recalls or somewhat experienced nurses to fill the stock values for accessions of Lieutenant Junior Grades into the system.

1. Considerations for Future Studies

As this process evolved, it has become obvious that there are problems with how the YOS variable was created for use in this model. The YOS variable as used in this thesis is constructed by dates that are constrained by the FY calendar. In future work, it would be ideal to develop a YOS variable that is not constrained by the FY, but rather on time periods based on actual dates of entry.

Another issue that has caused problems within this model is that it assumes that all of the accessions that enter the model are Ensigns (O-1). This is not necessarily true and the initial rank of the accessions does affect staffing levels of O-3's, the grade experiencing the greatest difficulty. In addition, we do not have the completion rates of initial training by accession source, so it was assumed that all candidates would

successfully complete initial training. Again, this does not reflect reality and would alter the initial recruiting goals of the NC.

Another issue to consider in calculating transition probabilities is that if an individual was selected for promotion in the final year of service, the promotion was ignored and the individual exited the system. Because of this, promotion rates as captured by the transition probabilities may be underestimated.

In future work, developing a more accurate picture of accession paygrades on entry and exit from the NC could alleviate some of the discrepancies noted above. It is believed that these two shortcomings in developing YOS for use in this model has led to over projecting Ensigns and under projecting Lieutenant Junior Grades and Lieutenants. Incorporating improved probabilities for the transitions used in this matrix based on newly developed YOS and grade transitions will provide a better forecasting tool for the NC.

Maeder showed that individuals with prior service, dependents, older individuals, and an individual's gender significantly increase the probability in staying in the Nurse Corps. Integrating these types of variables into the logit regression model used for this thesis should allow for more accurate predictions of the effect of accession source on stay rates. These new predictions for accession sources could be combined into the Markov model to allow for projecting future stocks based on accession sources.

In addition to the variables identified by Maeder, a reliable variable should be developed for individuals with prior service (PS). This variable should be incorporated into the regression for a more accurate prediction effect. It has been shown that prior service is a predictor for continued service. (Ref.8, p.27). Other promising avenues of research within this field would be to compare Navy Nurse Corps business practices with business practices of other services to yield other insight to personnel management. Another avenue of research would be to expand this model to cover the entire Nurse Corps to allow for more accurate predictions of the entire force.

D. SUMMARY

This thesis identified current business practices used by the NC in managing its accession programs and policies that constrain managing force structure (DOPMA). A Markov model was developed using Nurse Corps data that covered FY 1990 to 2003 in an attempt to predict future stock values for the ranks of O-1 through O-3. Once the Markov model was completed, several scenarios were run to forecast future stock values. A logit retention model was developed to analyze retention behavior of the various accession sources used by the NC. Output from these models allowed us to answer the question posed in this thesis: How many nurses must the Navy gain and lose each year to maintain the Nurse Corps? What paygrade do these losses need to be in to ensure adequate promotion opportunity? What number of nurses should come from each accession source program? What policy guidance can be learned/observed from the model?

To answer the first two questions, *FLORENCE* processed several scenarios and it found that the two-thirds/one-third split (between O-1 and O-2, respectively) of accessions into the NC produces the best staffing patterns over the ten year predicted period and is most feasible with current NC practices. For the third question, preliminary statistics show that MECP and RECALLS have higher retention rates than other accession programs so these maybe preferred programs for accessions. For the final question, we found that: (1) Attempting to achieve perfect staffing for the ranks of O-1 and O-2 results in unmanageable O-3 staffing levels; (2) Without accessing nurses directly into O-3 paygrades, the model has problems getting enough O-3's at baseline, therefore the model constantly predicts shortages at the O-3 level; (3) The best scenario derived from this thesis is to alter recruiting policy by accessing new O-2's and O-3's rather than only recruiting O-1's. We found that the two-thirds of accessions into the O-1 paygrade and one-third accessions into the O-2 paygrade worked well for current recruiting goals; and (4) Reducing force structure by cutting accessions is feasible. It takes about three years to see full effect. Cutting accessions by 50 percent led to a decrease in force structure of 24.5 percent in three years, which progressed to 50.1

percent at the end of ten years. However, mirroring findings of prior studies, this leads to more senior force with most of the understaffing occurring at the O-2 level.

