NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

THE INFANTRY MATURITY QUOTIENT: AN ANALYSIS OF THE MANPOWER EFFECTS OF MATURING THE MARINE INFANTRY

by

Matthew D. Tweedy

March 2022

Thesis Advisor: Marigee Bacolod
Co-Advisor: Chad W. Seagren

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** March 2022	**3. REPORT TYPE AND DATES COVERED** Master's thesis

4. TITLE AND SUBTITLE THE INFANTRY MATURITY QUOTIENT: AN ANALYSIS OF THE MANPOWER EFFECTS OF MATURING THE MARINE INFANTRY	**5. FUNDING NUMBERS**
6. AUTHOR(S) Matthew D. Tweedy	
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.

12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.	**12b. DISTRIBUTION CODE** A

13. ABSTRACT (maximum 200 words)

The composition of the Marine infantry is evolving to meet future battlefield demands. According to the Marine Corps' Force Design 2030, mature infantry resembling special operations and reconnaissance forces is required to achieve emerging operational requirements. This led to the proposal of a "maturity quotient"—wherein the status quo infantry rifle squad transitions from a 1:12 first-term enlistee to career Marine ratio to a mature 3:9 ratio—to guide planners.

This thesis develops a fixed inventory Markov chain model to forecast the timeline and effects of maturing the infantry in accordance with Force Design 2030. This thesis further applies statistical inference and data visualization to explore the impacts of increased physical and cognitive standards. Marine Corps' Total Force Data Warehouse provided enlisted infantry (03xx) fiscal year snapshots from 2011 to 2021.

The findings show that the Marine Corps can achieve the mature infantry by fiscal year 2027 through a reduction in total accessions and achieving specific rank targets. The Marine Corps currently retains smarter and fitter infantry Marines but not at the level of the Recon/MARSOC community.

14. SUBJECT TERMS personnel, infantry, maturity, Manpower Management, human resource management, talent management, retention, separation, elite forces, Expeditionary Advanced Base Operations, military, Marine Corps, Department of Defense, performance, reform, Force Design	**15. NUMBER OF PAGES** 77
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

THE INFANTRY MATURITY QUOTIENT: AN ANALYSIS OF THE MANPOWER EFFECTS OF MATURING THE MARINE INFANTRY

Matthew D. Tweedy
Major, United States Marine Corps
BA, Tufts University, 2010

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 2022

Approved by: Marigee Bacolod
Advisor

Chad W. Seagren
Co-Advisor

Marigee Bacolod
Academic Associate, Department of Defense Management

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

The composition of the Marine infantry is evolving to meet future battlefield demands. According to the Marine Corps' Force Design 2030, mature infantry resembling special operations and reconnaissance forces is required to achieve emerging operational requirements. This led to the proposal of a "maturity quotient"—wherein the status quo infantry rifle squad transitions from a 1:12 first-term enlistee to career Marine ratio to a mature 3:9 ratio—to guide planners.

This thesis develops a fixed inventory Markov chain model to forecast the timeline and effects of maturing the infantry in accordance with Force Design 2030. This thesis further applies statistical inference and data visualization to explore the impacts of increased physical and cognitive standards. Marine Corps' Total Force Data Warehouse provided enlisted infantry (03xx) fiscal year snapshots from 2011 to 2021.

The findings show that the Marine Corps can achieve the mature infantry by fiscal year 2027 through a reduction in total accessions and achieving specific rank targets. The Marine Corps currently retains smarter and fitter infantry Marines but not at the level of the Recon/MARSOC community.

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

AFQT	Armed Forces Qualification Test
ASR	Authorized Strength Report
ASVB	Armed Services Vocational Aptitude Battery
BRC	Basic Reconnaissance Course
CDD	Capabilities Development Directorate
CD&I	Combat Development and Integration
CNO	Chief of Naval Operations
CFT	combat fitness test
CPG	Commandant's Planning Guidance
DO	Distributed Operations
DOD	Department of Defense
DPG	Defense Planning Guidance
EABO	Expeditionary Advanced Base Operations
FD	Futures Directorate
FTAP	first-term alignment plan
FY	fiscal year
GAR	grade adjusted recapitulation
GT	general test
GWOT	Global War on Terrorism
HRDP	Human Resource Development Process
HQMC	Headquarters Marine Corps
IPT	Integrated Planning Team
LOCE	Littoral Operations in Contested Environment
M&RA	Manpower and Reserve Affairs
MAPE	mean absolute proportional error
MARDIV	Marine Division
MARSOC	Marine Special Operations Command
MCIP	Marine Corps Interim Publication
MCWL	Marine Corps Warfighting Laboratory
MOS	Military Occupational Specialty

MCCDC	Marine Corps Combat Development Command
NDS	National Defense Strategy
PFT	physical fitness test
PME	professional military education
SMCR	Selected Marine Corps Reserve
SOF	special operations force
STAP	subsequent term alignment plan
T2P2	troops, training, patient, and prisoner
TBS	The Basic School
TFDW	Total Force Data Warehouse
TFSD	Total Force Structure Division
TIG	time in grade
TIS	time in service
T/O	table of organization
USMC	United States Marine Corps

ACKNOWLEDGMENTS

Thank you to my wife, children, Dr. B, and Chad.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A. BACKGROUND

