NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

UNITED STATES MARINE CORPS BASIC RECONNAISSANCE COURSE: PREDICTORS OF SUCCESS

by

Albert Cole Nowicki

March 2017

Thesis Advisor:	Marigee Bacolod
Second Reader:	Chad Seagren

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704–0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.			
1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** March 2017	**3. REPORT TYPE AND DATES COVERED** Master's thesis	
4. TITLE AND SUBTITLE UNITED STATES MARINE CORPS BASIC RECONNAISSANCE COURSE: PREDICTORS OF SUCCESS			**5. FUNDING NUMBERS**
6. AUTHOR(S) Albert Cole Nowicki			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB number NPS.2016.0076-IR-EP5-A.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.			**12b. DISTRIBUTION CODE**

13. ABSTRACT (maximum 200 words)

The need for reconnaissance forces has been documented throughout history. Thus, the process for recruiting, assessing, and training Reconnaissance Marines should not be left to chance. The Marine Corps' Basic Reconnaissance Course (BRC) is at the forefront of this process. As identified by examining the data obtained from BRC, attrition rates have been nearly 50 percent over the last three years, illustrating there is room for improvement.

This study conducts a quantitative and qualitative analysis of the criteria used to select candidates for the BRC. The research uses multi-variate logistic regression models and survival analysis to determine to what extent the current requirements to attend the Basic Reconnaissance Course are indicators of success. Using data from multiple cohorts of BRC students, this research develops a predictive model that allows the Marine Corps to more successfully recruit and train the most likely candidates to graduate BRC.

The results of this study suggest that the Physical Fitness Test and General Test are the most significant predictors of success. The impacts of physical and cognitive capability on success are not surprising, but the magnitudes of these effects on the probability of graduating BRC provides commanders with survival percentages based on incremental changes in the prerequisites.

14. SUBJECT TERMS United States Marine Corps, reconnaissance, Basic Reconnaissance Course, attrition, success, survival analysis, Military Occupation Specialty (MOS), logistic regression, logit			**15. NUMBER OF PAGES** 107
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540–01-280-5500 Standard Form 298 (Rev. 2–89)
Prescribed by ANSI Std. 239–18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release. Distribution is unlimited.

UNITED STATES MARINE CORPS BASIC RECONNAISSANCE COURSE: PREDICTORS OF SUCCESS

Albert Cole Nowicki
Captain, United States Marine Corps
B.S., California State University, San Marcos, 2010

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 2017

Approved by: Marigee Bacolod
Thesis Advisor

Chad Seagren
Second Reader

Chad Seagren
Academic Associate
Graduate School of Business and Public Policy

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

The need for reconnaissance forces has been documented throughout history. Thus, the process for recruiting, assessing, and training Reconnaissance Marines should not be left to chance. The Marine Corps' Basic Reconnaissance Course (BRC) is at the forefront of this process. As identified by examining the data obtained from BRC, attrition rates have been nearly 50 percent over the last three years, illustrating there is room for improvement.

This study conducts a quantitative and qualitative analysis of the criteria used to select candidates for the BRC. The research uses multi-variate logistic regression models and survival analysis to determine to what extent the current requirements to attend the Basic Reconnaissance Course are indicators of success. Using data from multiple cohorts of BRC students, this research develops a predictive model that allows the Marine Corps to more successfully recruit and train the most likely candidates to graduate BRC.

The results of this study suggest that the Physical Fitness Test and General Test are the most significant predictors of success. The impacts of physical and cognitive capability on success are not surprising, but the magnitudes of these effects on the probability of graduating BRC provides commanders with survival percentages based on incremental changes in the prerequisites.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

AITB	Advance Infantry Training Battalion
AFQT	Armed Forces Qualification Test
ANGAU	Australian New Guinea Administrative Unit
ARS	Amphibious Reconnaissance School
ASVAB	Armed Forces Vocational Aptitude Battery
BDA	Battle Damage Assessment
BRC	Basic Reconnaissance Course
BRPC	Basic Reconnaissance Primer Course
CNA	Center for Naval Analyses
CFT	Combat Fitness Test
CRRC	Combat Rubber Reconnaissance Craft
CMC	Commandant of the Marine Corps
CO	Commanding Officer
DNF	Did Not Finish
DOD	Department of Defense
DOR	Drop on Request
EDIPI	Electronic Data Interchange Personal Identifier
FE	Fixed Effects
FELO	Far East Liaison Office
FMF	Fleet Marine Force
FMFM	Fleet Marine Force Manuals
FORECON	Force Reconnaissance
FY	Fiscal Year
GCT	General Classification Test
GT	General Test
HQMC	Headquarters Marine Corps
LF	Landing Force
M&RA	Manpower and Reserve Affairs
MARADMIN	Marine Administrative Message
MARSOC	United States Marine Corps Special Operations Command
MCDP	Marine Corps Doctrinal Publication
MCO	Marine Corps Order
MCRC	Marine Corps Recruiting Command

MCRISS	Marine Corps Recruiting Information Support System
MCRP	Marine Corps Reference Publication
MCT	Marine Combat Training
MCTFS	Marine Corps Total Force System
MCTIMS	Marine Corps Training Information Management System
MCWP	Marine Corps Warfighting Publication
METL	Mission Essential Task List
MEU (SOC)	Marine Expeditionary Unit (Special Operations Capable)
MFX	Marginal Fixed Effects
MOS	Military Occupational Specialty
MSG	Marine Security Guard
OTH	Over the Horizon
PFT	Physical Fitness Test
PMOS	Primary Military Occupational Specialty
POI	Period of Instruction
R&S	Reconnaissance and Surveillance
RTC	Reconnaissance Training Company
SARC	Special Amphibious Reconnaissance Corpsman
SERE	Survival-Evasion-Resistance-Escape
SFAS	Special Forces Assessment and Selection
SFQC	Special Forces Qualification Course
SOI	School of Infantry
SOP	Standard Operation Procedure
SWCS	Special Warfare and Center School
TABE	Test of Adult Basic Education
TECOM	Training Education Command
T&R	Training and Readiness
TD	Training Day
TFDW	Total Forces Data Warehouse
TIG	Time in Grade
TIS	Time in Service
TTP	Tactics Techniques and Procedure
TTUPAC	Troop Training Unit Pacific
USSOCOM	United States Special Operations Command
WSB	Water Survival Qualification Basic

ACKNOWLEDGMENTS

First, I would like to thank my wife, Gina, and our three sons, Jayden, Tyler, and Brady. They have been an unwavering support in all of my endeavors, often enduring tough situations without my physical presence. Their strength, patience, and unselfishness are the foundation for my success.

I would like to thank my thesis advisor, Dr. Marigee Bacolod. She provided me with the resources to meet the challenges I have faced while writing this thesis. Her insightful guidance was crucial at every step along this journey. Dr. Bacolod's ability to "torture" the data allowed the narrative of this research to take shape. Her wisdom extends beyond the walls of the classroom, and I will take these valuable insights with me as I continue this journey in life.

I would also like to offer my deepest gratitude to the numerous mentors, peers, friends, and leaders I have had the privilege to know throughout the years. There are too many to list by name, but I will never forget any of them. I am nothing if not a reflection of what I have taken from time spent together in war and peace. I am forever in the debt of these many individuals and hope to be called upon if ever needed.

The value of this life is not measured by accomplishments, but rather, the singular moments. I have been blessed with many cherished moments, and I am forever grateful. I dedicate this research to the Marines who set the standard before me, and to those who shall continue to raise the standard in the years to come. I offer my sincerest best wishes in this life and beyond.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

> Due to the fluid nature of war, gaps will rarely be permanent and will usually be fleeting. To exploit them demands flexibility and speed. We must actively seek out gaps by continuous and aggressive reconnaissance.
>
> —United States Marine Corps, 1993

A. OVERVIEW

Three general guidelines govern personnel and readiness issues within the Marine Corps. How do we recruit, train, and retain personnel? Over the years, several Commandants of the Marine Corps (CMCs) have identified the need for Marine reconnaissance units. There also exists a lingering issue: What policies should the Marine Corps implement to "fix recon"? Marine Administrative Messages (MARADMIN) 0412/09 and MARADMIN 033/11 identify the need to fix manpower issues in the reconnaissance occupational specialty and highlight the fact that sustaining a reconnaissance capability is inherent to the Marine Corps' success. However, the school that produces reconnaissance Marines, the Basic Reconnaissance Course (BRC), currently has one of the lowest graduation rates among Military Occupational Specialty (MOS)-producing schools within the Department of Defense (Fuentes, 2015). Since 2013, BRC's graduation rate is approximately 57 percent. For example, BRC Class 4–11 began with 53 candidates, and 13 of those candidates had already attempted BRC at least once. Twenty-four candidates failed the course, and only 23 candidates passed on their first attempt. Four years later, BRC Class 4–15 experienced similar results; 38 candidates began the course and only 21 passed. Of the 21 who passed, 17 passed on their first attempt. According to MCRP 2–10A.6, Ground Reconnaissance Operations,

> the success of the individual ground reconnaissance Marine (MOS 0321/0307) is essential to the success of the overall ground reconnaissance mission. Ground reconnaissance leaders and Marine Corps leadership must understand the psychological characteristics of those individuals most likely to succeed and thrive in the demanding and dangerous environments that typify ground reconnaissance training and operations. (Department of Defense [DOD], 2016, p. A-4)

This statement identifies the need for tough, realistic reconnaissance training, but it does not specify how the Marine Corps should implement policies to achieve sufficient manpower requirements for the Fleet Marine Force (FMF).

The high attrition rate at BRC has a significant impact on fiscal resources. Ideally, I would examine the financial impacts from a managerial accounting perspective, but the Marine Corps Accounting System is not designed to support managerial accounting principles. Instead, the system identifies financial transactions to support general ledger information to create Marine Corps Financial Statements. I found the most relevant fiscal-budget data for my research in a FY2011 analysis conducted by Training Command Headquarters G5. The G5 analysis examined source documents and interviewed command financial personnel to help determine the cost incurred per period of instruction (POI). This report found the cost of direct material support for BRC (CID# M10AHK2) was $258,000 in FY2011. Using cost estimation techniques to adjust for inflation, I estimate that the cost per POI in Fiscal Year 2017 will be $278,000.

Given this significant per POI cost of assessing and training a candidate in the reconnaissance trade, allocations of resources may be more effective and efficient if the reconnaissance community identifies a good recruitment match before arrival at BRC. Doing so would likely increase the probability that candidates succeed at BRC from the first training day.

B. PURPOSE OF STUDY

The purpose of this study is to conduct a quantitative and qualitative analysis of the criteria used to select candidates for the Marine Corps' Basic Reconnaissance Course. Using data from multiple cohorts of BRC students, this research develops a predictive model that allows the Marine Corps to more successfully recruit and train the candidates who are most likely to complete the BRC. From a resources optimization and allocation standpoint, this knowledge increases the effectiveness and efficiency of BRC in a time of constrained resources. More specifically, the research addresses the following questions:

1. Primary research question

- To what extent are the current requirements to attend the Basic Reconnaissance Course indicators of probable success?

2. Secondary research questions

- What determinants and hazards are statistically significant in the survivability of a potential BRC candidate?
- Which point(s) during the course is a BRC candidate most probable to attrite?

The benefit of this research results in a more probable successful candidate from Training-Day (TD) 1, minimizing attrition and increasing the overall graduation rate of each cohort. From a resources optimization and allocation standpoint, this knowledge will increase the overall effectiveness of BRC.

C. SCOPE AND LIMITATIONS

This study focuses on the candidates that attended the Basic Reconnaissance Course from fiscal year (FY) 2013 through FY 2016. The scope of this study focuses on BRC and does not examine the data associated with the newly formed Basic Reconnaissance Primer Course (BRPC). A significant limitation of the analyses is Total Forces Data Warehouse (TFDW) maintains only data points for active duty Marine candidates. There are no data points prior to starting BRC for Navy Corpsmen in the Special Amphibious Reconnaissance Corpsman (SARC) program, members of other U.S. services, or foreign military candidates.

D. METHODOLOGY

This study uses a two-pronged approach to examine the traits and characteristics of candidates that attend BRC. First, I estimate logistic regression models with the binary dependent variable of successful graduation (GRAD=1) as outcomes. There are four separate model estimates using STATA 13.1. The first model utilizes all the independent variables collected from the data to determine which, if any, factors significantly correlate with graduation. The second model focuses the analysis to categorical variables representing the current standards (Physical Fitness Test [PFT] score=225 and General Test [GT] score=105). The third model examines the impact of modifying the PFT score requirement to 275 and the GT score to 115 while holding all other variables constant. All throughout the analysis, I report and discuss the marginal effects and not the coefficients, that is, the effect of a unit-change in each covariate x on the probability of graduation, $\frac{\partial Prob(GRAD=1)}{\partial x}$. Finally, I estimate and validate all three models with cohort fixed effects (FE). Adding cohort FEs to the estimation controls for any cohort-specific unobserved variables, such as peer effects, instructor cadre quality and turnover, seasonal patterns, and other unobserved variation specific to each cohort that impact their likelihood to graduate.

Second, this research uses survival analysis to examine the uncensored observations, or those candidates who fail to graduate. Knowing that the time to complete BRC is 65 training days, I construct a duration variable and let T_Day=65 for candidates who do graduate while for those who do not graduate, T_Day<65 reflects the training day that the candidate attrits. Thus, T_Day reflects the length of time candidates survive at BRC, censored at 65 days. I estimate Cox proportional hazards regression models and relate the covariates with the duration of BRC candidate survival.

E. FINDINGS

The survival analysis provides the most significant findings. Tables 1 and 2 report the events and the days during the training cycle, respectively, that those candidates attrite. The significant events are DOR, which accounts for 27.08 percent of all candidates that attrite; land navigation, swim qualification, patrolling, and medical reasons are the other major contributing reasons for attrition. Meanwhile, Table 2 depicts T-Day 10 (land navigation), T-Day 15 (swim qualification), T-Day 53 and 55 (patrolling) are the most significant days for attrition.

Table 1. Percentages of Attrition by Drop-Code

DROP_CODE	Freq.	Percent
Academic (code-1)	13	2.12%
Administrative (code-2)	4	0.65%
DOR (code-3)	166	27.08%
PFT (code-4)	38	6.20%
Land Navigation (code-5)	86	14.03%
Medical (code-6)	106	17.29%
Patrolling (code-7)	46	7.50%
Fin Time Failure (code-8)	18	2.94%
Safety concern in pool (code-9)	25	4.08%
Swim Qual (code-10)	65	10.60%
Legal (code-11)	2	0.33%
Individual Skills Test (code-13)	3	0.49%
Integrity (code-14)	19	3.10%
Knots Test (code-15)	22	3.59%
Total	613	100.00%

Table 2. Percentages of Attrition by Training Day

T_Day	Freq.	Percent
0	94	13.93%
1	32	4.74%
2	26	3.85%
3	26	3.85%
4	19	2.81%
5	14	2.07%
6	25	3.70%
7	14	2.07%
8	14	2.07%
9	8	1.19%
10	100	14.81%
11	8	1.19%
12	13	1.93%
13	21	3.11%
14	24	3.56%
15	48	7.11%
16	24	3.56%
17	12	1.78%

T_Day	Freq.	Percent
18	7	1.04%
21	5	0.74%
22	1	0.15%
23	2	0.30%
26	3	0.44%
27	22	3.26%
28	3	0.44%
29	1	0.15%
30	7	1.04%
31	11	1.63%
32	3	0.44%
33	2	0.30%
34	2	0.30%
36	1	0.15%
37	2	0.30%
38	3	0.44%
39	1	0.15%
40	2	0.30%
41	5	0.74%
42	4	0.59%
44	4	0.59%
45	10	1.48%
49	1	0.15%
50	2	0.30%
53	21	3.11%
54	2	0.30%
55	26	3.85%
56-65	0	0.00%
Total	675	100.00%

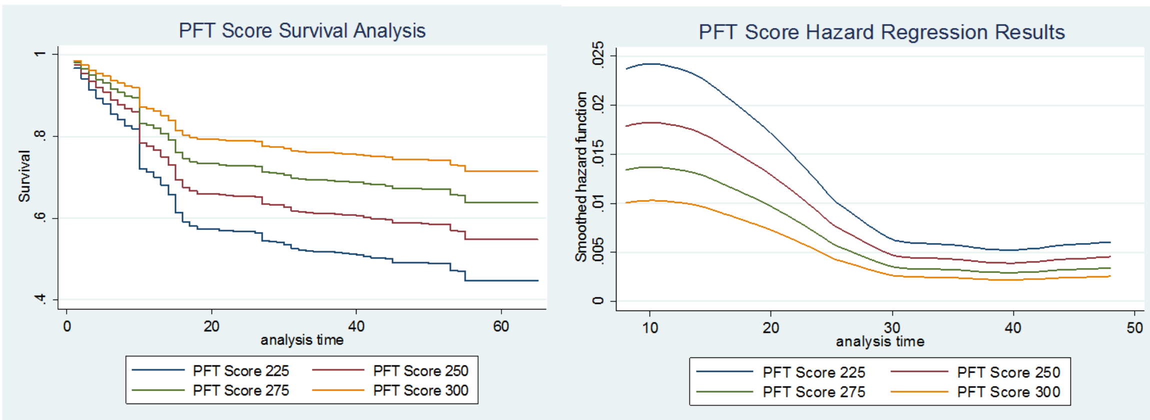
Table 3. Survival Analysis Results

Variables	Haz. Ratio	Std. Err.	P>z	[95% Conf.	Interval]
distance_PFT225	0.988433	0.002302	0.000	0.983931	0.992956
RIFLE_QUAL_SCORE	1.001138	0.00119	0.339	0.998809	1.003472
distance_GT105	0.980737	0.005461	0.000	0.970092	0.991499
PRO_CON	1.106202	0.065391	0.088	0.985184	1.242085
TIG	0.988333	0.006544	0.076	0.975591	1.001242
AGE	0.977133	0.014236	0.112	0.949625	1.005438
MARR	0.813985	0.109835	0.127	0.624827	1.060409
COMBAT_DEP	1.288728	0.113272	0.004	1.084789	1.531007
Some_College	0.902474	0.204144	0.650	0.57928	1.405985
number_prev_attmpts	0.778788	0.069235	0.005	0.654255	0.927025

1. PFT Score

Physical fitness is significant in predicting success at BRC. Figure 1 uses the estimates from Table 3 to illustrate the significant role of PFT score in predicting the success of a given candidate. The graph represents the survivability of a given candidate holding all other variables constant with a 25-point incremental increase in PFT score. The lower bound is the minimum PFT (225) and the upper bound is a perfect PFT score (300). The model suggests there is a significant increase in the probability of a candidate graduating BRC with an increase in PFT score, holding all other variables constant. Interpreting the estimates in Table 3 further highlights the effect of predicting success with a change in the prerequisite PFT score during recruitment. The variable distance_PFT225 is each candidate's raw PFT score minus 225, or is equal to "0" if the candidate has a score lower than 225. The hazard ratio states that for PFT score above 225, a one point increase in the PFT score increases the probability of graduation by 1.2% (100% - 98.84%) holding all other variables constant.