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APPENDIX A – YEAR 1 MATRIX FY 02 (BASE CASE)

Current Year Staffing By grade and YOS	FY2002					Accessions	Successful Completion	
					1	268	1	268
					2	0	1	0
					3	0	1	0
					4	0	1	0
					5	0	1	0
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS1	1	2	3	4	5	OUT	END STOCK
194	1	0.913	0.086	0	0	0	0.001	177
9	2	0	0.456	0.537	0	0	0.007	21
7	3	0	0	1	0	0	0	12
0	4	0	0	0	1	0	0	0
0	5	0	0	0	0	1	0	0
	210							
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS2	1	2	3	4	5	OUT	END STOCK
239	1	0.048	0.944	0	0	0	0.008	12
4	2	0	0.526	0.461	0	0	0.013	228
10	3	0	0	0.992	0.008	0	0	12
1	4	0	0	0	1	0	0	1
0	5	0	0	0	0	1	0	0
	263							
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS3	1	2	3	4	5	OUT	END STOCK
8	1	0.302	0.245	0	0	0	0.453	2
216	2	0	0.914	0.076	0	0	0.010	199
18	3	0	0	0.948	0.026	0	0.026	34
7	4	0	0	0	1	0	0	7
0	5	0	0	0	0	1	0	0
	206							
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS4	1	2	3	4	5	OUT	END STOCK
0	1	0.4	0.45	0	0	0	0.15	0
210	2	0	0.183	0.771	0	0	0.045	38
29	3	0	0	0.897	0.040	0	0.063	188
3	4	0	0	0	0.875	0	0.125	4
0	5	0	0	0	0	1	0	0
	242							
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS5	1	2	3	4	5	OUT	END STOCK
0	1	0.5	0.313	0	0	0	0.188	0
4	2	0	0.086	0.061	0	0	0.853	0
176	3	0	0	0.846	0.016	0	0.138	149
1	4	0	0	0	1	0	0	4
0	5	0	0	0	0	1	0	0
	181							
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS6	1	2	3	4	5	OUT	END STOCK
0	1	0.28	0.72	0	0	0	0	0
0	2	0	0.3	0.45	0	0	0.25	0
189	3	0	0	0.853	0.041	0	0.106	161
2	4	0	0	0	0.906	0.031	0.063	10
0	5	0	0	0	0	1	0	0
	191							
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS7	1	2	3	4	5	OUT	END STOCK
0	1	0.231	0.769	0	0	0	0	0
0	2	0	0.111	0.815	0	0	0.074	0
183	3	0	0	0.852	0.042	0	0.107	156
2	4	0	0	0	0.95	0.017	0.033	10
0	5	0	0	0	0	1	0	0
	185							
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS8	1	2	3	4	5	OUT	END STOCK
0	1	0	1	0	0	0	0	0
0	2	0	0.267	0.733	0	0	0	0
211	3	0	0	0.845	0.031	0	0.123	178
0	4	0	0	0	0.915	0.012	0.073	7
0	5	0	0	0	0	1	0	0
	211							
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS9	1	2	3	4	5	OUT	END STOCK
0	1	0	0	0	0	0	1	0
0	2	0	0.25	0.75	0	0	0	0
130	3	0	0	0.837	0.054	0	0.109	109
0	4	0	0	0	0.913	0.043	0.043	7
0	5	0	0	0	0	1	0	0
	130							
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS10	1	2	3	4	5	OUT	END STOCK
0	1	1	0	0	0	0	0	0
0	2	0	0	1	0	0	0	0
136	3	0	0	0.378	0.550	0	0.072	51
2	4	0	0	0	0.937	0.027	0.036	77
0	5	0	0	0	0	1	0	0
	138							
	from\to	ENS	LTJG	LT	LCDR	CDR		
STOCK	YOS11	1	2	3	4	5	OUT	END STOCK
0	1	1	0	0	0	0	0	0
0	2	0	1	0	0	0	0	0
54	3	0	0	0.630	0.267	0	0.103	34
103	4	0	0	0	0.977	0.006	0.018	115
0	5	0	0	0	0	1	0	1
	157							