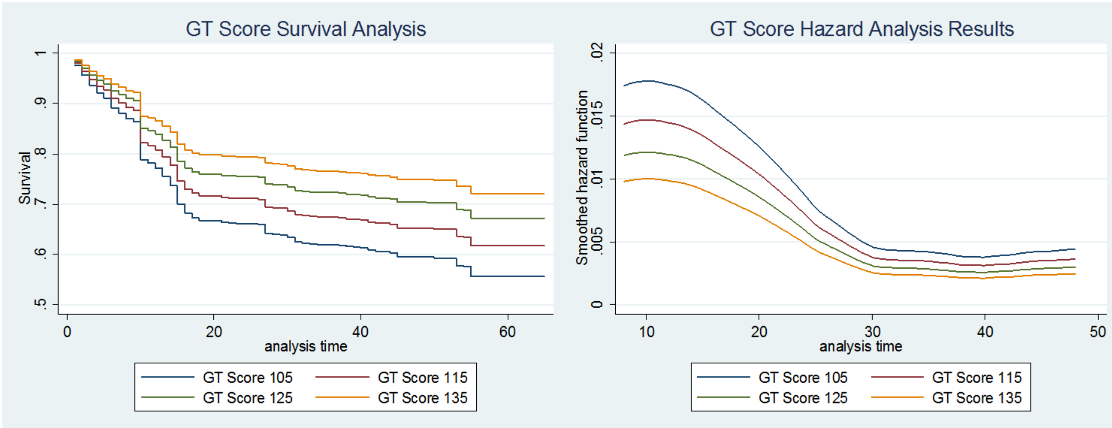
Figure 1. PFT Score Survival and Hazard Results



2. GT Score

The results suggest that cognitive ability is second to physical attributes when predicting success at BRC, but also still is statistically significant. Figure 2 illustrates the significant role of GT score in predicting the success of a given candidate. The graph represents the survivability of a given candidate holding all other variables constant with a 10-point incremental increase in GT score from the current minimum score of 105. The lower bound is the minimum GT score (105) and the upper bound is a GT score of 135. The model suggests there is a significant increase in the probability of a given candidate graduating with every an increase in the GT score requirement, holding all other variables constant. Turning to Table 3, the hazard ratio states that for GT score above 105, a one point increase in the GT score increases the probability of graduating by about 2 percent (100%-98.073%) holding all other variables constant.

Figure 2. GT Score Survival and Hazard Results



3. Land Navigation

Figures 1 and 2 also highlight the significant, steep drop in candidate survivability on T-Day 10, when the training event is land navigation. This makes sense since land navigation requires the candidate to not only use cognitive skills to problem solve, but also requires the candidates to move over terrain, under load, while problem solving.

F. OVERVIEW OF CHAPTERS

The research is analyzed over the following five chapters. Chapter II takes a deeper dive into the Marine Corps reconnaissance community, examining the history of reconnaissance and the Basic Reconnaissance Course. Chapter III analyzes previous scientific research applicable to this study. Chapter IV explains the data and lays the groundwork for the approach used in this study. Chapter V discusses the results of the predictive models and survivability model applicable to the Basic Reconnaissance Course. Finally, Chapter VI provides recommendations for future research.

THIS PAGE INTENTIONALLY LEFT BLANK

II. BACKGROUND

This chapter provides background on the reconnaissance community from the early creation of amphibious reconnaissance doctrine, to the early development of forces prior to World War II. The history of Marine reconnaissance training is discussed beginning with the formation of informal training through the transition to formal training for the Marine Corps reconnaissance MOS. The third section provides a description of the BRC and its rigorous demands.

A. HISTORY OF MARINE CORPS RECONNAISSANCE

The genesis of Marine Corps reconnaissance occurs shortly after the turn of the century. Major Dion Williams first introduced the idea and necessity for staffing and equipping a reconnaissance unit in 1906. This force would enable Landing Force (LF) commanders to plan, sending an amphibious force ashore to gather information across the spectrum of reconnaissance, from hydrographic surveys to close reconnaissance of enemy disposition and strengths. Later, Major Dion Williams said that

> in order to prepare intelligent plans for the attack or defense of a harbor or bay, it is necessary to have at hand a comprehensive description of the hydrographic features and accurate charts showing the depths of water at all points, the reefs, rocks, shoals, and peculiar currents which constitute dangers to navigation, and the tributary streams and channels which may form avenues of attack or furnish anchorage for a portion of the floating defenses or auxiliaries of the defenders (p. 11).

To comprehend the necessity of maintaining a healthy reconnaissance force within the Marine Corps, it is essential to examine the genesis of these elite warriors. The history of reconnaissance units within the Marine Corps begins with an identified requirement during World War II. During the "Island Hopping" campaign in the South Pacific, the requirement arose to provide a force that was capable of landing clandestinely on hostile beaches to conduct reconnaissance and surveillance (R&S) that would be crucial to the landing force that followed. Due to the requirement and capability needed, the Marine Corps Raiders were founded. In 1943, this elite unit expanded and re-designated as Amphibious Reconnaissance Company for the remainder of the war.

In *Swift, Silent, and Deadly*, Meyers (2004) notes that in Korea, Marine Corps reconnaissance units found themselves at the forefront of hostilities. Marine reconnaissance units were the eyes and ears of the Marine Corps as they battled on frozen, inhospitable terrain and were responsible for providing early warning and interdiction of North Korean People's Army and later the Chinese Communist Forces. Meyers noted that with the introduction of the helicopter in the battlespace, reconnaissance units were able to penetrate deeper behind enemy lines and report to Combatant Commanders critical information about the terrain, enemy, and resources in the tactical area of operation (TAO).

At the conclusion of the Korean War, Marine reconnaissance units were split and subsequently one unit was stationed on the West Coast (Camp Pendleton, California) and one on the East Coast (Camp Lejeune, North Carolina). These units found themselves generally undermanned and operating without much guidance until the Vietnam War began in 1965.

As the Vietnam War escalated, the Marine Corps again recognized the benefits of having a force trained and capable of conducting reconnaissance of the battlespace. The pre-war years of insufficient funding and personnel manning gave way to an increased interest in providing a capability, but the cost for being unprepared was paid with the loss of lives. As the Vietnam War subsided and the Marine Corps returned to a peacetime force, reconnaissance units began to deteriorate once again.

In 1985, the mission of the Marine Corps reconnaissance units was revived with the creation of the Marine Expeditionary Unit-Special Operation Capable (MEU-SOC). While other services collaborated to form the United States Special Operations Command (USSOCOM), the Marine Corps abstained, instead choosing to advertise its MEU (SOC) as a force in readiness capable of expeditionary special operations throughout the world.

Marine reconnaissance units continued to play a pivotal role on the battlefields of the Persian Gulf War and into the Global War on Terrorism. They have been instrumental in the success of campaigns reaching from the arduous terrain of Afghanistan to the barren desert of Iraq and to intense urban fighting as seen in Fallujah. As the Marine

Corps continues to adapt, often time reconnaissance units have been the first to suffer from lack of qualified personnel and funding. Never was this more evident than in 2006 when Secretary of Defense Donald Rumsfeld mandated the Marine Corps join USSOCOM (Smith, 2005).

The personnel required to activate the Marine Corps Special Operations Command came from the reconnaissance community with the expectation that they would continue to provide a capability to the Marine Corps as the need arose. However, the years following have seen USSOCOM take sole ownership of these forces leaving the Marine Corps stripped of highly trained, capable Marines. Having a high attrition rate at BRC was once merely an accepted fact within the Marine Corps, but now this is proving to be detrimental to sustaining the force as the foreseeable future requirements demand the employment of small, highly trained units to combat our enemies across the world. According to an interview with Major General Fredrick Padilla ("MARSOC and recon," 2014) the rise of MARSOC complicates the effort to maintain the optimal manning levels in the Marine reconnaissance community. Furthermore, Major General Padilla recognizes the mission of making reconnaissance Marines is difficult, requiring significant time and resources.

B. HISTORY OF THE BASIC RECONNAISSANCE COURSE

Scholars and warriors have noted over the centuries, training for war demands acceptance that evaluation must occur in realistically tough conditions to determine the merit of the individual and differentiate the courageous from the cowardly. Therefore, it should be no surprise that the men selected to perform the mission of reconnaissance within the Marine Corps must be specially selected and trained prior to reaching the Fleet Marine Force.

The first documented Marine Corps amphibious training course appeared in 1943, as reported in a letter from First Lieutenant Frim to Major Richards (as cited in DOD, 1989). The letter from Frim suggested that the Intelligence Section (D-2) founded the first Amphibious training course as result of the planned requirements foreshadowing the upcoming Island Hopping Campaign of the Pacific. In Australia, the Fifth Marine

Regiment conducted the eight-week reconnaissance course. The instructor cadre was a diverse group, consisting of U.S. Marines, Australians from the AIF, and natives assigned by the Far East Liaison Office (FELO) and Australian New Guinea Administrative Unit (ANGAU) (DOD, 1989).

Early in the selection process of these newly trained reconnaissance Marines it was identified that these men should possess “superior mental and physical characteristics, swimming ability, and known courage” (DOD, 1989, p. 50). As acknowledged by Meyers (2004), Fleet Marine Force Pacific SOP 2–3 (1943) stated the type of training required to insure success of the given operation includes, but is not limited to physical fitness and swimming, stamina for long duration hikes, map reading and compass use, patrolling for long durations with minimum rations, sketching, use of cameras, hydrography, beach reports, small-rubber boat training, weapons, and explosives.

The interim years between WWII and Korea saw little significant interest in developing and maintaining a professional reconnaissance force within the Division. Most training conducted appeared to have been on an ad-hoc basis depending on the personalities commanding those units. After the Korean War, we see resurgence in the interest to train and maintain a professional reconnaissance force within the Marine Corps. Meyers (2004) mentioned that in 1952 the Marine Corps established the Amphibious Reconnaissance School (ARS) of Troop Training Unit Pacific (TTUPAC). He stated that within a few years, the TTUPAC school was discontinued and once again the Marine Corps was left without a standalone institution to select, screen and train Marines in the skills required to conduct reconnaissance. Instead of formalized training, individual units within the individual divisions trained their own organic reconnaissance units.

In the 1980s, reconnaissance training formalized with the establishment of the Basic Reconnaissance Course at Coronado, California, and the Amphibious Reconnaissance School (ARS) at Little Creek, Virginia. Though separated geographically, they shared a program of instruction in order to maintain an identical standard for producing a Reconnaissance Marines. However, due to decreased funding, Training Education Command (TECOM) merged the schools into one reconnaissance school in 2007. The singular school responsible for training and re-designating Marines as Reconnaissance Marines is the Basic Reconnaissance Course located at the School of Infantry (SOI) West at Camp Pendleton, California.

In 2002, Marine Administrative message (MARADMIN) 043/02 established the primary military occupation specialty (MOS) 0321, Marine Reconnaissance Man, for the ranks of Private through Master Gunnery Sergeant. This fundamentally changed the force structure and funding of the reconnaissance community within the Marine Corps. However, this has done little to curb the attrition rates at the Basic Reconnaissance Course, as Captain Jason Quinn states:

> You've got high attrition in BRC, coupled with casualties in combat and just the high turnover rate in our MOS of losing guys to MARSOC, losing [special amphibious recon] corpsmen to MARSOC, and guys just naturally getting out after a couple of deployments. (Fuentes, 2015, p.1)

Today, BRC provides Marines with the skills to conduct amphibious entry, extraction, and beach reconnaissance. Reconnaissance Marines must be knowledgeable in operating and navigating the Combat Rubber Reconnaissance Craft (CRRC) in order to deploy forces from over the horizon (OTH) in support of amphibious operations.

C. DESCRIPTION OF THE BASIC RECONNAISSANCE COURSE

1. Mission Statement

The mission of BRC is to produce Marines with the basic understanding of how to operate within the reconnaissance team. BRC is a 12-week course (65 training days) that trains reconnaissance Marine candidates in amphibious reconnaissance tactics, techniques, and procedures (TTPs). The desired outcome of BRC is for Marines to earn the Reconnaissance Man MOS (Military Occupational Specialty 0321). According to the Reconnaissance Training Company website, "BRC combines lectures, demonstrations, and practical application which emphasize individual and team land navigation, water survival, supporting arms, surveillance, patrolling, communications, amphibious operations and combat conditioning" (Reconnaissance Training Company, n.d.).

As stated in Marine Corps Order 3500.73, the following Mission Essential Task List is mandated:

1. Plan, coordinate and conduct amphibious / ground reconnaissance and surveillance to observe, identify, collect, and report enemy activity, and collect other information of military significance.

2. Conduct specialized reconnaissance. Assist in specialized engineer, NBC, radio, mobile and other unique reconnaissance missions.

3. Conduct Initial Terminal Guidance (ITG) for helicopters, landing craft, and parachutist.

4. Designate and engage selected targets with Force Fires and other operations to support battlespace shaping. This includes terminal guidance of precision-guided munitions.

5. Conduct post-strike reconnaissance to determine and report battle damage (BDA) to a specific target or area.

6. Conduct counter-reconnaissance.

7. Conduct limited scale raids.

8. Conduct insertion / extraction of reconnaissance forces in support of recon operations.

9. Conduct other operations as directed by the supported commander. (DOD, 2004c)

A graduate from the Basic Reconnaissance Course is capable of operating within a team to accomplish designated missions as guided by the METL, but to understand the individual skills required, NAVMC 1200.1A, the *Military Occupation Specialty Manual* states that the Reconnaissance Marine

> is an Infantry Marine skilled in amphibious reconnaissance and ground reconnaissance. In addition to basic infantry skills, he possesses proficiency in scout swimming, small boat operations and refined observation, scouting, patrolling, and long-range communication skills. Reconnaissance Men receive advanced training as Static Line and Military Freefall Parachutists and Jumpmasters, as well as Combatant Divers and Diving Supervisors. (DOD, 2015a)

2. Personal Selection

> The training that students undergo while attending any of our courses is mentally and physically challenging by design. To be successful as a Reconnaissance Marine on the battlefield, it requires intellect, strength, endurance, skill and team work. As such, we are looking for individuals who possess the drive, discipline, maturity and courage to rise to the challenge and fill the ranks of these storied warrior communities. If successful, your remaining journey will increase in difficulty, but the sacrifices you will make and the hard work you will put forth will result in immeasurable reward. (Reconnaissance Training Company, n.d.)

The prerequisites to attend BRC have changed minimally over the last twenty years. In 2002, the Marine Corps authorized any MOS to submit a lateral move request to attend BRC and transition to the Reconnaissance Man MOS. Previously, the Primary MOS of Reconnaissance Man had been limited to the Infantry (all 03xx MOSs). Essentially this directive increased the overall pool of candidates eligible to obtain this highly skilled MOS.

Today, Marines that are eligible to apply for lateral move into the Reconnaissance Man MOS are: enlisted Marines in any MOS, pay grades E1 (Private) – E4 (Corporal) and officers from paygrade O1 (Second Lieutenant) – O3 (Captain). Enlisted Marines in paygrade E5 (Sergeant) are eligible if they have been a Sergeant for less than two years. Prior to assignment to the Reconnaissance Training Company (RTC), Marines that lateral move from MOSs outside the Infantry must complete the Basic Infantryman Course at the Marine Combat Training (MCT).

Headquarters Marine Corps (HQMC) recognizes that guaranteed enlisted reconnaissance contracts are beneficial to the Marine Corps as recruiting tool and increase the talent pool from which the reconnaissance community can select. Headquarters Marine Corps directs how Enlistment Option Programs would be implemented in Marine Corps Order 1130.53R (DOD, 2012). This order dictates the policy for recruiting Marines into all entry-level MOSs, including the Reconnaissance Man MOS. This order directs the minimum critical skills and technical skills needed to be eligible to obtain an Enlistment Option Program guaranteed contract. These incentives are tools for Manpower and Reserve Affairs (M&RA) to meet the MOS needs of the

Marine Corps and the overall end strength goals as directed by Congress. Marine Corps Recruiting Command (MCRC) uses the Enlistment Option Program to offer job skill to highly attractive, qualified applicants in order to meet its accession mission.

Figure 3. Requirements for Reconnaissance Marine Enlistment Option Program (Source: DOD, 2012)

HZ	RECONNAISSANCE BONUS $4,000	M	5	GT 105
0300	INFANTRY			No Waivers
0321	Reconnaissance Man			

*Must be a U.S. Citizen. (No waivers)
*GT Score of 105. (No Waivers)
*Must be eligible for Secret Clearance, NO Conduct or Drug Waivers above the Recruiting Station Level. No Misconduct Offenses.
*Must obtain WS-B(+)upon completion of Basic Reconnaissance Course (BRC).
*Must obtain 1st Class Physical Fitness Test (PFT) score upon completion of Recruit Training.
*Pass the Normal Color Perception (NCP) Test w/PIP (12 out of 14 correct) or FALANT. Verify by DD 2808 (No waivers)
*** Understand that if removed from this program for any reason, that the Marine Corps MAY assign an MOS within the 0300 Occupational Field. Refuse to Train/Drop on Request (DOR) anytime time before the completion of the Basic Reconnaissance Course (BRC) that the Marine Corps MAY assign any MOS based on the needs of the Marine Corps.***
*Tier I in accordance with MPPM.
*MALE Only.
*FIVE (5) Year Term of Enlistment (TOE)
• No waivers given for monetary gain.
• May be combined with MCCF.
Individual will be removed from program for the following reasons:
Use drugs while in the Delayed Entry Program, or
Fail a required course of training and fail to obtain the MOS assigned, or
Is disciplined at any time due to behavior, or
Cannot acquire the appropriate security clearance, or
Have lied about education or other qualifications for program or enlistment, or
Fail to meet the required mental, physical or Conduct standards.

MARADMIN 0412/09 states the additional requirements for current Marines to attend BRC:

- Male
- U.S. citizen
- GT score of 105 or higher
- WSB swim qualification
- Score 225 or higher on PFT
- Normal color vision. If a Marine cannot pass PIP or FALANT test for color vision he must be able to identify red and/or green as projected by the Ophthalmological projector or stereo vision testing (STV).
- Visual acuity. Corrected vision must be correctable to 20/20 in one eye and 20/100 in the other eye within 8 diopters of plus or minus refractive error. Personnel who do not meet the visual acuity standards but who have a completed favorable refractive surgery consult conducted by a Department of Defense optometrist will be considered on a case-by case basis.
- Security clearance. Must be eligible for a “Secret” clearance
- Letter from command security manager is required with submission of Lateral Move request.
- Respiratory health. Must be free of all upper respiratory problems and ear, nose, and skin disorders which might preclude a Marine from participating in prolonged training in salt water.
- Musculoskeletal health. Must be free from injuries to the ankles, knees, back, and shoulders which might preclude participating in field training and normal physical fitness training.
- Marine must be medically and physically qualified to participate in arduous physical activities and training.
- Marines who do not meet Marine Corps Body Composition standards will not be considered for lateral move into MOS 0321. (DOD, 2009)

3. Phases of Training

The current program of instruction (POI) for BRC is 65 days in length. It consists of three phases of training.

- Phase 1: Provides candidates with the individual skills necessary to conduct reconnaissance.
- Phase 2: Provides candidates with the individual and team amphibious skills required to conduct operations in an open ocean environment.
- Phase 3: Provides the candidates with individual and team skills required to conduct reconnaissance patrolling operations and long-range communications.

Phase one consists of individual training skills with a particular emphasis on physical strength and stamina. The physical evaluations consist of land-based and water-based events. The land-based events include high-intensity physical training, movement over terrain with full combat equipment, including minimum weighted ruck packs, for time and score, obstacle courses, and day/night land navigation with time constraints. The water-based events include high-intensity pool exercises, water calisthenics, distance swim with fins and equipment in the pool and open-ocean, and water survival training. Additionally, candidates conduct hours of academic instruction throughout the training day on subjects ranging across the required basic, individual reconnaissance requirements as listed in the Training and Readiness Manual (DOD, 2004c).

Phase two focuses on amphibious operations, in particular, the skills required to conduct maritime missions from OTH. During this phase, evaluation of the candidates occurs over numerous open ocean swims with fins and full combat load. Candidates are required to maintain a pace of 15 minutes per 500 yards over 2000 yards (one nautical mile) in the open ocean with full combat equipment. Candidates are required to demonstrate mastery of amphibious reconnaissance skills, boat operations, and nautical navigation from over the horizon using nautical charts and plotting boards with the aid of a compass.

Phase three focuses on patrolling operations. In addition to continuing the aforementioned physical activities on both land and water, candidates are required to demonstrate mastery of patrolling skills as listed in the Training and Readiness (T&R) Manual (DOD, 2004c). The culminating exercise is an extended patrolling operation during which time candidates conduct sequential full-mission profiles for evaluation.

The BRC graduate is prepared to join a reconnaissance unit in the Fleet Marine Force. Once in the Fleet Marine Force, Reconnaissance Marines must attend specialized school within the Marine Corps and other service's Special Operations Schools such as Survival-Evasion-Resistance-Escape (SERE) training, basic airborne school, military free-fall course, Jump Master training, Ranger Course, combatant diver course, and many other USSOCOM, Naval Special Warfare, and Army Special Warfare Schools (DOD, 2016).

THIS PAGE INTENTIONALLY LEFT BLANK

III. SCIENTIFIC LITERATURE REVIEW

This chapter provides a review of relevant scientific research conducted in the past. The first section reviews research on the attributes used to create a predictive model for the successful completion of the Marine Security Guard School (MSG). While research on Marine Corps high-risk training is starting to gain traction in academia, the United States Army has conducted numerous studies on which attributes are most predictive of success in the Special Forces introduction training. The next two sections review research on the attributes and associated models determined to provide the Army Special Forces with a candidate most probable to succeed prior to selection. The chapter concludes with a summary of previous research and links how this study will expand the Marine Corps knowledge in this field.

A. USMC RESEARCH

The requirement and challenge of recruiting, selecting, training, and retaining is nothing new for the Marine Corps. This challenge is particularly difficult when determining which Marines should have the opportunity to further progress their training from the pool of available candidates during times of austerity and resource constraint. Despite attrition rates historically around 43 percent, no prior academic research examines BRC in particular. A USMC study closely related to this research is a study in 1993 examining the Marine Corps Security Guard School.

Building off previous research conducted by the Center for Naval Analyses (CNA), Marine Corps Captain Michael Snyder’s 1993 thesis develops a model to determine the predictors of success for Marines who attend the MSG School. While the CNA study focuses on attributes that predict success after graduation from MSG School, Snyder (1993) focuses on predicting graduation from MSG school using data collected prior to commencement of the school.

Using data of 15 MSG classes from September 1989 to December 1991 (n=1,794), Snyder (1993) defines success as graduation from MSG School. The following table lists the independent variables he examines in his research:

Table 4. Background Characteristics/Variables. Adapted from Snyder (1993).

Variable	**Variable Name in SAS**
Name	NAME
Grade	PAYGRADE – E3, E4, E5
SSN	SSN
Sex	SEX – MALE, FEMALE
Race	RACE – WHITE, BLACK, HISPANIC
Primary MOS	PMOS
Current Enlistment	ENLIST, ENL2ND, ENL1ST2D
Length of Enlistment	LENENL
Education Level	EDUCLEV
PFT Score	PFTSCORE
Rifle Score	RIFLESCR
Marital Status	MARSTAT
Ethnic Background	ETHNIC
Time in Service (TIS)	TIS
Time in Grade (TIG)	TIG
ASVAB Score	GTVE, ELCIAR, MMMAPA, CL
Current Age	AGE
Age Entered USMC	AGEENTRY
MSG School Class Average	AVG
Number of Dependents	NODEPN

Due to the dichotomous dependent variable of the desired model for his study, the author chose to estimate logistic regression models. Snyder (1993) finds that PFT, rifle, and GT scores are best suited to predict success at MSG School. In addition, age, grade, race, and TIG are statistically significant when holding all other variables constant.

Of course, this model, in isolation, cannot determine the candidate most likely to successfully complete MSG School because this model does not include other unobserved factors such as grit and personality. More importantly, the model does not account for the recommendation from the candidate’s Commanding Officer (CO). However, if used in conjunction with the CO’s recommendation, this model can be useful in determining which candidate presents the best option when allocating resources to train the Marine for follow-on service prior to allocating resources.

My research will extend the knowledge of predictive models used in conjunction with Marine Corps schools by analyzing the statistically significant determinants and researching the points in time where these characteristics are instrumental in assessing when a candidate is likely to attrite.

B. ARMY SPECIAL FORCES RESEARCH

Given the inherent risks associated with sending small teams of highly trained Marines into uncertain, hostile environments, it is imperative that the Marine Corps selects the right personnel to perform these missions. The training is rigorous by design, and is such that the vast majority of the population need not apply for such professions. The attributes studied in the Army Special Forces parallel the desired attributes needed for success in Marine Corps reconnaissance with the exception of language training. So what are these attributes needed for success in such high-risk, mentally and physically demanding occupations?

A study by Landale (2014) reviews accession and retention of Special Forces soldiers. As part of her study, Landale examines the predictors of success at the John F, Kennedy Special Warfare Center and School (SWCS). Landale uses the data from 23,070 candidates from the Special Forces Assessment and Selection (SFAS) course during 2006 through 2013. Only 9,371 (40.16%) of those candidates are selected for training in the Special Forces Qualification Course (SFQC). In addition to the 61 measures obtained during SFAS, the research uses three descriptive variables, including MOS, and one demographic variable (age) prior to attending SFAS/SFQC.

Given the dichotomous dependent variable of the desired model for this study, where she codes success as STATDUM =1 and failure STATDUM=0, Landale (2014) estimates logistic regression models. Landale's research examines twenty-three independent variables including ten variables for basic military descriptors of the candidate, six components from the principal component analysis of different training events, scores and traits, and seven dummy variables to account for unobserved changes over time. The multivariate regression analysis and survivability model determine which measurable attributes are relevant in predicting success throughout the observed time.

The findings confirm the hypotheses, and Table 5 summarizes the results.

Table 5. Summary of Key Results & Implications. Source: Landale (2014).

Summary of Key Results & Implications					
Factor	SFAS Results		SFQC Results		Implications
Cognitive Ability	.346	***	.078	*	Cognitive ability helps sort the "wheat from the chaff" in SFAS, however this service competency is less helpful in SFQC where the majority of candidates are likely to be of similar cognitive ability.
Navigational Ability	.953	***	.234	***	Navigational ability is highly predictive of both SFAS and SFQC success. This soldiering skill is a critical service competency for successful SF performance and could serve as a gated event, whereby candidates who are unsuccessful are immediately eliminated from training.
Physical Strength	.192	***	.204	***	Physical strength is also a critical service competency for successful training performance, as it is predictive of both SFAS and SFQC success. The measures of physical strength could easily be performed before the soldier enters SFAS. Failure to meet the physical strength requirements could be used as a means to deterring unqualified candidates.
Short-Term Endurance	.147	***	-.007	ns	Short- and long-term endurance help sort the "wheat from the chaff" in SFAS, however this service competency is less helpful in SFQC where the majority of candidates are likely to be of similar endurance ability.
Long-Term Endurance	.301	***	.002	ns	
Ranger Status	.422	***	.345	***	Ranger status is highly predictive of SFAS and SFQC success. This proxy measure of service competency and tenure suggests Army SF should focus their recruiting efforts on Ranger-qualified candidates who already have the soldiering skills and experience necessary to successfully complete training.
Peer Evaluations	.770	***	.232	***	Peer evaluations (of personality characteristics and peer rankings) are highly predictive of SFAS and SFQC success. To pre-screen potential candidates for service inclination, SF training applications could require the candidate to submit recommendation letters from his peer(s) and supervisor(s) that vouch for the candidate's positive personality characteristics.
Age^2	-.058	***	-.032	ns	Army SF should seek candidates who have the right combination of youthful strength and experienced wisdom.
Infantry Career Field	.246	***	.049	ns	The career field from which the candidate matriculates is an important predictor of training success. Those from the Infantry fare well in SFAS, but do not stand out from the crowd in SFQC. On the other hand, candidates who were recruited from outside the Army perform very well in both SFAS and SFQC. The 18X program could continue to work well if the Army is able to recruit the same caliber of candidates.
SF Career Field	.644	***	.637	***	
* p<.05 ** p<.01 *** p<.001					

The research I conduct is similar to Landale's in that it seeks to determine which attributes are statistically significant in predicting success using multivariate regression analysis. Additionally, my study will determine at which point in the course a candidate with given attributes will access or attrite, providing a survivability model for incoming cohorts.

Other researchers have examined the variables and attributes that affect candidates throughout training in SFAS and SFQC. One of these attributes is grit. Grit is the resilience to achieve long-term goals over time with sustained effort and perseverance (Duckworth, Peterson, Mathews, Keely, 2007). According to a review of literature, the grit trait is significant to obtaining education goals. Many experts identify grit as important in the success of an individual. The U.S. Army is the leader in conducting research on methods to measure grit in candidates for accession into military schools.

The ability to "not quit" in the face of adversity is crucial to the success of any candidate. Throughout BRC, individuals face arduous demands, some unobtainable, and how the individual internalizes the conflict within oneself dictates whether the candidate overcomes his desire to quit. According to a study conducted on a cohort of Australian

Special Forces candidates, among the (51) applicants that did not finish (DNF) the course, the vast majority of them (34) that withdrew themselves from the course demonstrated a lack of grit or perseverance to overcome adversity (Gayton & Kehoe, 2015).

Can grit be used to predict success for reconnaissance Marines in the same manner as Army Special Forces Assessment and Selection? While appealing, grit is difficult to measure and often overlooked in quantitative analyses due to the inability to easily conduct a test and/or have a psychometrically validated instrument. There is little research on how to measure a candidate's grit accurately. According to research conducted by several Special Forces around the world, surveys are the primary means of determining a candidate's grit (Duckworth et al., 2007). However, it remains an open question whether grit measures are significant in predicting the success of any given candidate holding all other variables constant. Due to lack of conclusive evidence in accurately measuring grit, and more importantly, the lack of data surveying previous cohorts of BRC candidates on their grit, my research does not examine grit.

The next attribute measured prior to selection to such schools is cognitive ability. The Marine Corps, much like its sister services, relies on tests which identify an individual's cognitive ability. The Marine Corps uses the Armed Forces Vocational Aptitude Battery (ASVAB) score and the GT score to measure the cognitive ability of its members. The ASVAB test measure knowledge and ability in several areas including general science, math, word knowledge, mechanical and electronic comprehension, and verbal expressions. This test is not an IQ test, but rather a tool to measure knowledge and ability. The current pre-requisite GT score of 105 is the minimum, but other studies suggest this may not be the optimal requirement. The optimum score to balance successful graduation of Army Special Forces Assessment and Selection with manpower requirements is a GT score of 115 (Brooks & Zazanis, 1997). Due to the similarities in cognitive skills required to accomplish individual skillsets, both the Army Special Forces and Marine Corps Reconnaissance attempt to recruit, train, and retain similar personnel.

Research suggests that tools to measure intellectual ability, such as the ASVAB, should include other non-cognitive measures. This will enable a model to predict military performance in school environments to be more accurate, reducing the standard error (Driskell, Hogan, Salas, Hoskin, 1994).

The role of cognitive ability is even more important when a candidate faces physically demanding tasks due to the necessity to be able to think, judge, and adapt in order to complete Special Forces Selection and Assessment. In his findings, Beal (2010) reports that the test that is most probable to predict cognitive ability accurately in Special Forces candidates is the Test of Adult Basic Education (TABE). The ability of cognitive measures to predict success is actually greater than the measure of perseverance.

The importance of physical ability cannot go understated in any research involving predicting success among candidates that undergo arduous, grueling training over a significant duration. The physical demands of BRC are extremely high, and it is crucial that any prospective candidate possess a high physical endurance in order to decrease the likelihood of an injury preventing the candidate for graduating. In a study conducted in 2013 suggests that personnel who begin training without having the required level of physical stamina and endurance are at a greater risk of sustaining an injury and are more likely to attrite (Hunt, Orr, Billing, 2013).

The physical demand of BRC divides into events on the land and water. The current requirement to obtain Water Survival Basic prior to attending BRC is inefficient in predicting success. The current requirement is similar to the minimum requirement to graduate Recruit Training; therefore, technically, every Marine currently serving has obtained the minimum standard. The current standard does not sufficiently establish the guidelines that enable differentiation among prospective candidates.

C. SUMMARY

In summary, prior academic literature points to cognitive ability, physical ability, and to some extent, grit or perseverance, as likely predictors of success at an MOS producing school like BRC. The predictive model I will develop in the next chapter uses all available information on BRC cohorts. This analysis and the survivability model will enable the Marine Corps to structure/restructure the POI to better select, screen, and train the most highly talented candidates, and possibly (re)organize the training more efficiently to produce Marines for the specialty of reconnaissance.

THIS PAGE INTENTIONALLY LEFT BLANK

IV. DATA AND METHODOLOGY

This report is quantitative and requires bringing together several data sources for a given candidate. The purpose of this chapter is to discuss each data source and how the population of BRC candidates is constructed, their data and variables cleaned and coded to enable statistical analyses using the software STATA. Next, I describe the empirical approach and statistical models I use in the analyses.

A. DATA SOURCES

1. Total Forces Data Warehouse

The data for this research comes from two sources. The first source is the TFDW. TFDW consolidates personnel data from accession to separation for the Marine Corps. Information in the TFDW actually comes from a range of sources, but for my research, I use the Marine Corps Total Force System (MCTFS), the Marine Corps Training Information Management System (MCTIMS), and the Marine Corps Recruiting Information Support System (MCRISS). The data at TFDW is a monthly snapshot of a Marine taken on the last day of each month. TFDW data in this study is thus drawn from the month prior to a given candidate's BRC convene date.

Each candidate has a unique identifier and matches to other data sources by either social security number or Department of Defense Identification Number (EDIPI). Next, I verify each candidate did in fact populate in MCTIMS as having attended BRC.

TFDW provided me with the variables listed in Tables 6 and 7.

Table 6. Definitions of variables in BRC_FY”Y”_MAIN files from TFDW.

Variable Name	**Variable Description**
RANK	Current rank
L_NAME	Last name
F_NAME	First name
MI	Middle initial
SSN	Social security number
EDIPI	Department of Defense ID
CLASS	BRC class attended
GCT_GT_TOTAL	GT score for enlisted, GCT score for commissioned officer
AFQT_SCORE	Armed Forces Qualification Test
AR	ASVAB subtests Arithmetic Reasoning
CS	ASVAB subtests Coding Speed
EI	ASVAB subtests Electronic Information
GS	ASVAB subtests General Science
MC	ASVAB subtests Mechanical Comprehension
MK	ASVAB subtests Mathematics Knowledge
PC	ASVAB subtests Paragraph Comprehension
VE	ASVAB subtests Sum of Word Knowledge and Paragraph Comprehension
WK	ASVAB subtests Word Knowledge
PFT_SCORE	Physical Fitness Test (PFT) total score
PFT_PULL_UP	PFT pull-up score
PFT_RUN_TM	PFT run time
CFT_SCORE	Combat Fitness Test (CFT) total score
MTC_TM	CFT Movement to Contact time
MANUF_TM	CFT Maneuver time

Variable Name	Variable Description
RIFLE_QUAL_SCORE	Rifle Qualification Score
COMBAT_DEP	Number of previous Combat Deployments
ETHNICITY	As reported by the candidate
PROMO_DATE	Date promoted to current rank
PEBD	Pay Entry Base Date, the day the candidate assessed into the Marine Corps
PMOS	Primary Military Occupational Specialty (PMOS)
MARR	Identifies if the candidate is married

Table 7. Definitions of variables in BRC_FY”Y”_MIL_SCHOOLS

Variable Name	Variable Description
RANK	Current rank
L_NAME	Last name
F_NAME	First name
MI	Middle initial
SSN	Social security number
EDIPI	Department of Defense ID
CLASS	BRC class attended
SCHOOL_CODE	Code uniquely identifies the school
SCHOOL_NAME	Name of school attended
SCHOOL_STATUS	Identifies whether or not the candidate completed the school
SCHOOL_DT	Date school was attended
SCHOOL_STATUS	Identifies whether or not the candidate completed the school
SCHOOL_DT	Date school was attended

A limitation of the data from TFDW is that it does not provide data points for service members from other branches of the Department of Defense (Navy, Army, and Airforce) or foreign military personnel. I retain these observations in the data set for further analyses, as dropping these observations would bias the analysis and create missing indicators.