Year	Grades	Total Yr Stock	End of Year Stock	Target	Difference b/w actual and target
2003	1	441	459	301	158
	2	443	487	592	-105
	3	1143	1084	1140	-56
	4	121	241	644	-403
	5	0	1	0	1
		2148	2271	2677	-406

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APPENDIX B – INPUTS FY 02 (BASE CASE)

ACCESSIONS

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
ENS	**1**	268	224	267	296	261	263	263	263	263	263	**2631**
LTJG	**2**	0	0	0	0	0	0	0	0	0	0	**0**
LT	**3**	0	0	0	0	0	0	0	0	0	0	**0**
LCDR	**4**	0	0	0	0	0	0	0	0	0	0	**0**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**268**	**224**	**267**	**296**	**261**	**263**	**263**	**263**	**263**	**263**	**2631**

INITIAL STAFFING

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	**1**	194	239	8	0	0	0	0	0	0	0	0	**441**
LTJG	**2**	9	4	216	210	4	0	0	0	0	0	0	**443**
LT	**3**	7	10	18	29	176	189	183	211	130	136	54	**1143**
LCDR	**4**	0	1	7	3	1	2	2	0	0	2	103	**121**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**210**	**254**	**249**	**242**	**181**	**191**	**185**	**211**	**130**	**138**	**157**	**2148**

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APPENDIX C – PREDICTED YEARS OUTPUT

PREDICTIONS: EOY-1/BOY-2

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	1	268	177	12	2	0	0	0	0	0	0	0	459
LTJG	2	0	21	228	199	38	0	0	0	0	0	0	487
LT	3	0	12	12	34	188	149	161	156	178	109	51	1050
LCDR	4	0	0	1	7	4	4	10	10	7	7	77	126
CDR	5	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	268	210	252	243	230	153	171	165	185	116	128	2121

PREDICTIONS: EOY-2/BOY-3

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	1	224	245	9	3	1	0	0	0	0	0	0	482
LTJG	2	0	23	178	211	38	3	0	0	0	0	0	453
LT	3	0	0	21	29	184	161	127	137	132	149	41	982
LCDR	4	0	0	0	1	8	7	10	16	14	16	66	137
CDR	5	0	0	0	0	0	0	0	0	0	0	0	1
	TOTAL	224	268	208	244	230	171	137	153	146	165	108	2055

PREDICTIONS: EOY-3/BOY-4

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	1	267	205	12	3	1	0	0	0	0	0	0	488
LTJG	2	0	19	243	165	40	4	1	0	0	0	0	472
LT	3	0	0	11	34	188	158	139	108	116	110	56	921
LCDR	4	0	0	0	1	2	11	13	14	19	19	97	176
CDR	5	0	0	0	0	0	0	0	0	0	1	1	2
	TOTAL	267	224	266	202	232	173	153	123	135	131	154	2059

PREDICTIONS: EOY-4/BOY-5

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	1	296	244	10	4	1	1	0	0	0	0	0	555
LTJG	2	0	23	203	225	31	4	1	0	0	0	0	488
LT	3	0	0	9	29	157	162	136	119	92	97	42	843
LCDR	4	0	0	0	0	2	5	16	18	17	23	79	161
CDR	5	0	0	0	0	0	0	0	0	0	1	1	4
	TOTAL	296	267	222	257	192	172	154	138	109	122	122	2050