2. Basic Reconnaissance Course

The staff at BRC provides the second source of data for this research. The data includes Excel spreadsheets reflecting each candidate's records of performance throughout the course at individual events, as well as individual counseling sheets for candidates who fail an event. While the BRC cadre is very experienced in training reconnaissance Marines, the fidelity of the data varies over time. In addition to the information in counseling documents, Table 8 depicts the variables this study uses from BRC.

Table 8. Definition of Variables in BRC Data.

Variable Name	**Variable Description**
RANK	Current rank
L_NAME	Last name
F_NAME	First name
MI	Middle initial
SSN	Social security number
EDIPI	Department of Defense ID
CLASS	BRC class attended
GRAD	Binary indicator of whether or not candidate graduated BRC
T-Day	The training day identified if a candidate dropped from training

Variable Name	**Variable Description**
PHASE_ATTRITE	Identifies which phase a candidate dropped from training
NUMBER_PREV_ATTEMPTS	Identifies the number of previous attempts to pass BRC
REASON_ATTRITE	Identifies the reason the candidate did not complete BRC

Table 9 reflects the sum total of observations from BRC and TFDW by fiscal year.

Table 9. Number of Observations by Fiscal Year from the Combined Data from TFDW and BRC.

Fiscal Year (FY)	**Number of Observations**
2013	497
2014	440
2015	353
2016	298
Total	1,588

B. DATA CLEANING AND VARIABLE CONSTRUCTION

This section discusses the techniques I use to clean the data and construct variables. On more than one occasion, it was necessary to examine individual data points in order to determine accurately what the data represents. The merging of the two data sets (BRC and TFDW) requires extensive work and attention paid to particular details. The following section details the construction of variables I use for the subsequent analyses.

1. TFDW Independent Variables

a. Personal and Demographic Information

First, the naming convention in the data from TFDW is different from that at BRC. I make variable names uniform, as well as the entries in the variables itself, such as characters (e.g., spaces and hyphens) in individuals' last or first name or middle initial. Next, I create dummy or indicator variables to capture the ethnicity of each candidate as BLACK or HISPANIC. Candidate age derives from the date of birth variable (DOB) in TFDW, and is a candidate's age (in years) as of the first day of BRC. To determine how long a candidate has been in his current rank, I create a Time in Grade variable using the present rank date and the convene date (DOC) for BRC.

$$Time\ in\ Grade\ (TIG) = ((DOC - PRESENT\ RANK\ DATE) * 12)/356$$

Similarly, I calculate time in service (TIS) as:

$$Time\ in\ Service\ (TIS) = ((DOC - PEBD) * 12)/356$$

b. Military Occupation Specialty (MOS)

The occupational fields each candidate originates from prior to attending BRC may be a relevant factor in determining survivability at BRC. To make the analysis tractable, I identify certain fields in the TFDW variable PRIMARY_MOS_CODE. According to the MOS Manual, all basic MOSs are easily identifiable with the last four numbers in the MOS code as "00." With this information, I generate a code to create a BASIC_MOS if the last two numbers in the MOS code were in fact "00." Based on the MOS manual, I generate the occupational fields of each observation (OccFlds) based on the first two numbers in the MOS code. Next, I capture the OccFld and generate three subcategories to reflect the origin of each candidate. Table 10 annotates the occupational specialty fields.

Table 10. Military Occupational Specialty by Occupational Fields.

Marine Corps Military Occupational Specialty (MOS) Category	MOS Category Variable Name	Associated MOSs from the data sets
Air Support	OccFld_Air_Support	6000,6100,6500,6600
Ground Combat	OccFld_Ground_Combat	0300,0800,1300
Ground Support	OccFld_Ground_Support	0600,5800,0100,0400,3000,3100,3300,3500,1100,3400,4300,4400,2100,2800, 0200,2600

c. Enlisted/Commissioned Officer

In order to determine if the observation is an Enlisted Marine or a Commissioned Officer, I generate a code to capture those Ranks associated with Commissioned Officers (2NDLT, 1STLT, CAPT, MAJ) and assign them as ENLISTED=0.

d. Marital Status

I code a candidate as married if the TFDW variable reflecting marital status as of the month prior to attending BRC is equal to an "M."

e. Proficiency and Conduct Marks

For enlisted Marines the Marine Corps codes proficiency and conduct marks from a range of 0.0 – 5.0 with the following explanations:

Table 11. Marine Corps Proficiency and Conduct Scale Definitions. Adapted from DOD (2008).

Score	Corresponding Adjective
0.0 to 1.9	Unacceptable
2.0 to 2.9	Unsatisfactory
3.0 to 3.9	Below average
4.0 to 4.4	Average

Score	Corresponding Adjective
4.5 to 4.8	Excellent
4.9 to 5.0	Outstanding

However, the proficiency and conduct marks for enlisted Marines in this research's analysis sample are highly collinear (rho=.99). To avoid a problem of collinearity in later analysis, I combined pro and con marks to construct the PRO_CON variable:

$$PROCON = \left(\frac{CONDUCT\ AVERAGE\ SERVICE + PROFICIENCY\ AVERAGE\ SERVICE}{2}\right) * .1$$

This variable is multiplied by 0.1 because the data from TFDW does not contain the decimal point noted on Table 11.

Of the three proficiency and conduct scores made available by TFDW (in current rank, average during current enlistment, or average over entire service), I determine the best reflection of an observation's true conduct and proficiency marks prior to attending BRC is the average in service. The issue with using average current enlistment is that there are observations with more than one enlistment and others with less than one enlistment complete. The average proficiency and conduct score for current rank are over a shorter period, and I determine it to be a less complete reflection of the true performance of an enlisted candidate.

f. Navy/Marine Corps Candidate

Since the data from TFDW does not contain information for Navy personnel, I create a dummy variable NAVY to capture those candidates that were in the Navy based on their rank. I generate code variable NAVY=1 for a subset of individuals without data in TFDW with Navy ranks. All other observations code as "0" and therefore not Navy.

g. Cognitive Ability

The standard approach across the Department of Defense to measure a service member's cognitive ability is performance on the ASVAB test. The GT score is a combination of subtests. The GT score differs from service to service. In the Marine Corps, GT is a metric that sums the subtest of word knowledge and paragraph comprehension and arithmetic reasoning. This measurement reflects the candidate's potential cognitive ability and suitability for MOS selection. For this model, Table 4 defines the subtests. I discard the subtests variables from the TFDW dataset due to collinearity (rho>=74.8) with their respective tests. I create a variable to analyze candidates that score 105 on the GT with the variable GCT_GT_TOTAL_gt105 as baseline. I also create a variable for candidates that score 115 on the GT (GCT_GT_TOTAL_gt115). In my analyses, I compare and contrast the effects of these two metrics on the predicted outcome of candidates. The Marine Corps uses the General Classification Test (GCT) instead of the ASVAB for commissioned officers. However, according to Marine Corps Oder 1230.5C, the GCT is not for officer placement or selection to an MOS. For my study, I aggregate the two in order to determine if GCT is a predictor of cognitive ability for the Commissioned Officers that attend BRC.

h. Physical Fitness Test (PFT)/Combat Fitness Test (CFT)

Raw scores on the physical fitness test or PFT (PFT_SCORE) and combat fitness test or CFT (CFT_SCORE) are also included in the analyses. Additionally, I examine the run time (PFT_RUN_TM) and number of pullups (PFT_PULL_UP), but not the number of sit-ups because there is not enough variation. The same holds true for the ammo can lift portion of the CFT. For the CFT, I keep the maneuver under fire (MANUF_TM) and movement to contact (MTC_TM) times for use in the analyses. These scores are the more recent recorded scores in MCTIMS prior to the candidate's convene date at BRC.

i. Education

TFDW data contains several variables to record an individual's education level. After a thorough analysis of the variables, I combine civilian education and civilian education certificate. I create a dummy variable (HSonly) to capture those who obtain a civilian education of "12" years or a civilian education certificate of "GED" or "HS DIPL." I then generate a dummy variable (Some_College) to capture those who obtain the civilian education "college" or the civilian education certification of "1 SEM COL" or "ASSOC DEG."

j. Military School Experience

The data from TFDW contains all the information regarding who attended what schools, when they attended them, and if they completed the course. For the purpose of this research, I recode the existing SCHOOL_CODE variable with the corresponding codes (1-5):

1. Defines basic schools as schools that will generate a MOS upon successful completion.
2. Defines sustainment schools as schools that enhance the mission readiness of the individual within the MOS.
3. Defines advance schools as schools that provide the Marine with advance MOS training and are usually required to hold key billets within the occupational specialty.
4. Professional Military Education (PME) is schools that are required for promotion within a given MOS.
5. BRC Primer Course (BRPC) indicates if the candidate attended BRPC prior to attending BRC.

k. Combat Deployments

The variable reflecting the number of combat deployments (COMBAT_DEP) is in the TFDW data. The numeric values reflect how many combat deployments a candidate completes prior to attending BRC. I replace candidates with missing combat deployment information in TFDW (.) with the numeric value of zero (0) and construct a missing dummy variable.

l. Categorical Variables

After creating continuous variables, analyses determines multi-collinearity exists and low variations with few statistically significant variables are present. The statistically significant variables provide a low magnitude of economic significance. As a result, I create categorical variables for analyses.

(1) Physical Fitness

I create two categorical variables to measure physical fitness using PFT score. The first variable I construct categorizes PFT scores using the current prerequisite of 225 (PFT_gt225). The second variable constructs PFT scores using the former standard for selection and assessment into FORECON. The minimum PFT score was 275 out of 300 for enlisted Marines. Therefore, I create the variable PFT_gt275 to identify the threshold of candidates scoring less than or greater than 275 on the PFT. In my analysis, I use maneuver under fire because CFT scores present minimum variation. I construct the variable MANUF_less210 to capture the candidates that scored a perfect score on this CFT subtest.

(2) Cognitive Ability

I create two categorical variables to measure cognitive ability. The first is GCT_GT_TOTAL_gt105. This variable identifies candidates that score the minimum GT score as identified in the prerequisites. The second variable (GCT_GT_TOTAL_gt115) adjusts the threshold to the minimum score of 115 for comparison. A score of 115 is the optimum score to balance quality and quantity for selection into Army SF (Brooks & Zazanis, 1997). After analyzing the data, the threshold for the AFQT is determined to be 90 (AFQT_gt90).

2. BRC Dependent and Independent Variables

a. Graduation from BRC

The main dependent variable I use in this research is a binary (0/1) indicator equal to (1) if the candidate completes BRC and (0) otherwise. The variable (GRAD) is consistent in both the BRC and TFDW data.

b. Training Day

As outlined earlier, data from BRC includes spreadsheets with individual event scores and individual counselling forms for students that fail to meet graduation criteria at a point in time during the course. Using the spreadsheets and counselling forms, I am able to identify which training day a candidate drops from training. The variable training day (T_Day) captures the date the individual drops from BRC. T_Day is the dependent variable I use to define duration in the survival models in the next chapter.

c. Phase Attrite

BRC data contains detailed training schedules. I use the detailed training schedule to annotate which phase (phase 1–3) a candidate drops from training in BRC.

d. Reason Attrite

Using the spreadsheets and counselling in aggregation, I determine why each candidate fails to graduate BRC. I then categorize these reasons and construct a variable (DROP_CODE) as listed in Table 12.

Table 12. Definitions of Variable DROP_CODE.

DROP_CODE (assigned)	Reason	Explanation
1	Academic	Candidate failed to achieve the minimum score on a written test
2	Admin	Candidate failed to meet prerequisite criteria upon arrival to BRC
3	Drop of Request (DOR)	Candidate voluntarily withdraws from training
4	PFT	Candidate failed to achieve minimum PFT score
5	Land navigation	Candidate failed to achieve the minimum score on day and/or night land navigation
6	Medical	Candidate had a medical condition which prevented continuation of training
7	Patrolling	Candidate failed to achieve

DROP_CODE (assigned)	Reason	Explanation
		the minimum score on graded patrols
8	Fin	Candidate failed to achieve the minimum score on open water surface swims with fins and combat equipment
9	Safety pool	Candidate identified as a safety hazard while training in the pool and risk of further training deemed to high
10	Swim qual	Candidate failed to demonstrate the necessary skills to pass Water Survival Advanced as outlined in MCO 1500.52D
11	Legal	Candidate was subjected to legal action during training
12	Unknown	Unable to decipher reason for attrite with given data
13	Individual skills test	Candidate failed to achieve the minimum score on one of the individual skills test administered during the course
14	Integrity	Candidate demonstrated a lack of maturity and judgment during the duration of the course
15	Knots test	Candidate failed to achieve the minimum score to pass the knots test

e. Number of Previous Attempts

The number of previous attempts (numbr_prev_attmpts) depicts how many times a candidate attends BRC prior to the current attempt. Additionally, FY15 and FY16 data contains a variable to reflect how many attempts the candidate took to complete BRPC (num_brpc_attempts).

C. MERGING BRC AND TFDW DATA

Once the data from TFDW and BRC is clean and variables constructed, I proceed to merge the datasets for further analyses. In order to merge the datasets, I use the candidate's last name, first name, middle initial, SSN, and class. When I cannot match records using all five fields, I match on four fields: last name, first name, SSN, and class. Remaining unmatched observations are merged by last name and first name and class, and then subsequently by SSN and class if still unmatched. The match rate across Fiscal Years is 95 to 100 percent. Due to variances in the number of spaces and inputs in FY15 datasets, for example, it is necessary to merge the data iteratively four times (starting with the finest coverage as outlined above and limiting to matching in 2 fields) in order to match over 95 percent of the observations. In FY16, the data sets from BRC do not include the candidate's social security number. Instead, I complete the merge using the Department of Defense identification number (formerly referred to as the Electronic Data Interchange Personal Identifier [EDIPI]).

D. OMITTED OBSERVATIONS

Due to the observations with incomplete data points, potential exists for omitted variable bias. To solve this issue and analyze the complete dataset, I create dummy variables. To construct these variables I generate a dummy variable if the respective variable was a ."" and replace it with a "0." This technique allows me to analyze all observations in the dataset with class fixed effects to account for unobservable variables specific to that class. Table 13 provides a description of the dummy variables.

Table 13. Definition of Dummy Variables

Variable Name	**Variable Description**
x_GCT_GT_TOTAL	=1 if missing GT score for enlisted, GCT score for commissioned officer
x_AFQT_SCORE	=1 if missing Armed Forces Qualification Test
x_PFT_SCORE	=1 if missing Physical Fitness Test (PFT) total score
x_PFT_RUN_TM	=1 if missing PFT run time

x_MANUF_TM	=1 if missing CFT Maneuver time
x_RIFLE_QUAL_SCORE	=1 if missing Rifle Qualification Score
x_COMBAT_DEP	=1 if missing number of previous Combat Deployments
x_BLACK	=1 if missing race/ethnicity
x_TIG	=1 if missing time in current grade
x_TIS	=1 if missing time the candidate has been in the service
x_OccFld	=1 if missing Primary Military Occupational Specialty (PMOS)
x_MARR	=1 if missing marital status
x_HSonly	=1 if missing education candidate obtained

E. DATA STATISTICS

1. Summary Statistics

The total number of BRC candidates in this research thus consists of 1,577 observations from FY2013 to FY2016. Each observation is a unique BRC candidate in that cohort within that fiscal year. Individual BRC candidates who fail out of one cohort and try again in a subsequent cohort could thus be the same Marine. Each observation in the data includes information for that candidate's event scores while at BRC as well as data points (including demographics, evaluation marks, and test scores) captured in the month prior to beginning at BRC.

Table 14 provides summary statistics of this data. Data for this analysis are 100 percent male because this MOS was not open to women prior to FY2016. The overall graduation rate from FY2013 to FY2016 is 57 percent. BRC candidates during FY13-FY16 are on average 22.5 years old and have a GT score of 118. Ninety three percent of the candidates are enlisted, 15.1 percent are Navy Corpsmen, and 70 percent originate from a combat arms occupational specialty. Twenty-four percent of the candidates previously attended an "advance" MOS school prior to BRC, and 13.5 percent complete combat deployments prior to attending BRC.

Table 14. Data Descriptive Statistics.

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
GRAD	57.2%	.4949499	0	1
GCT_GT_TOTAL	118.13	9.640125	87	148
PFT_SCORE	283.10	15.45936	201	300
CFT_SCORE	295.75	6.396117	243	300
COMBAT_DEP	13.9%	0.667028	1	6
AGE (years)	22.48	3.403562	18.16	34.68
OccFld_Ground_Combat	70.4%	0.456858	0	1
ENLISTED	93.1%	0.253402	0	1
MARR	32.5%	0.468564	0	1
PRO_CON	4.40	0.197555	4.0	5.0
NAVY	15.1%	0.358552	0	1
NO_ADVANCE_SCHOOL	11.6%	0.750669	1	10

2. Descriptive Statistics

Figure 4 through Figure 14 illustrate the frequency and distribution of the continuous variables in this study.