PREDICTIONS: EOY-5/BOY-6

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	1	261	270	12	3	1	1	0	0	0	0	0	548
LTJG	2	0	25	242	188	43	3	2	0	0	0	0	503
LT	3	0	0	11	24	199	135	140	117	101	77	37	840
LCDR	4	0	0	0	0	1	4	12	21	20	20	75	154
CDR	5	0	0	0	0	0	0	0	1	1	1	2	4
	TOTAL	261	296	265	215	245	143	153	139	122	98	114	2050

PREDICTIONS: EOY-6/BOY-7

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	1	263	238	13	4	1	1	0	0	0	0	0	520
LTJG	2	0	22	268	224	36	4	1	0	0	0	0	557
LT	3	0	0	12	28	167	171	117	120	99	85	29	827
LCDR	4	0	0	0	0	1	5	10	17	23	24	61	140
CDR	5	0	0	0	0	0	0	0	0	1	2	2	5
	TOTAL	263	261	293	257	205	181	128	138	123	110	92	2049

PREDICTIONS: EOY-7/BOY-8

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	1	263	240	12	4	1	1	0	0	0	0	0	521
LTJG	2	0	23	237	249	43	3	2	0	0	0	0	556
LT	3	0	0	10	32	198	143	148	100	102	83	32	848
LCDR	4	0	0	0	0	1	4	11	14	19	26	69	145
CDR	5	0	0	0	0	0	0	0	0	1	2	2	5
	TOTAL	263	263	259	284	244	151	161	115	122	111	103	2075

PREDICTIONS: EOY-8/BOY-9

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	1	263	240	12	4	2	1	0	0	0	0	0	521
LTJG	2	0	23	239	219	47	4	1	0	0	0	0	534
LT	3	0	0	10	28	220	170	124	127	85	85	31	881
LCDR	4	0	0	0	0	2	5	9	17	16	23	70	142
CDR	5	0	0	0	0	0	0	0	0	0	1	3	5
	TOTAL	263	263	261	251	271	180	135	145	102	110	104	2082

PREDICTIONS: EOY-9/BOY-10

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	1	263	240	12	4	1	1	0	0	0	0	0	521
LTJG	2	0	23	239	221	42	5	2	0	0	0	0	530
LT	3	0	0	10	28	194	189	147	106	108	71	32	886
LCDR	4	0	0	0	0	1	5	11	14	19	19	68	139
CDR	5	0	0	0	0	0	0	0	0	1	1	2	4
	TOTAL	263	263	261	253	239	199	161	121	128	92	103	2080

PREDICTIONS: SUMMARY

		PY 2	PY 3	PY 4	PY 5	PY 6	PY 7	PY 8	PY 9	PY 10
ENS	1	459	482	488	555	548	520	521	521	521
LTJG	2	487	453	472	488	503	557	556	534	530
LT	3	1050	982	921	843	840	827	848	881	886
LCDR	4	126	137	176	161	154	140	145	142	139
CDR	5	0	1	2	4	4	5	5	5	4
	TOTAL	2121	2055	2059	2050	2050	2049	2075	2082	2080

APPENDIX D – SUMMARY OUTPUT (BASE CASE)

END OF CURRENT YEAR PREDICTIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	459	301	158
LTJG	2	487	592	-105
LT	3	1084	1140	-56
	TOTAL	**2030**	**2033**	**-3**

EOY- 2 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	482	300	182
LTJG	2	453	591	-138
LT	3	1014	1136	-122
	TOTAL	**1949**	**2027**	**-78**

EOY- 3 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	488	301	187
LTJG	2	472	593	-121
LT	3	947	1140	-193
	TOTAL	**1907**	**2034**	**-127**

EOY- 4 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	555	301	254
LTJG	2	488	593	-105
LT	3	878	1141	-263
	TOTAL	**1921**	**2035**	**-114**

EOY- 5 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	548	301	247
LTJG	2	504	593	-89
LT	3	866	1141	-275
	TOTAL	**1918**	**2035**	**-117**

EOY- 6 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	520	301	219
LTJG	2	557	593	-36
LT	3	851	1141	-290
	TOTAL	**1928**	**2035**	**-107**

EOY- 7 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	521	301	220
LTJG	2	556	593	-37
LT	3	867	1141	-274
	TOTAL	**1944**	**2035**	**-91**

EOY- 8 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	521	301	220
LTJG	2	534	593	-59
LT	3	902	1141	-239
	TOTAL	**1956**	**2035**	**-79**

EOY- 9 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	521	301	220
LTJG	2	530	593	-63
LT	3	906	1141	-235
	TOTAL	**1958**	**2035**	**-77**

EOY- 10 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	521	301	220
LTJG	2	530	593	-63
LT	3	919	1141	-222
	TOTAL	**1970**	**2035**	**-65**

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APPENDIX E – O-1 TO O-5 OUTPUT

END OF CURRENT YEAR PREDICTIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	459	301	158
LTJG	2	487	592	-105
LT	3	1084	1140	-56
LCDR	4	241	644	-403
CDR	5	1	0	1
	TOTAL	**2271**	**2677**	**-406**

EOY- 2 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	482	300	182
LTJG	2	453	591	-138
LT	3	1014	1136	-122
LCDR	4	226	642	-416
CDR	5	1	0	1
	TOTAL	**2176**	**2669**	**-493**

EOY- 3 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	488	301	187
LTJG	2	472	593	-121
LT	3	947	1140	-193
LCDR	4	252	645	-393
CDR	5	3	0	3
	TOTAL	**2162**	**2679**	**-517**

EOY- 4 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	555	301	254
LTJG	2	488	593	-105
LT	3	878	1141	-263
LCDR	4	270	645	-375
CDR	5	5	0	5
	TOTAL	**2197**	**2680**	**-483**

EOY- 5 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	548	301	247
LTJG	2	504	593	-89
LT	3	866	1141	-275
LCDR	4	243	645	-402
CDR	5	6	0	6
	TOTAL	**2167**	**2680**	**-513**

EOY- 6 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	520	301	219
LTJG	2	557	593	-36
LT	3	851	1141	-290
LCDR	4	224	645	-421
CDR	5	7	0	7
	TOTAL	**2158**	**2680**	**-522**

EOY- 7 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	521	301	220
LTJG	2	556	593	-37
LT	3	867	1141	-274
LCDR	4	212	645	-433
CDR	5	7	0	7
	TOTAL	**2164**	**2680**	**-516**

EOY- 8 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	521	301	220
LTJG	2	534	593	-59
LT	3	902	1141	-239
LCDR	4	218	645	-427
CDR	5	7	0	7
	TOTAL	**2181**	**2680**	**-499**

EOY- 9 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	521	301	220
LTJG	2	530	593	-63
LT	3	906	1141	-235
LCDR	4	216	645	-429
CDR	5	7	0	7
	TOTAL	**2181**	**2680**	**-499**

EOY- 10 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	521	301	220
LTJG	2	530	593	-63
LT	3	919	1141	-222
LCDR	4	207	645	-438
CDR	5	6	0	6
	TOTAL	**2184**	**2680**	**-496**

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APPENDIX F – OPTIMAL SCENARIO (INPUT AND SUMMARY OUTPUT)

ACCESSIONS

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
ENS	**1**	110	187	121	179	128	173	134	168	138	164	**1502**
LTJG	**2**	105	104	195	147	147	135	151	145	149	143	**1421**
LT	**3**	0	0	0	0	0	0	0	0	0	0	**0**
LCDR	**4**	0	0	0	0	0	0	0	0	0	0	**0**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**215**	**291**	**316**	**326**	**275**	**308**	**285**	**313**	**287**	**307**	**2923**