Figure 4. PRO_CON Distribution

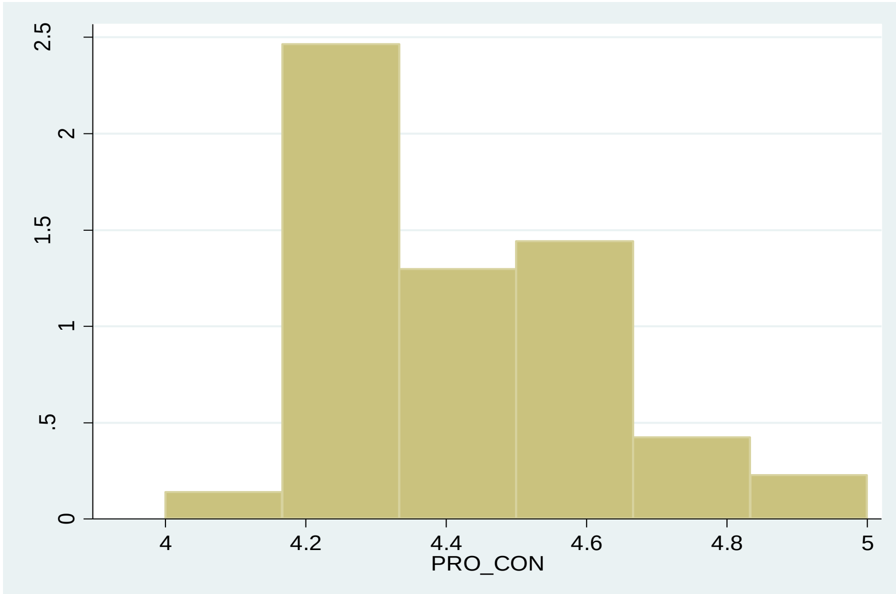


Figure 5. Age Distribution

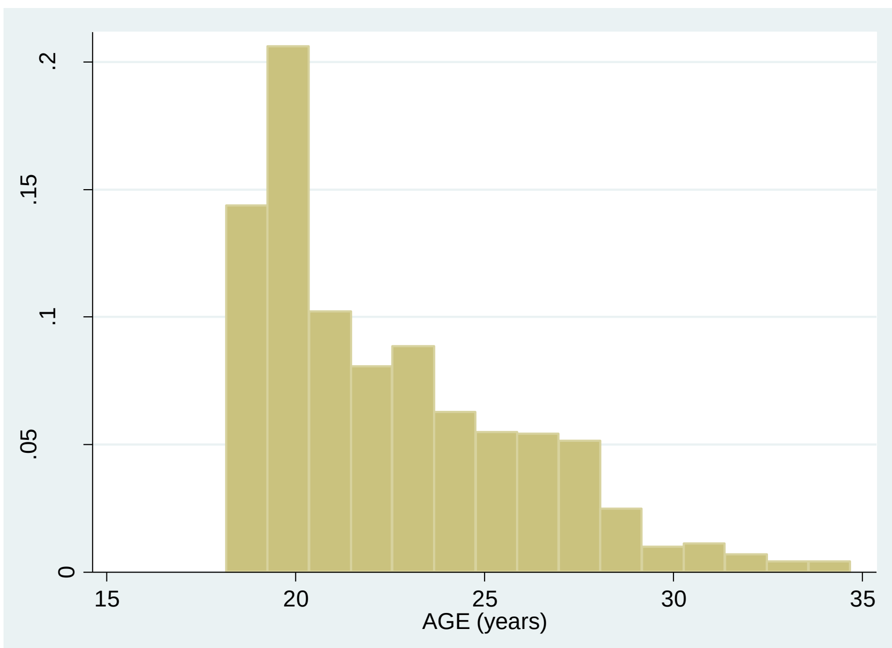


Figure 6. GCT_GT_TOTAL Distribution

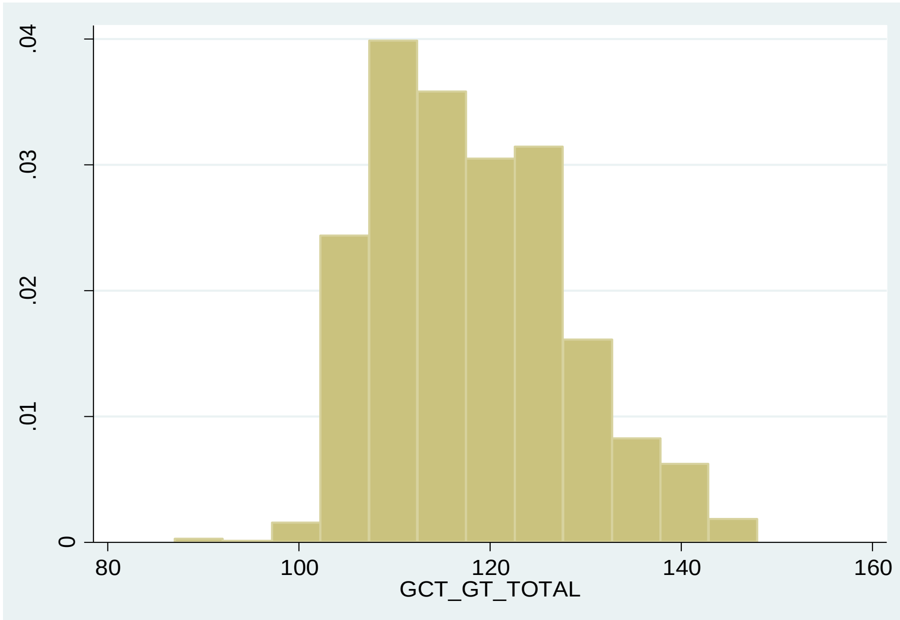


Figure 7. AFQT_SCORE Distribution

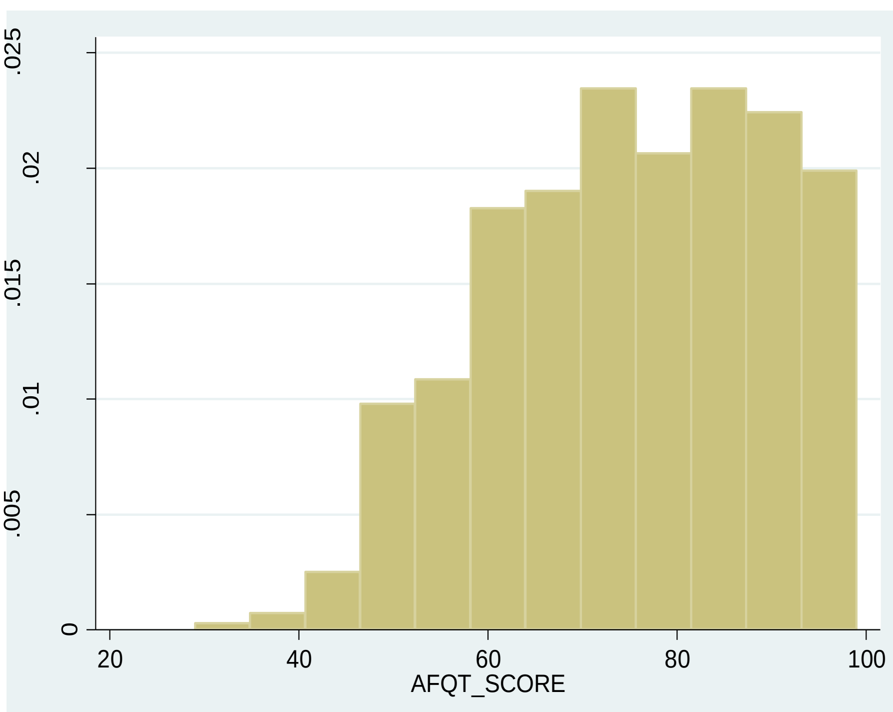


Figure 8. TIG Distribution

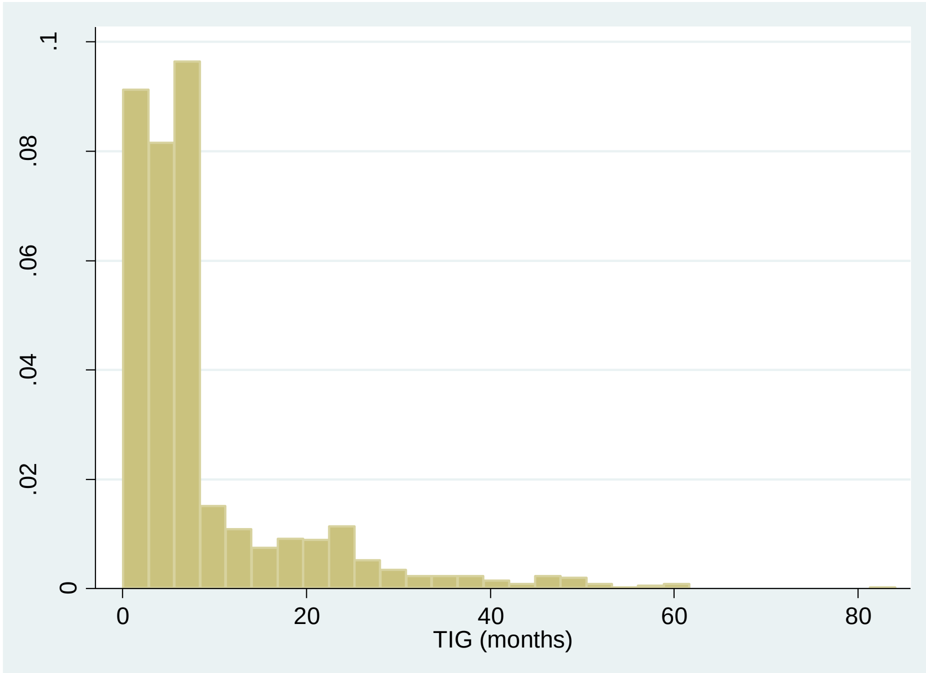


Figure 9. TIS Distribution

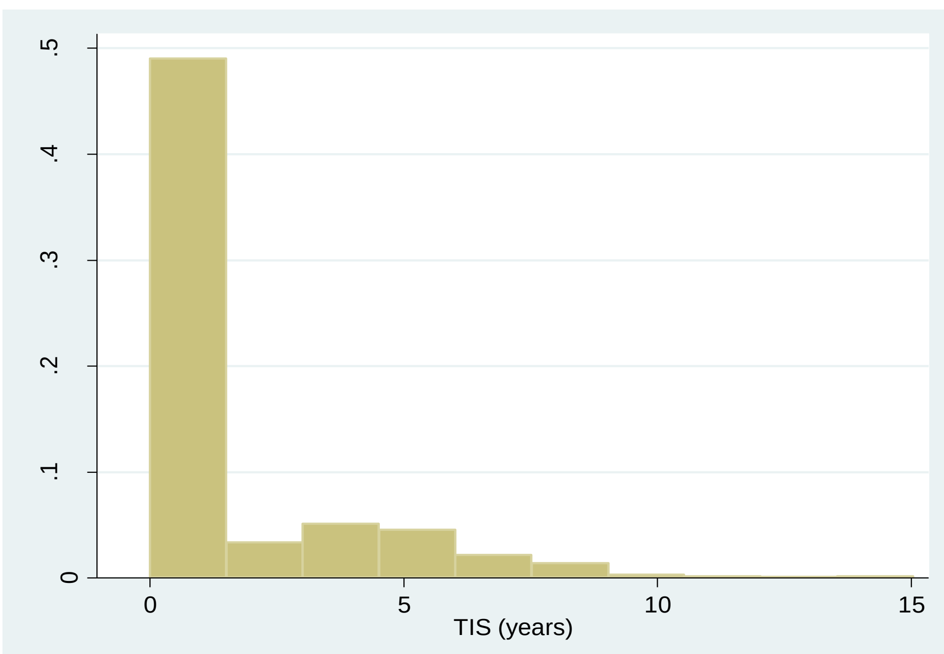


Figure 10. PFT_Score Distribution

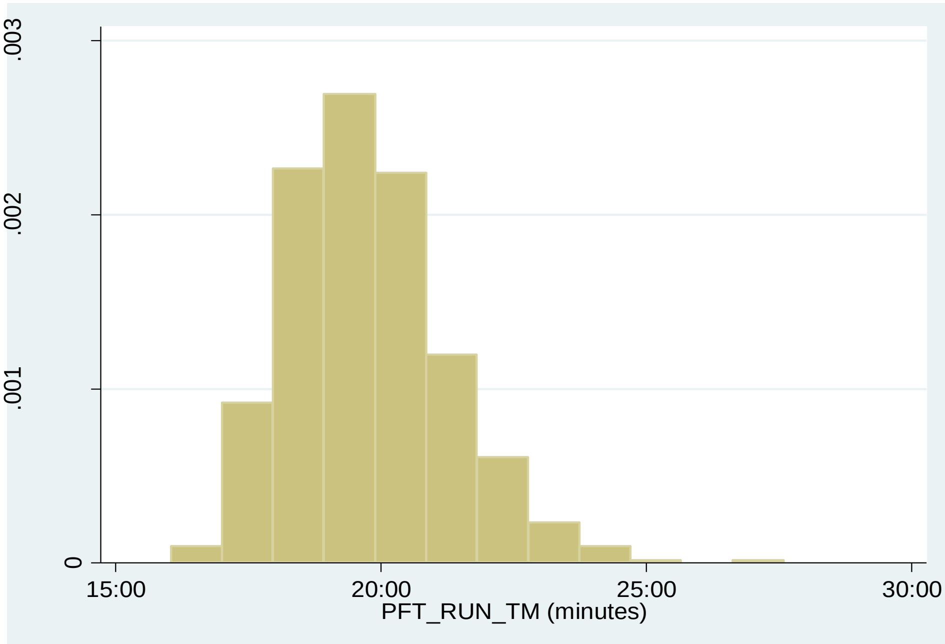


Figure 11. CFT_SCORE Distribution

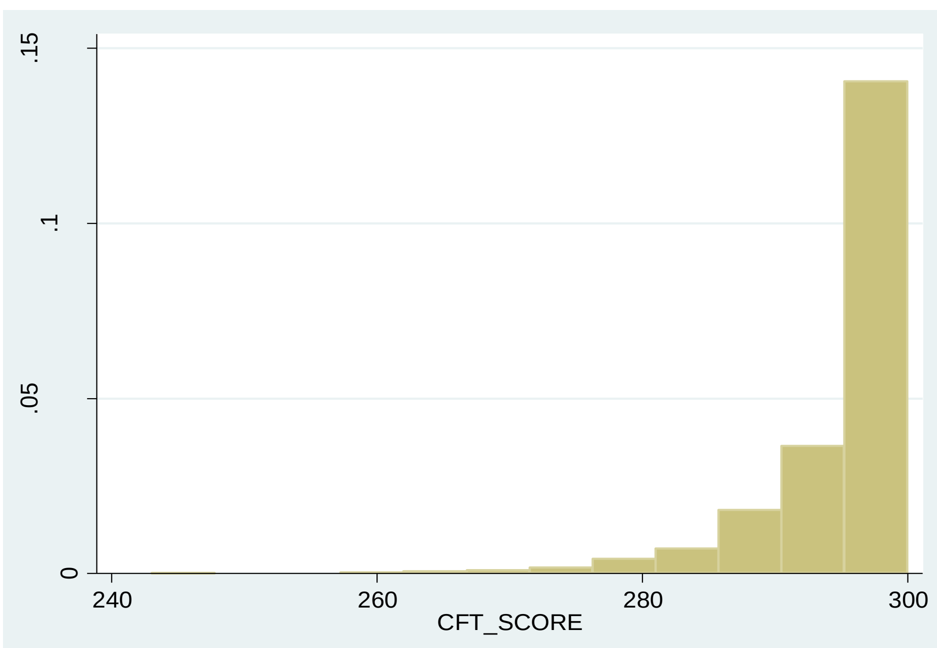


Figure 12. MANUF_TM Distribution

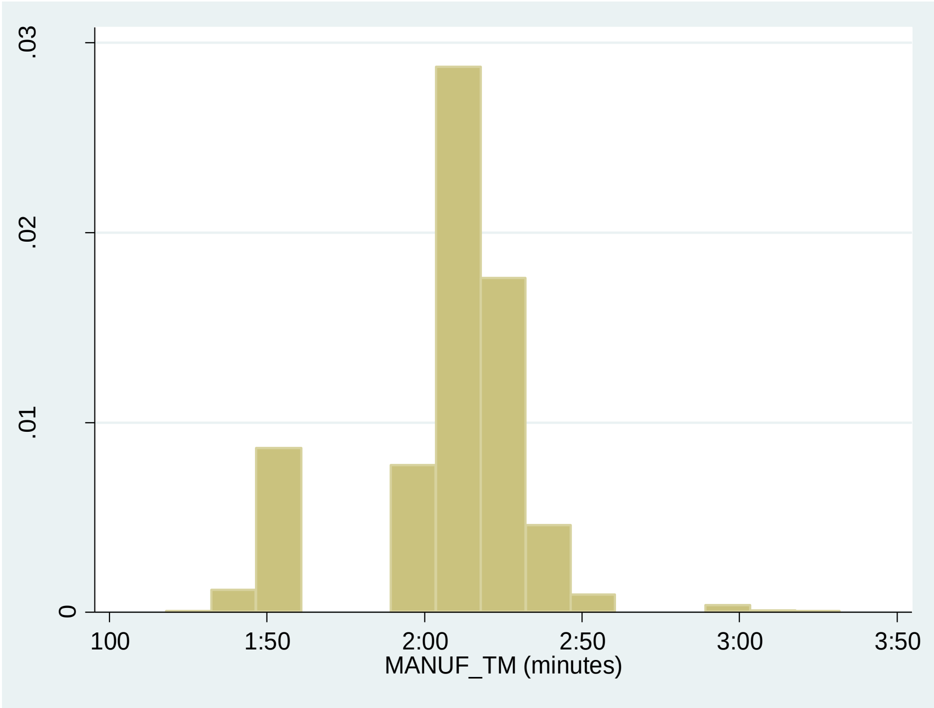


Figure 13. RIFLE_QUAL_SCORE Distribution

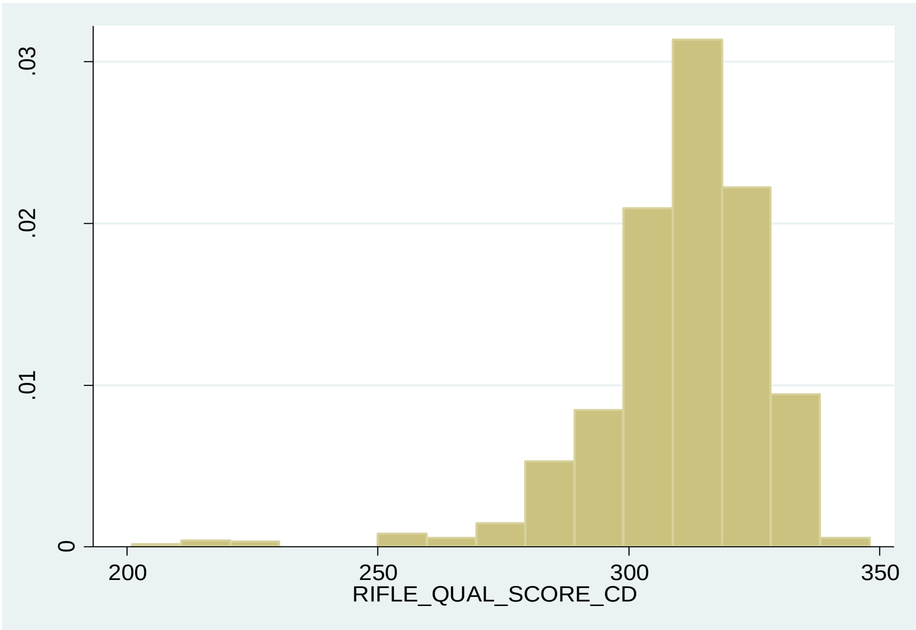
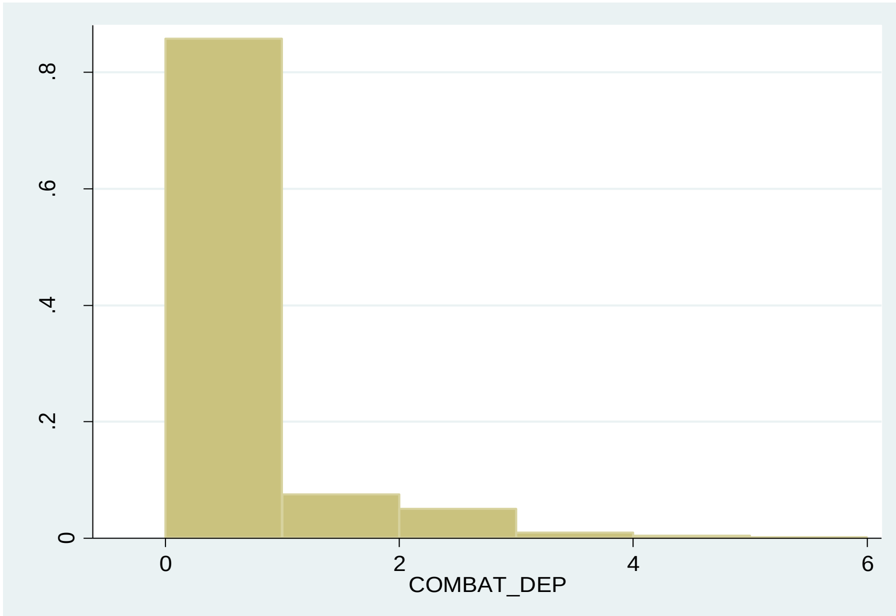