INITIAL STAFFING

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	**1**	194	239	8	0	0	0	0	0	0	0	0	**441**
LTJG	**2**	9	4	216	210	4	0	0	0	0	0	0	**443**
LT	**3**	7	10	18	29	176	189	183	211	130	136	54	**1143**
LCDR	**4**	0	1	7	3	1	2	2	0	0	2	103	**121**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**210**	**254**	**249**	**242**	**181**	**191**	**185**	**211**	**130**	**138**	**157**	**2148**

END OF CURRENT YEAR PREDICTIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	301	301	0
LTJG	2	592	592	0
LT	3	1084	1140	-56
	TOTAL	**1977**	**2033**	**-56**

EOY- 2 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	300	300	0
LTJG	2	591	591	0
LT	3	1071	1136	-65
	TOTAL	**1962**	**2027**	**-65**

EOY- 3 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	301	301	0
LTJG	2	593	593	0
LT	3	1074	1140	-66
	TOTAL	**1969**	**2034**	**-65**

EOY- 4 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	301	301	0
LTJG	2	593	593	0
LT	3	1118	1141	-23
	TOTAL	**2012**	**2035**	**-23**

EOY- 5 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	301	301	0
LTJG	2	593	593	0
LT	3	1124	1141	-17
	TOTAL	**2017**	**2035**	**-18**

EOY- 6 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	301	301	0
LTJG	2	593	593	0
LT	3	1189	1141	48
	TOTAL	**2083**	**2035**	**48**

EOY- 7 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	301	301	0
LTJG	2	593	593	0
LT	3	1211	1141	70
	TOTAL	**2106**	**2035**	**71**

EOY- 8 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	301	301	0
LTJG	2	593	593	0
LT	3	1266	1141	125
	TOTAL	**2160**	**2035**	**125**

EOY- 9 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	301	301	0
LTJG	2	593	593	0
LT	3	1279	1141	138
	TOTAL	**2173**	**2035**	**138**

EOY- 10 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	301	301	0
LTJG	2	593	593	0
LT	3	1324	1141	183
	TOTAL	**2218**	**2035**	**183**

APPENDIX G – TWO THIRDS/ONE THIRD MIX (INPUT AND SUMMARY OUTPUT)

ACCESSIONS

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
ENS	**1**	180	150	179	198	175	176	176	176	176	176	**1762**
LTJG	**2**	88	74	88	98	86	87	87	87	87	87	**869**
LT	**3**	0	0	0	0	0	0	0	0	0	0	**0**
LCDR	**4**	0	0	0	0	0	0	0	0	0	0	**0**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**268**	**224**	**267**	**296**	**261**	**263**	**263**	**263**	**263**	**263**	**2631**

INITIAL STAFFING

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	**1**	194	239	8	0	0	0	0	0	0	0	0	**441**
LTJG	**2**	9	4	216	210	4	0	0	0	0	0	0	**443**
LT	**3**	7	10	18	29	176	189	183	211	130	136	54	**1143**
LCDR	**4**	0	1	7	3	1	2	2	0	0	2	103	**121**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**210**	**254**	**249**	**242**	**181**	**191**	**185**	**211**	**130**	**138**	**157**	**2148**

END OF CURRENT YEAR PREDICTIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	371	301	70
LTJG	2	575	592	-17
LT	3	1084	1140	-56
	TOTAL	**2030**	**2033**	**-3**

EOY- 2 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	327	300	27
LTJG	2	560	591	-31
LT	3	1062	1136	-74
	TOTAL	**1949**	**2027**	**-78**

EOY- 3 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	328	301	27
LTJG	2	529	593	-64
LT	3	1048	1140	-92
	TOTAL	**1905**	**2034**	**-129**

EOY- 4 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	372	301	71
LTJG	2	515	593	-78
LT	3	1032	1141	-109
	TOTAL	**1919**	**2035**	**-116**

EOY- 5 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	367	301	66
LTJG	2	511	593	-82
LT	3	1033	1141	-108
	TOTAL	**1911**	**2035**	**-124**

EOY- 6 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	348	301	47
LTJG	2	546	593	-47
LT	3	1030	1141	-111
	TOTAL	**1924**	**2035**	**-111**

EOY- 7 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	349	301	48
LTJG	2	545	593	-48
LT	3	1049	1141	-92
	TOTAL	**1942**	**2035**	**-93**

EOY- 8 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	348	301	47
LTJG	2	528	593	-65
LT	3	1080	1141	-61
	TOTAL	**1957**	**2035**	**-78**

EOY- 9 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	348	301	47
LTJG	2	526	593	-67
LT	3	1088	1141	-53
	TOTAL	**1962**	**2035**	**-73**

EOY- 10 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	348	301	47
LTJG	2	526	593	-67
LT	3	1102	1141	-39
	TOTAL	**1976**	**2035**	**-59**

APPENDIX H – 50% CUT IN ACCESSIONS (INPUT AND SUMMARY OUTPUT)

ACCESSIONS

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	TOTAL
ENS	**1**	135	112	134	148	130	132	132	132	132	132	**1319**
LTJG	**2**	0	0	0	0	0	0	0	0	0	0	**0**
LT	**3**	0	0	0	0	0	0	0	0	0	0	**0**
LCDR	**4**	0	0	0	0	0	0	0	0	0	0	**0**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**135**	**112**	**134**	**148**	**130**	**132**	**132**	**132**	**132**	**132**	**1319**

INITIAL STAFFING

		YOS 1	YOS 2	YOS 3	YOS 4	YOS 5	YOS 6	YOS 7	YOS 8	YOS 9	YOS 10	YOS 11	TOTAL
ENS	**1**	194	239	8	0	0	0	0	0	0	0	0	**441**
LTJG	**2**	9	4	216	210	4	0	0	0	0	0	0	**443**
LT	**3**	7	10	18	29	176	189	183	211	130	136	54	**1143**
LCDR	**4**	0	1	7	3	1	2	2	0	0	2	103	**121**
CDR	**5**	0	0	0	0	0	0	0	0	0	0	0	**0**
	TOTAL	**210**	**254**	**249**	**242**	**181**	**191**	**185**	**211**	**130**	**138**	**157**	**2148**

END OF CURRENT YEAR PREDICTIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	326	301	25
LTJG	2	487	592	-105
LT	3	1084	1140	-56
	TOTAL	**1897**	**2033**	**-136**

EOY- 2 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	248	300	-52
LTJG	2	442	591	-149
LT	3	1014	1136	-122
	TOTAL	**1704**	**2027**	**-323**

EOY- 3 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	247	301	-54
LTJG	2	342	593	-251
LT	3	942	1140	-198
	TOTAL	**1530**	**2034**	**-504**

EOY- 4 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	279	301	-22
LTJG	2	263	593	-330
LT	3	860	1141	-281
	TOTAL	**1402**	**2035**	**-633**

EOY- 5 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	274	301	-27
LTJG	2	255	593	-338
LT	3	750	1141	-391
	TOTAL	**1279**	**2035**	**-756**

EOY- 6 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	260	301	-41
LTJG	2	280	593	-313
LT	3	662	1141	-479
	TOTAL	**1202**	**2035**	**-833**

EOY- 7 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	261	301	-40
LTJG	2	278	593	-315
LT	3	602	1141	-539
	TOTAL	**1141**	**2035**	**-894**

EOY- 8 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	261	301	-40
LTJG	2	267	593	-326
LT	3	563	1141	-578
	TOTAL	**1091**	**2035**	**-944**

EOY- 9 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	261	301	-40
LTJG	2	266	593	-327
LT	3	515	1141	-626
	TOTAL	**1043**	**2035**	**-992**

EOY- 10 PREDICITIONS

	GRADES	EOY STOCK	TARGET	Δ ACTUAL vs. TARGET
ENS	1	261	301	-40
LTJG	2	266	593	-327
LT	3	484	1141	-657
	TOTAL	**1011**	**2035**	**-1024**

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