Figure 14. COMBAT_DEP Distribution



F. METHODOLOGY

1. Multivariate Regression

I use STATA version 13.1 throughout this research. Logistic regression is the first model I analyze in this research to identify which independent variables are statistically significant in predicting success at BRC. Logistic regression is appropriate to use in this study because of the binary nature of the dependent variable (GRAD) reflecting graduation from BRC (GRAD=1) or attrition (GRAD=0). I examine 27 independent variables in the logistic regression. The following equation represents the logistic regression I estimate in this study:

$$P(GRAD = 1|x) = \frac{e^z}{1 + e^z}$$

where

$$z = b_0 + b_1 PFT_{SCORE} + b_2 RIFLE_{QUAL_{SCORE}} + b_3 GCT_{GT_{TOTAL}} + b_4 PRO_{CON} + b_5 TIG + b_6 AGE + b_7 MARR + b_8 COMBAT_{DEP} + b_9 Some\_Coll + b_{10} number\_prev\_attmpts$$

b_0= the intercept or constant term

b_1= change in likelihood of graduating BRC associated with change in physical ability as measured by the PFT (holding all other variables constant)

b_2= change in likelihood of graduating BRC associated with change in rifle qualification score (holding all other variables constant)

b_3= change in likelihood of graduating BRC associated with change in cognitive ability as measured by the GT score (holding all other variables constant)

b_4= change in likelihood of graduating BRC associated with change in proficiency and conduct score (holding all other variables constant)

b_5= changes in likelihood of graduating BRC associated with change in time in current grade at convene date of BRC (holding all other variables constant)

b_6= changes in likelihood of graduating BRC associated with change in age at convene date of BRC (holding all other variables constant)

b_7= change in likelihood of graduating BRC associated with change in marital status of candidate (holding all other variables constant)

b_8= change in likelihood of graduating BRC associated with change in number of combat deployments (holding all other variables constant)

b_9= change in likelihood of graduating BRC associated with change in having some post high school education at completing BRC (holding all other variables constant)

b_{10}= change in likelihood of graduating BRC associated with change in number of previous attempts at completing BRC (holding all other variables constant)

2. Survival Model

In addition to the logit model, this research uses survival analysis to examine the uncensored observations, or those candidates who fail to graduate. Knowing that the time to complete BRC is 65 training days, I construct a duration variable and let T_Day=65 for candidates who do graduate while for those who do not graduate, T_Day<65 reflects the training day that the candidate attrits. Thus, T_Day reflects the length of time candidates survive at BRC, censored at 65 days.

The goal in this research is to construct a predictive model of survival to graduation in BRC, and in particular, to identify the variables that are statistically significant in describing this relationship. The following equation represents this relationship, where *h(.)* indicates the hazard rate at training day *t*:

$$h(t|x) = h_0(\mathrm{t})\mathrm{e}^{(x\beta_x)}$$

Survival analysis methods differ from logit regressions by assessing a hazard rate (at time *t* given *x* covariates, the probability of attriting in the next instant given they have survived up to time *t*) instead of an absolute proportion (proportion of BRC candidates who survive and graduate over the entire period). To estimate this model, I use the Cox proportional hazards regression model, which allows me to estimate the probability of survival as a function of the candidate's characteristics or covariates *x* (Cleves, Gould &Gutierrez, 2004).

In STATA 13.1, I implement survival analysis by fitting the Cox model and then using the command "stcurve" to plot the survivor curve of a given observation when holding variables constant. Additionally, I use the hazard and cumulative hazard, H(*t*), commands to estimate the hazardous contributions against the established baseline. This method is appropriate for establishing a fitted model to display the survival probability based on the independent variables inputted into the model (Cleves, Gould, &Gutierrez, 2004).

From the data I know that every candidate began assessing into BRC on training day zero (T-Day=0) and graduation is on training day 65 (T_Day=65). The data also annotates which day a given candidate attrits from BRC. In their book, *Introduction to Survival Analysis Using Stata*, Cleves, Gould, and Gutierrez recommend the following hazard regression rate for the *j*th subject

$$h(t|x_j) = h_0(t)e^{x_j\beta_x}$$

G. CHAPTER SUMMARY

In summary, this chapter provides insight into the variables models I use in this research. I review the methods to clean and merge the data in order to prepare the data for estimating statistical models in Stata 13.1. The chapter also outlines the construction of the dependent, independent, and dummy variables. Finally, I construct the logistic regression models and survival model estimated in the next chapter.

THIS PAGE INTENTIONALLY LEFT BLANK

V. RESULTS AND ANALYSIS

Chapter V presents the findings from estimating the multivariate logistic model and survival model. The first section discusses the multivariate logistic model and associated findings. The second section discusses the survival model and analyses of the findings.

A. MULTIVARIATE LOGISTIC REGRESSION MODEL

The results suggest that PFT score, GT score, and completing at least one semester of college (some_coll) are significant predictors of success at BRC. In particular, PFT score is associated with nearly one percent increase in probability of graduation for every one-point increase in PFT score. GT score is associated with nearly one percent increase in probability of graduation for every one-point increase in GT score. Finally, having completed at least one semester of college is associated with an 20.5 percent increase in the probability of graduating BRC.

1. Logistic Regression Model

First, I report estimates from the full logit model as described in Chapter IV where I include all continuous variables to examine the probability of graduating BRC during the period FY13-FY16. This is my preferred specification of these continuous variables because alternatives did not lead to results that were easy to interpret. For instance, I control for individual ASVAB sub-test scores, but these components are highly collinear with each other and with the GT/GCT scores.

Table 15 reports the marginal effects from this logistic regression. These are not the coefficients b outlined in the previous chapter, but rather the effect of a unit-change in each covariate x on the probability of graduation, $\frac{\partial Prob(GRAD=1)}{\partial x}$.

Table 15. Logistic Multivariate Regression MFX Results

Model 1 Results		
	GRAD	P>|z|
VARIABLES	mfx dydx	
PFT_SCORE	0.0015***	0.000
	(0.0003)	
RIFLE_QUAL_SCORE_CD	-0.0009*	0.053
	(0.0005)	
GCT_GT_TOTAL	0.0007	0.539
	(0.0011)	
PRO_CON	-0.0298*	0.091
	(0.0177)	
TIG	0.0043**	0.023
	(0.0019)	
AGE	0.0038	0.405
	(0.0045)	
MARR	0.0817**	0.031
	(0.0379)	
COMBAT_DEP	-0.0998***	0.000
	(0.0273)	
Some_College	0.1172**	0.049
	(0.0595)	
number_prev_attmpts	0.0826***	0.002
	(0.0267)	
Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		
Observations 1,576		
Pseudo R2 = 0.0473		

Next, I discuss the results for each individual covariate.

a. PFT Score

First, I find that PFT score is positively predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial PFT}$=.0015, P>0.00). Although the marginal effect is statistically significant, the magnitude suggests that a ten point increase in PFT score increases the probability of graduation by 2.6 percent (.0015/.5719721=.00262251) , holding all other variables constant.

b. Rifle Score

Rifle score is not highly predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial RIFLE\_SCORE}$= [-] 0.0009, P>0.053). The p-value is just outside the margin of significance of **α**= 0.05.

c. GT Score

GT score as a continuous variable is also not predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial GT\ SCORE}$= .0007, P>0.539). The p-value is outside the margin of significance of **α**= 0.05. However, after examining Figure 4 (distribution of GT scores), I conclude that the lack of significance is from lack of variation in the data. The prerequisite score to assess into the reconnaissance MOS are from the top tier of prospective candidates, and so in later analyses, I will re-specify this measure of cognitive ability.

d. Proficiency and Conduct Score

Proficiency and conduct scores are not predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial PRO\_CON}$= [-].0298, P>0.091). The p-value is outside the margin of significance of **α**= 0.05.

e. Time In Grade (TIG)

Time in grade is statistically significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial TIG}$ = .0043, P>0.023). The results suggest that increasing the time in grade by six months increases the probability of graduating BRC by 4.5 percent, holding all other variables constant.

f. Age

According to the results of the model, a candidate's age is not significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial AGE}$ =.0038, P>.405). The p-value is outside the margin of significance of **α**= 0.05.

g. Marital Status

A candidate's marital status is significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial MARR}$ = .0817, P>0.031). The results suggest that if a candidate is married the probability of graduating BRC increases by 0.1428 or 14.3 percent, holding all other variables constant.

h. Combat Deployments

The number of combat deployments is statistically significant, but the sign of the coefficient is negative ($\frac{\partial Prob(GRAD=1)}{\partial COMBAT\_DEP}$= [-] .0998, P>0.000). I control for age and all other constants, yet a candidate with one more combat deployment is less likely to graduate. I hypothesize combat deployments is negatively correlated with mental health or resiliency, and if resiliency is positively correlated with graduation, the omitted variable bias results in the negative coefficient.

i. Post High School Education

Post high school education is statistically significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial Some\_Coll}$= .1172, P>0.049). The independent variable is a categorical variable; therefore, the probability of graduating BRC increases 20.5 percent if a prospective candidate has taken some college courses prior to attending BRC, holding all other variables constant.

j. Number of Previous Attempts at BRC

The number of times a candidate has attempted BRC is statistically significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial number\ previous\ attmpts}$= .0826, P>0.002). The results of the model suggest that every previous attempt at BRC increases the likelihood of graduating BRC by 14.4 percent, holding all other variables constant.

2. Logistic Regression Model with Current Prerequisites

The next model I estimate instead takes into account current prerequisites for assessing into BRC rather than the continuous measures used in the previous section. I create categorical variables for PFT score and GT score that reflect thresholds for eligibility. Table 16 presents the results.

Table 16. Logistic Multivariate Regression Results

Model 2 Results		
VARIABLES	GRAD	P>|z|
	mfx dydx	
PFT_gt225	0.3645***	0.000
	(0.0727)	
RIFLE_QUAL_SCORE_CD	-0.0001	0.771
	(0.0005)	
GCT_GT_TOTAL_gt105	-0.2161**	0.049
	(0.1099)	
PRO_CON	-0.0177	0.311
	(0.0174)	
TIG	0.0041**	0.030
	(0.0019)	
AGE	0.0066	0.142
	(0.0045)	
MARR	0.0618	0.105
	(0.0381)	
COMBAT_DEP	-0.1016***	0.000
	(0.0273)	
Some_Coll	0.1449**	0.012
	(0.0575)	
number_prev_attmpts	0.0801***	0.003
	(0.0266)	
Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		
Observations 1,576		
Pseudo R2 = 0.0446		

a. PFT Score

At the eligibility threshold margin, having a PFT score higher than 225 is positively predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial PFT\_gt225}$= .3645, P>0.00). In this model, PFT_gt225 is a categorical independent variable equal to "1" if the candidate has a score higher than 225 and "0" otherwise. Given over 98 percent of candidates possess a PFT score higher than 225 prior to attending BRC, it makes sense that this categorical variable is significant.

b. Rifle Score

Rifle score is not predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial RIFLE\ SCORE}$= [-] 0.0001, P>0.771). The p-value is outside the margin of significance of **α**= 0.05.

c. GT Score

GT score as a categorical variable is negatively predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial GT\_gt105}$= [-].2161, P>0.049). Examining the data, I find that over 95 percent of candidates possess a GT score higher than 105 with a mean score of 118.31 and standard deviation of 9.64, but the results are heavily skewed (Figure 4). Since the current graduation rate is approximately 57 percent, the sign of this coefficient is negative.

d. Proficiency and Conduct Score

Proficiency and conduct scores are not predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial PRO\_CON}$= [-].0177, P>0.311). The p-value is outside the margin of significance of **α**= 0.05.

e. Time In Grade (TIG)

Time in grade is statistically significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial TIG}$ = .0041, P>0.030). The results suggest that increasing the time in grade by six months increases the probability of graduating BRC by 4.3 percent, holding all other variables constant.

f. Age

According to the results of the model, a candidate's age is not significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial AGE}$=.0066, P>.142). The p-value is outside the margin of significance of **α**= 0.05.

g. Marital Status

A candidate's marital status is not significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial MARR}$= .0618, P>0.105). The p-value is just the margin of significance of **α**= 0.05.

h. Combat Deployments

The number of combat deployments is statistically significant, but the sign of the co-efficient is negative ($\frac{\partial Prob(GRAD=1)}{\partial COMBAT\_DEP}$= [-] .1016, P>0.000). I control for age and all other constants, yet a candidate with one more combat deployment is less likely to graduate. I hypothesize combat deployments is negatively correlated with mental health or resiliency, and if resiliency is positively correlated with graduation, the omitted variable bias results in the negative coefficient.

i. Post High School Education

Post high school education is statistically significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial Some\_Coll}$= .1449, P>0.012). The independent variable is a categorical variable; therefore, the probability of graduating BRC increases 25.3 percent if a prospective candidate has taken some college courses prior to attending BRC, holding all other variables constant.

j. Number of Previous Attempts at BRC

The number of times a candidate has attempted BRC is statistically significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial number\ previous\ attmpts}$= .0801, P>0.003). The results of the model suggest that every previous attempt at BRC increases the likelihood of graduating BRC by 14 percent, holding all other variables constant.

3. Logistic Regression Model with Increased Prerequisites

Next, I examine the marginal effects to see if increasing prerequisite thresholds is associated with greater chances of success. I estimate various such thresholds, and Table 17 below reports my preferred model.

Table 17. Logistic Multivariate Regression MFX Results

Model 3 Results		
VARIABLES	GRAD	P>|z|
	mfx dxdy	
PFT_gt275	0.1598***	0.000
	(0.0333)	
RIFLE_QUAL_SCORE_CD	-0.0001	0.848
	(0.0003)	
GCT_GT_TOTAL_gt115	0.1017***	0.000
	(0.0292)	
PRO_CON	-0.0243	0.149
	(0.0169)	
TIG	0.0044**	0.019
	(0.0019)	
AGE	0.005	0.244
	(0.0043)	
MARR	0.0684*	0.067
	(0.0374)	
COMBAT_DEP	-0.0908***	0.001
	(0.0273)	
x_some_coll	0.0951	0.119
	(0.061)	
number_prev_attmpts	0.0910***	0.001
	(0.0267)	
Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		
Observations 1,576		
Pseudo R2 = 0.0487		

a. PFT Score

At the margin, having a PFT score higher than 275 is positively predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial PFT\_gt275}$= .1598, P>0.00). In this model, PFT_gt275 is a categorical independent variable increasing the probability of graduating from BRC by 28 percent.

b. Rifle Score

Rifle score is not predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial RIFLE\ SCORE}$= [-] 0.0001, P>0.848). The p-value is outside the margin of significance of **α**= 0.05.

c. GT Score

GT score as a categorical variable is positively predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial GT\_gt115}$= .1017, P>0.000). The results of the model suggest that requiring a GT score of 115 increases the probability of graduating from BRC by 17.8 percent, holding all other variables constant.

d. Proficiency and Conduct Score

Proficiency and conduct scores are not predictive of success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial PRO\_CON}$= [-].0243, P>0.149). The p-value is the margin of significance of **α**= 0.05.

e. Time In Grade (TIG)

Time in grade is statistically significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial TIG}$ = .0044, P>0.019). The results suggest that increasing the time in grade by six months increases the probability of graduating BRC by 4.6 percent, holding all other variables constant.

f. Age

According to the results of the model, a candidate's age is not significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial AGE}$ =.005, P>.244). The p-value is outside the margin of significance of **α**= 0.05.

g. Marital Status

A candidate's marital status is not significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial MARR}$= .0684, P>0.067). The p-value is just outside the margin of significance of **α**= 0.05.

h. Combat Deployments

The number of combat deployments is statistically significant, but the sign of the co-efficient is negative ($\frac{\partial Prob(GRAD=1)}{\partial COMBAT\_DEP}$= [-] .0908, P>0.001). I control for age and all other constants, yet a candidate with one more combat deployment is less likely to graduate. I hypothesize combat deployments is negatively correlated with mental health or resiliency, and if resiliency is positively correlated with graduation, the omitted variable bias results in the negative coefficient.

i. Post High School Education

Post high school education is not statistically significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial Some\_Coll}$= .0951, P>0.119). The p-value is outside the margin of significance of **α**= 0.05.

j. Number of Previous Attempts at BRC

The number of times a candidate has attempted BRC is statistically significant in predicting success at BRC ($\frac{\partial Prob(GRAD=1)}{\partial number\ previous\ attmpts}$= .0910, P>0.001). The results of the model suggest that every previous attempt at BRC increases the likelihood of graduating BRC by 15.9 percent, holding all other variables constant.

4. Logistic Regression with Cohort Fixed Effects

After analyzing the first model, I decide to use the logistic regression model with cohort fixed effects (FE). Adding cohort FE allows the regression to eliminate much of the bias that originates from variation within cohorts. Variation may result from unobserved differences in demographic characteristics of a particular cohort. There is variation across cohorts in the proportions of non-Marine BRC candidates, which induces cohort differences in lack of data points for candidates. Cohort FE also controls for the differences in unobserved qualities across cohorts. Some of the unobserved qualities may be the result of peer effects, seasonal changes, instructor cadre turnover, and changes in recruitment just to name a few. The following equation was estimated incorporating cohort FEs:

$$\Pr(GRAD_{ic} = 1) =$$
$$F(\beta_0 + \beta_1 PFT\_SCORE_{iC} + \beta_2 GT\ SCORE_{iC} + \beta_3 RIFLE\_SCORE_{iC} +$$
$$\beta_4 COMBAT\_DEP_{iC} + \beta_5 AGE_{iC} + \beta_6 TIG_{iC} + \beta_7 MARR_{iC} + \beta_8 PRO\_CON_{iC} +$$
$$\beta_9 some_{coll} + \beta_{10} number\_prev\_attmpts_{iC} + a_C)$$

where *i* = an individual candidate, *c* = the class and F (.) is the logistic regression function described in the previous chapter. The independent variables remain the same as previous models. Table 18 illustrates the results.

Table 18. Logistic Regression MFX Results with Cohort FE

	Model 1	Model 2	Model 3	FE Model
VARIABLES	GRAD	GRAD	GRAD	GRAD
	mfx dydx	mfx dydx	mfx dydx	mfx dydx
PFT_SCORE	0.0015***			0.0014***
	(0.0003)			(0.0003)
PFT_gt225		0.3645***		0.3517***
		(0.0727)		(0.0816)
PFT_gt275			0.1598***	0.1659***
			(0.0333)	(0.0365)
RIFLE_QUAL_SCORE_CD	-0.0009*	-0.0001	-0.0001	-0.0014***
	(0.0005)	(0.0005)	(0.0003)	(0.0005)
GCT_GT_TOTAL	0.0007			0.0019
	(0.0011)			(0.0012)
GCT_GT_TOTAL_gt105		-0.2161**		-0.1736
		(0.1099)		(0.1215)
GCT_GT_TOTAL_gt115			0.1017***	0.1434***
			(0.0292)	(0.0311)
PRO_CON	-0.0298*	-0.0177	-0.0243	-0.0296
	(0.0177)	(0.0174)	(0.0169)	(0.0187)
TIG	0.0043**	0.0041**	0.0044**	0.0036*
	(0.0019)	(0.0019)	(0.0019)	(0.002)
AGE	0.0038	0.0066	0.005	0.0015
	(0.0045)	(0.0045)	(0.0043)	(0.0047)
MARR	0.0817**	0.0618	0.0684*	0.0719*
	(0.0379)	(0.0381)	(0.0374)	(0.0404)
COMBAT_DEP	-0.0998***	-0.1016***	-0.0908***	-0.0507*
	(0.0273)	(0.0273)	(0.0273)	(0.0287)
x_some_coll	0.1172**	0.1449**	0.0951	0.1198*
	(0.0595)	(0.0575)	(0.061)	(0.0616)
number_prev_attmpts	0.0826***	0.0801***	0.0910***	0.1270***
	(0.0267)	(0.0266)	(0.0267)	(0.0294)
Fixed Effects	No	No	No	Yes
Standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				
Observations	1,576	1,576	1,576	1,576
Pseudo R2	0.0473	0.0446	0.0487	0.1501

5. Summary

The results provide estimates that show which variables are predictive of success at BRC, as measured by the probability of graduating BRC (dependent variable). The findings summarized below may prove helpful in determining what prerequisites require further evaluation.

First, PFT score is highly predictive of success at BRC. This is not surprising in isolation due to the highly demanding physical requirements of BRC. The findings suggest that raising the current PFT score threshold eligibility of 225 can increase the probability of graduating. Second, cognitive skills are also predictive of success at BRC. While the continuous variable of GT score is predictive, the magnitude is not economically significant. When the GT score threshold adjusts to 115, however, it becomes statistically significant and economically meaningful. Table 19 reports the predictive effects at the margins of adjusting the required PFT and GT score for recruitment of candidates. The goal is to find the optimal prerequisites while maintaining the force structure to meet manpower requirements.

As expected, the number of previous attempts is highly predictive of a candidate's probability of graduating. However, this indicator does not represent an efficient or economical characteristic for recruiting and selecting the best candidates. The evaluation of a given BRC candidate's reaction to a given scenario at first exposure provides a crucial and unbiased assessment of the candidate. Repeated exposure(s) to an event reduces the effectiveness of the test as a measurement of the candidate's potential in the operating forces.

Overall, a candidate with an education level beyond high school has a higher probability of graduating BRC. Again, this is a reflection of cognitive ability and critical thinking skills obtained at higher education institutions. These skills may be beneficial, especially in activities that test the candidate's ability to problem solve –such as land navigation. The Marine Corps should seek to focus recruitment and selection of candidates that possess higher bundles of both cognitive ability and physical ability.

Table 19. Predictive Margins Results for PFT and GT Score

Predictive margins	Expression : Pr(GRAD), predict()					
Delta-method			Number of obs=		1,576	
_at	Margin	Std. Err.	z	P>z	[95% Conf. Inter]	
PFT_SCORE =225 GT = 105	0.5833476	0.0130502	44.7	0	0.5577696	0.6089256
PFT_SCORE =225 GT = 110	0.5864282	0.0153992	38.08	0	0.5562463	0.6166101
PFT_SCORE =225 GT = 115	0.5895035	0.018747	31.45	0	0.55276	0.626247
PFT_SCORE =225 GT = 120	0.5925734	0.0226437	26.17	0	0.5481926	0.6369541
PFT_SCORE =225 GT =125	0.5956375	0.0268408	22.19	0	0.5430306	0.6482445
PFT_SCORE =225 GT = 130	0.5986958	0.0312078	19.18	0	0.5375296	0.659862
PFT_SCORE =250 GT = 105	0.6177694	0.0122006	50.63	0	0.5938567	0.641682
PFT_SCORE =250 GT = 110	0.6207781	0.0138812	44.72	0	0.5935715	0.6479847
PFT_SCORE =250 GT = 115	0.6237792	0.0167898	37.15	0	0.5908717	0.6566867
PFT_SCORE =250 GT = 120	0.6267723	0.0203904	30.74	0	0.5868079	0.6667367
PFT_SCORE =250 GT = 125	0.6297574	0.0243626	25.85	0	0.5820076	0.6775072
PFT_SCORE =250 GT = 130	0.6327342	0.0285379	22.17	0	0.5768009	0.6886675
PFT_SCORE =275 GT = 105	0.6512417	0.0142722	45.63	0	0.6232687	0.6792146
PFT_SCORE =275 GT = 110	0.654152	0.0150591	43.44	0	0.6246366	0.6836674
PFT_SCORE =275 GT = 115	0.6570524	0.0171022	38.42	0	0.6235327	0.6905721
PFT_SCORE =275 GT = 120	0.6599427	0.0199982	33	0	0.6207469	0.6991385
PFT_SCORE =275 GT = 125	0.6628227	0.0234135	28.31	0	0.6169331	0.7087123
PFT_SCORE =275 GT = 130	0.6656923	0.0271354	24.53	0	0.6125078	0.7188767

B. SURVIVAL MODEL

Next, I use survival and duration analysis to assess empirically if a given candidate does attrite from BRC, what event (time) does failure occur and what data correlates with that candidate's duration of survival at BRC. First, I determine at what time and for what reason candidates attrite from BRC. Table 20 summarizes the reasons or events candidates attrite. The significant extracts are DOR, which accounts for 27.08 percent of all candidates that attrite; land navigation, swim qualification, patrolling, and medical reasons are the other major contributing reasons for attrition. Table 21 depicts what days during the training cycle that candidates are likely to attrite. Of significance are T-Day 10 (land navigation), T-Day 15 (swim qualification), T-Day 53 and 55 (patrolling).

Table 20. Percentages of Attrition by Drop Code

DROP_CODE	Freq.	Percent
Academic (code-1)	13	2.12%
Administrative (code-2)	4	0.65%
DOR (code-3)	166	27.08%
PFT (code-4)	38	6.20%
Land Navigation (code-5)	86	14.03%
Medical (code-6)	106	17.29%
Patrolling (code-7)	46	7.50%
Fin Time Failure (code-8)	18	2.94%
Safety concern in pool (code-9)	25	4.08%
Swim Qual (code-10)	65	10.60%
Legal (code-11)	2	0.33%
Individual Skills Test (code-13)	3	0.49%
Integrity (code-14)	19	3.10%
Knots Test (code-15)	22	3.59%
Total	613	100.00%

Table 21. Percentages of Attrition by Training Day

T_Day	Freq.	Percent
0	94	13.93%
1	32	4.74%
2	26	3.85%
3	26	3.85%
4	19	2.81%
5	14	2.07%
6	25	3.70%
7	14	2.07%
8	14	2.07%
9	8	1.19%
10	100	14.81%
11	8	1.19%
12	13	1.93%
13	21	3.11%
14	24	3.56%
15	48	7.11%
16	24	3.56%
17	12	1.78%
18	7	1.04%
21	5	0.74%
22	1	0.15%
23	2	0.30%
26	3	0.44%
27	22	3.26%
28	3	0.44%
29	1	0.15%
30	7	1.04%
31	11	1.63%
32	3	0.44%
33	2	0.30%
34	2	0.30%
36	1	0.15%
37	2	0.30%
38	3	0.44%
39	1	0.15%
40	2	0.30%
41	5	0.74%
42	4	0.59%

T_Day	Freq.	Percent
44	4	0.59%
45	10	1.48%
49	1	0.15%
50	2	0.30%
53	21	3.11%
54	2	0.30%
55	26	3.85%
Total	675	100.00%

Figure 15 through Figure 20 present the results of the survival models based on the comparison of three independent variables (PFT, GT, and some college). Overall, the results illustrate a significant, steep drop in survivability on T-Day 10. This makes sense since land navigation is both a cognitively and physically challenging evaluation. Land navigation requires the candidate to not only use cognitive skills to problem solve, but also requires the candidates to move over terrain, under load, while problem solving.

Table 22. Survival Analysis Results

Variables	Haz. Ratio	Std. Err.	P>z	[95% Conf.	Interval]
distance_PFT225	0.988433	0.002302	0.000	0.983931	0.992956
RIFLE_QUAL_SCORE	1.001138	0.00119	0.339	0.998809	1.003472
distance_GT105	0.980737	0.005461	0.000	0.970092	0.991499
PRO_CON	1.106202	0.065391	0.088	0.985184	1.242085
TIG	0.988333	0.006544	0.076	0.975591	1.001242
AGE	0.977133	0.014236	0.112	0.949625	1.005438
MARR	0.813985	0.109835	0.127	0.624827	1.060409
COMBAT_DEP	1.288728	0.113272	0.004	1.084789	1.531007
Some_Coll	0.902474	0.204144	0.650	0.57928	1.405985
number_prev_attmpts	0.778788	0.069235	0.005	0.654255	0.927025

6. PFT Score

Physical fitness is significant in predicting success at BRC. Figure 15 and Figure 16 illustrate the significant role of PFT score in predicting the success of a given candidate. The graphs plot TD survival rates (proportion who survive to the next T-Day given survival up to each T-Day) and smoothed hazard rates (attrition at each T-Day) for 25-point incremental increase in PFT score, holding all other variables constant. The lower bound is the minimum PFT (225) and the upper bound is a perfect PFT score (300). The model suggests there is a significant increase in the probability of a given candidate's success at each training day with an increase in PFT score holding all other variables constant. On the first and even second day of the training cycle, Figure 15 shows differences in the effect of 25-point incremental increases in PFT scores on survival to the next training day are little to none. These differences become apparent by TD 3 and magnify over the training cycle. Note that the proportionality in the differences in survival rate across the 25-point incremental changes in PFT is an assumption of the Cox proportional hazards model.

Table 22 lists the estimates of the survival model that underlie the graphs. Interpretation of these hazard ratios highlights the effect of predicting success with changes in the required PFT during recruitment. The hazard ratio states that for PFT score above 225, a one point increase in the PFT score increases the probability of graduation by nearly one percent (100%-98.843%) holding all other variables constant.

Figure 15. PFT Score Survival Analysis Results

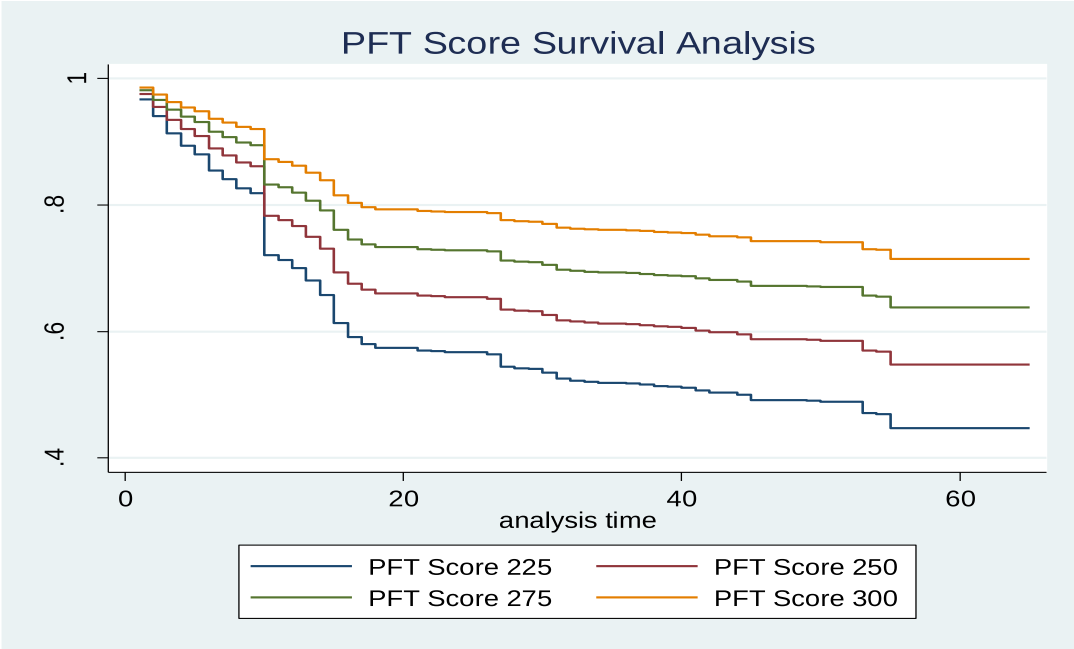
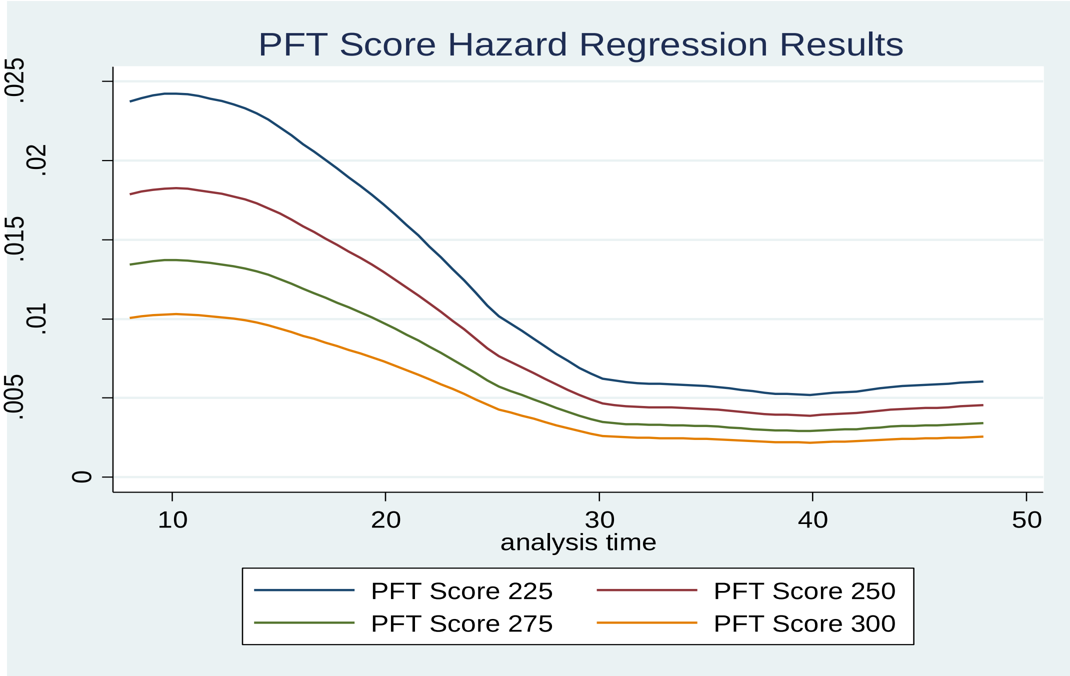


Figure 16. PFT Score Hazard Analysis Results



7. GT Score

The results suggest that cognitive ability is second to physical attributes when predicting success at BRC, but is also statistically significant. Similar to Figures 15 and 16, Figures 17 and 18 illustrates the significant role of GT score in predicting the success of a given candidate. The graph represents the survival and hazard rates of a given candidate holding all other variables constant with a 10-point incremental increase in GT score from the minimum score of 105. The lower bound is the minimum GT score (105) and the upper bound is a GT score of 135. The model suggests there is a significant increase in the probability of a given candidate to survive each training day with an increase in GT score holding all other variables constant.

Using the results in Table 22, I conclude changes that increase GT score, holding all other variables constant, positively affects the survival probability of a given candidate at BRC. The hazard ratio states that for GT score above 105, a one point increase in the GT score increases the probability of graduating by about two percent (100%-98.073%) holding all other variables constant.

Figure 17. GT Score Survival Analysis Results

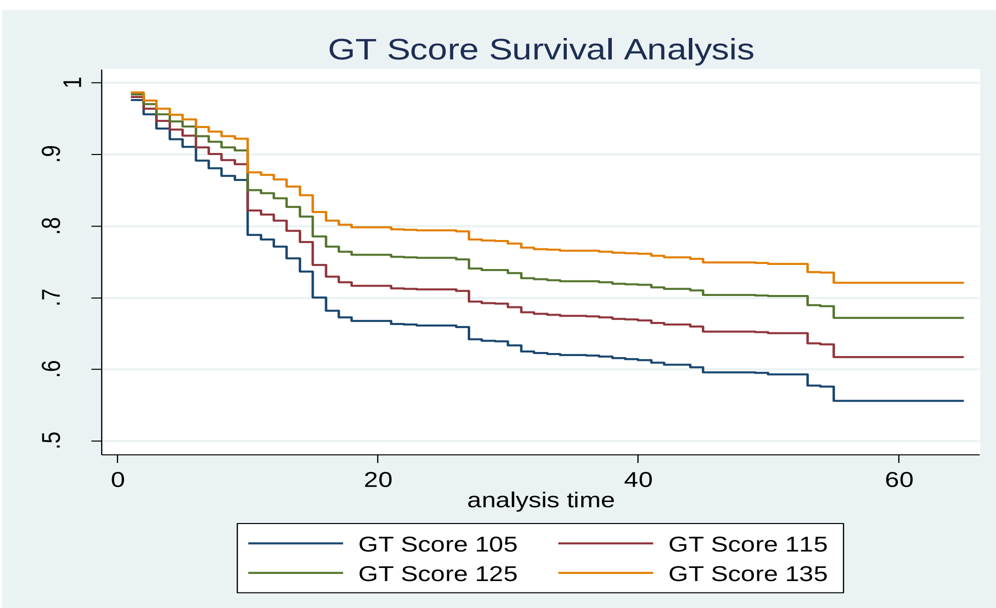
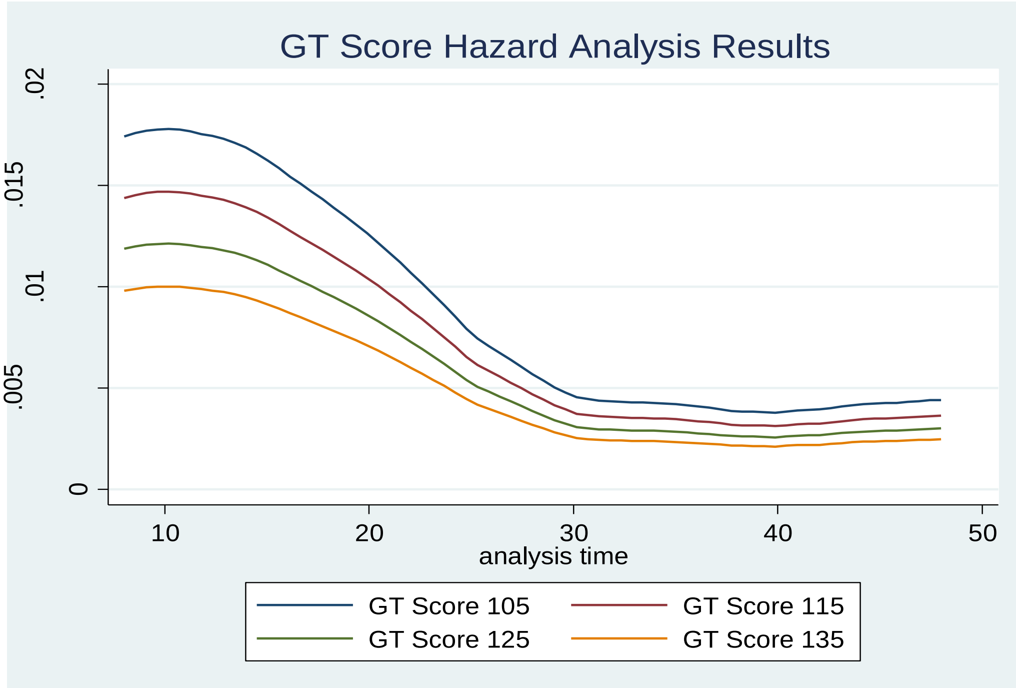


Figure 18. GT Score Hazard Analysis Results



8. Previous Attempts

Figure 19 illustrates the impact of having attempted BRC previously. The graph represents the survivability of a given candidate holding all other variables constant with an incremental increase of one previous attempt. The lower bound is zero previous attempts and the upper bound reflects a candidate with four previous attempts. The model suggests there is a significant increase in the probability of a given candidate graduating with an increase in previous attempts, holding all other variables constant. However, as the candidate progresses through the course and enters phase three of BRC, the probability of survival nearly converges. This finding suggests there is minimal difference (less than 2 percent) in the probability of graduating based on the hazard of previous attempts of candidates in phase three, suggesting that any competitive edge of prior BRC attempts dissipate over time.

Using the results in Figure 20, I conclude that a candidate with previous attempts at BRC, holding all other variables constant, positively affects the probability of a given candidate graduating BRC. The hazard ratio states that for candidates with previous attempts, the probability of graduating increases by 22 percent (100%-77.88), holding all other variables constant.

Figure 19. Previous Attempts Survival Analysis Results

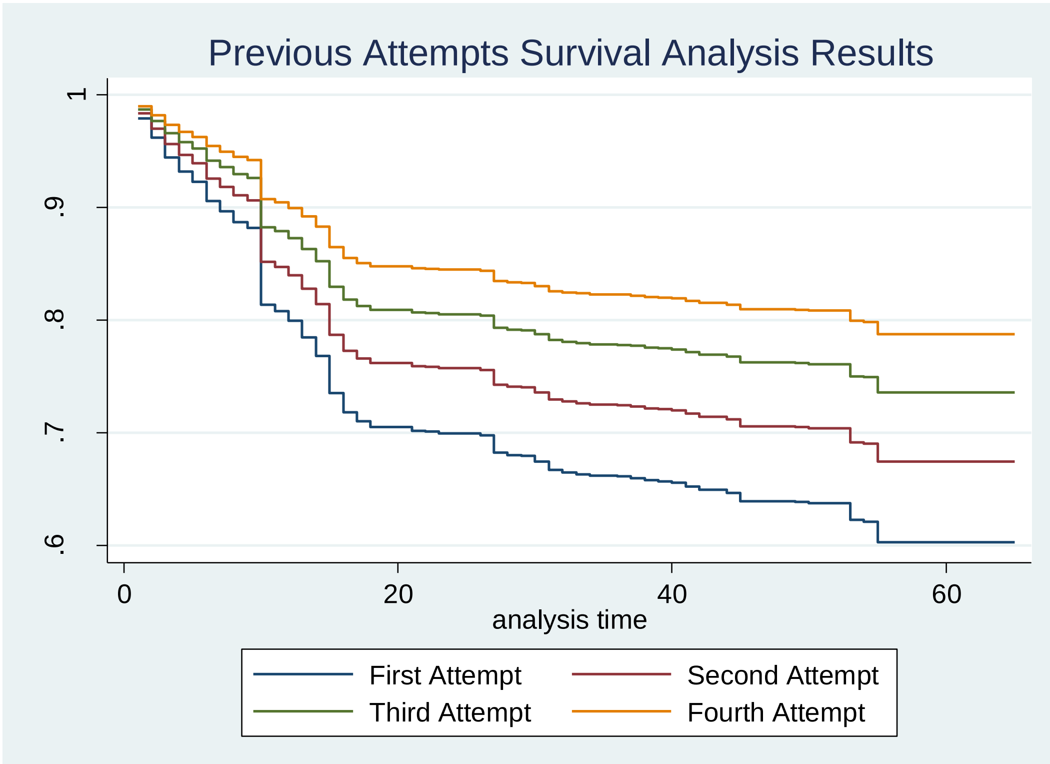
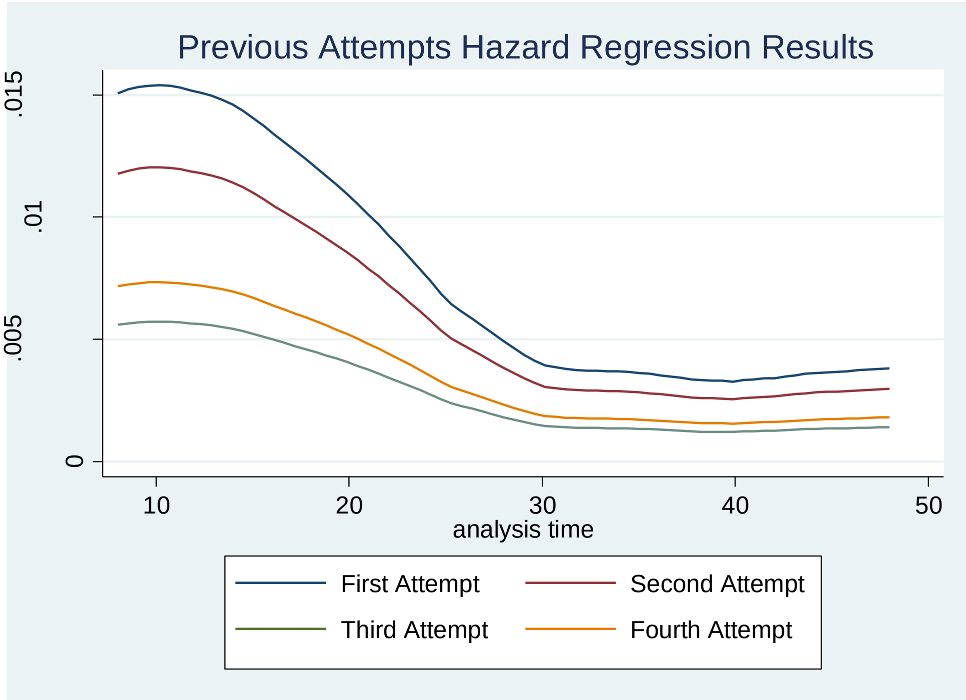


Figure 20. Previous Attempts Hazard Analysis Results



THIS PAGE INTENTIONALLY LEFT BLANK

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The objective of my research is to provide quantitative evidence identifying the candidate's characteristics, if any, that are significantly predictive of successful completion of the MOS school for the reconnaissance Marine, BRC. Selecting the right candidate is not only beneficial by efficiently allocating training resources and increasing graduation rates, but the true measure of benefit is in the effectiveness of any given graduate of BRC forward-deployed in the operational forces. With historically high attrition rates and the constant threat of constrained resources, the results of this research provide a foundation for policy makers to improve the selection process of candidates.

For my research, I conduct multivariate logistic regression models and the Cox survival model. The research highlights at least three statistically significant variables that, if adjusted, provide significant magnitude of impact on increasing the accession rate at BRC.

First, I find that PFT score is a good predictive indicator of potential success at BRC. There is evidence that supports increasing the minimum requirement for PFT score will yield immediate increases in the graduation rate at BRC.

The second finding suggests that a combination of cognitive ability and physical attributes are necessary to complete the arduous and demanding BRC curriculum. GT score measures the Cognitive ability for selection to MOS producing schools for enlisted Marines. The results, and other research reviewed in Chapter III, suggest that raising the minimum threshold for GT score will also positively affect the probability of a given candidate graduating BRC.

The third finding reinforces the concept that continual exposure to a scenario will increase the probability of successfully completing the event. However, the Marine Corps must maintain a balance with the realization that repeat exposures to a certain event degrades the effectiveness of measuring and evaluating a candidate's potential for success as a reconnaissance Marine. Furthermore, the extended resources used to continue to train a candidate may be more effectively allocated and requirement to retrain reduced by recruiting the "right Marine" for the job with the correct prerequisites.

Finally, the survival analysis provides insight into how each independent variable will affect the retention rate over the course of 65 training days. The results confirm the statistically significant independent variables and inform commanders that adjusting particular variables will achieve the desired end-state. The results of this research provide commanders with many different courses of action, including predicted candidate survival rates at various eligibility thresholds on the PFT and GT tests.

B. RECOMMENDATIONS FOR FUTURE RESEARCH

1. Swim Qualification

Currently the prerequisite for selection to attend BRC is WSB+ (Figure 3). This standard for BRC is the same standard for graduating Marine Corps Recruit Training. Maintaining this standard is not effective in discerning which candidate will pass the significant hazard at T-Day 15 (swim qualification). With an attrition rate of 15 percent on T-Day 15, there is significant concern the right candidates are not being recruited. This lack of confidence and ability in the water may potentially spill over into the amphibious operations in the open-ocean environment and present a significant hazard. Further research should determine if there is a better prerequisite that can separate the population and only recruit those candidates with the highest probability of successfully completing BRC.

2. Maintaining Data

This research would not have been possible without the data collected from BRC and TFDW. A limitation of this study is the amount of missing and uncollected information. Improvements in collecting and compiling systematic data will be vital going forward as commanders throughout DOD determine policies based on analysis of accurate data. For instance, TFDW interfacing with MCTIMS is essential. Identifying what data is relevant and ensuring accurate collection of it is essential. Evidence-based policymaking is only as good as the data collected. There is room for improvement in this study with data that has more fidelity.

3. Effects of Reconnaissance Contracts on Recruiting

The Marine Corps has been using guaranteed reconnaissance contracts over the past few years as an incentive to enlist Marines. With high attrition rates, it is inevitable that a significant portion of these guaranteed contracts do not graduate BRC. An analysis of the performance of these Marines after attriting from BRC will provide commanders with the measurable impact of this contract incentive. For this future research, it may prove beneficial to track the performance of these Marines as they pursue other occupational specialties within the Marine Corps.

4. Predicting Success Beyond BRC

In the triad of recruiting-training-retaining, expanding on this research and examining the performance of BRC graduates in the operating forces may further expand the knowledge base on recruiting the "right Marine" for the job. Examining in depth the attributes and characteristics that are predictive of successful performance and retention of the MOS will allow for examination of talent management in the Marine Corps beyond initial exposure.

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF REFERENCES

Beal, S. A. (2010). *The roles of perseverance, cognitive ability, and physical fitness in us army special forces assessment and selection* (ARI-RR-1927). Fort Bragg, NC: U.S. Army Research Institute for the Behavioral and Social Sciences. Retrieved from http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA525579

Brooks, J. E., & Zazanis, M. M. (1997). *Enhancing U.S. Army Special Forces: Research and Applications* (ARI-SR-33). Fort Bragg, NC: U.S. Army Research Institute for the Behavioral and Social Sciences. Retrieved from http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA339086

Cleves, M.A., Gould, W.M., & Gutierrez, R.G. (2004). *An introduction to survival analysis using stata* (2nd ed.). College Station, TX: Stata Press Publication.

Department of Defense. (1906). *Naval Reconnaissance, Instructions for the Reconnaissance of Bays, Harbors and Adjacent Country*. Washington, DC: Dion Williams.

Department of Defense. (1943). *Fleet Marine Force Pacific SOP 2–3*. Washington DC: Author.

Department of Defense. (1976). *Amphibious Reconnaissance* (FMFM 2–2). Washington DC: Author.

Department of Defense. (1993). *Warfighting* (MCDP-1). Washington DC: Author.

Department of Defense. (2000). *Scouting and Patrolling* (MCWP3-11.3). Washington DC: Author.

Department of Defense. (2002a). *Designation of 0321 Reconnaissance Marine as a Primary MOS PVT;/to MGYSGT*. Marine Administrative Message (MARADMIN 043/02). Washington, DC. Retrieved from www.marines.mil/news/messages/maradmins.

Department of Defense. (2002b). *Ground Combat Operations* (MCWP 3–1). Washington DC: Author.

Department of Defense. (2004a). *Marine Corps Helicopter Rope Suspension Techniques Policy (HRST) and Program Administration* (MCO 3500.42A). Washington DC: Author.

Department of Defense. (2004b). *Marine Corps Parachuting and Diving Policy and Program Administration* (MCO 3500.20B). Washington DC: Author.

Department of Defense. (2004c). *Reconnaissance Training and Readiness Manual* (MCO P3500.73). Washington DC: Author.

Department of Defense. (2008). *Proficiency, Conduct Marks and Composite Score Computation.* Marine Administrative Message (MARADMIN 360/97). Washington, DC. Retrieved from: www.marines.mil/news/messages/maradmins.

Department of Defense. (2009). *Reconnaissance Marine Lateral Move Policy and Procedures*. Marine Administrative Message (MARADMIN 412/09). Washington, DC. Retrieved from: www.marines.mil/news/messages/maradmins.

Department of Defense. (2012). *Enlistment Incentive Programs* (MCO 1130.53R). Washington DC: Author.

Department of Defense. (2015a). *Military Occupational Specialties Manual* (NAVMC 1200.1A). Washington DC: Author.

Department of Defense. (2015b). *Organization of Marine Corps Forces* (MCRP 5–12D). Washington DC: Author.

Department of Defense. (2016). *Ground Reconnaissance Operation* (MCRP 2–10A.6). Washington DC: Author.

Driskell, J. E., Hogan, J., Salas, E., & Hoskin, B. (1994). Cognitive and personality predictors of training performance. *Military Psychology*, *6*(1), 31–46. doi:10.1207/s15327876mp0601_2

Duckworth, A. L., Peterson C., Mathews, M. D., & Keely, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology*, *92*, 1087–1101.

Fuentes, G. (2015, June 1) Marine recon rebrands: All it takes is all you got. *Marine Corps Times*. Retrieved from https://www.marinecorpstimes.com

Gayton, S. D., & Kehoe, E. J. (2015). A prospective study of character strengths as predictors of selection into the Australian Army Special Forces. *Military Medicine, 180*(2), 151–157. doi: 10.7205/MILMED-D-14-00181

Hunt, A. P., Orr, R. M., & Billing, D. (2013). Developing physical capability standards that are predictive of success on Special Forces selection courses. *Military Medicine, 178*(6), 619–24. Retrieved from doi: 10.7205/MILMED-D-12-00347.

Landale, K. A. F. (2014). *Examining accession and retention and the role of relationship marketing in public service organizations: Three studies*. Doctoral dissertation, University of North Carolina, Chapel Hill, NC.

Meyers, B.F. (2000). *Fortune Favors the Brave: The story of First Force Recon*. Annapolis, MD: Naval Institute Press.

Meyers, B.F. (2004). *Swift, Silent, and Deadly*. Annapolis, MD: Naval Institute Press.

MARSOC and recon: Does the corps need both? (2014, February 4). *Military Times*. Retrieved from www.militarytimes.com.

Snyder, M.J. (1993). *Predicting success at Marine Security Guard (MSG) school utilizing the Headquarters Master File (HMF)* (Master's thesis). Retrieved from http://calhoun.nps.edu/bitstream/handle/10945/24216/predictingsucces00snyd.pdf?sequence=1

Smith, Stew (2005). Marine Special Operations (MARSOC). Military.Com. Retrieved from http://www.military.com/special-opertions.html.

United States Marine Corps. (1989). *AARUGHA!* (FMFRP 12–21). Washington, DC: Stubbe, R.W.

THIS PAGE INTENTIONALLY LEFT BLANK

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California