Marine Commandant David H. Berger is convinced that to compete and win in future fights, the Marine Corps must get smarter, tougher, and older. The Marine Corps is the nation's youngest service, with 60% of its ranks on first-term contacts (Harkins, 2021). Unlike the Army, the Marine Corps' infantry model consistently puts young Marines in charge of complex tasks and combat operations. No longer. According to Force Design 2030, the future infantry squad will be led by Staff Sergeants in contrast to the Sergeants who lead squads today (Headquarters Marine Corps, 2021). Internal Marine Corps planning documents propose a "maturity quotient" (Integrated Planning Team, 2020) to sustain the "quality, maturity, and experience of small unit leader tactical skills and decision-making" (USMC, 2021). The "maturity quotient" is operationalized as an ideal ratio of first-term to career-level Marines. Presently, the ratio is one career-level Sergeant to twelve first-term Marines. The goal is for a Staff Sergeant squad leader and two Sergeant fire team leaders, for a total of three career-level Marines in each squad. The future infantry squad will thus be composed of relatively older and more experienced Marines, providing the "maturity quotient" required to compete. Such a change has immense effects across the Marine Corps and reflects the broader Marine Corps goals for a more experienced, better trained, and more mature service.

B. PURPOSE

This study contributes to the ongoing *Force Design 2030* project in the Marine Corps. The empirical models assist in validating and/or refining infantry modernization efforts, specifically the feasibility of implementing a "maturity quotient" from the existing manpower supply by 2030 (the target year of General Berger's reforms). In one sense, this research will answer if the Marine Corps *can* mature the force by measuring the empirical effects on promotion rates, time in grade, and retention within the enlisted infantry population. This research is relevant to all stakeholders within the Marine Corps and Department of Defense. The primary and secondary research questions are:

1. Primary

- Given the 3:9 infantry squad maturity ratio, what is the timeline to reach a mature state?

2. Secondary

- How will increased physical and intelligence standards impact the timeline to reach a mature state?

C. ASSUMPTIONS

This research depends on a set of decision assumptions. The assumptions and a short description are below. Research findings could range dramatically depending on how these input levers are manipulated. Regardless, the chosen assumptions enabled the establishment of a baseline model necessary to further discussion.

Future Force Strength. The future infantry population decreases. Headquarters Marine Corps (HQMC) provided the information used to build predictive Markov chain models. This includes an experimental Force Design 2030 infantry battalion Authorized Strength Report (ASR) and a forecasted FY 2027 Grade Adjustment Recapitulation (GAR) analysis. The 2030 ASR is treated as a planning document and is subject to change. The 2027 GAR is likely to change over the next five years, but for the purpose of this research, we assume it will not. Both documents reflect a reduced enlisted infantry population.

Entry-level infantry training. This research does not consider the attrition effects of the proposed future infantry program and military occupational specialty (MOS) realignment. For this research, attention to individual infantry MOS' is omitted. Instead, 03xx serves as a proxy for all military occupational specialties within the infantry community. Though experimentation is ongoing, the Force Design 2030 ASR signals a change in infantry MOS. For example, the only E5 and below enlisted infantry MOSs on the Force Design 2030 T/O are 0311 (*infantryman)* and 0341 (*mortarman*). There are no 0331 (*machine-gunner)* or 0352 (*anti-tank missileman*).

D. LIMITATIONS

The Markov model is built from historical data. To forecast personnel behavior within the infantry population, the model assumes historical behavior is consistent. Multiple factors impact individual decision to enlist, continue, or exit service. These factors range from economic conditions or unemployment rates to the geopolitical conditions. To address these limitations, future models should include the most current data available.

E. METHODOLOGY

This study utilizes a quantitative approach to explore the empirical implications of maturing the infantry. This thesis uses fixed inventory Markov chain models to forecast realization of the "maturity quotient."

Quantitatively, the research addresses two research questions. The first question applies two scenarios to forecast and measure the effects of applying the maturity quotient. The two scenarios are considered pathways to achieve the maturity quotient. Beginning with FY 2021, the status quo, the scenarios forecast the impacts of reaching a Force Design 2030 "steady state" where the maturity quotient is successfully applied. The scenarios are:

- Scenario 1: Achieve mature state through by grade inventory targets vectors.
- Scenario 2: Achieve mature state by controlling time in grade vectors.

We use inferential statistical analysis and data visualization to answer the secondary research question. The minimum physical and cognitive standards required to attend Basic Reconnaissance Course (BRC) serve as a proxy to assess the likely impact of increased physical and cognitive standards on the Force Design 2030 infantry.

F. FINDINGS

We find that the Marine Corps can achieve the mature infantry by fiscal year 2027 through a reduction in total accessions and achieving specific rank targets. These results are derived from the Force Design 2030 ASR and 2027 GAR provided to us by Headquarters Marine Corps and assume that manpower planners will seek graduation reduction in 03xx end strength from 27,000 to 23,000 Marines from FY2022 to FY2027. Our results show that average Time in Grade decreases for most ranks. Notably, achieving the mature infantry requires promoting lance corporals (E3) to corporal one year sooner than the status quo.

This research also explores the impact of increased physical and cognitive standards on the infantry with occupational and career milestone comparisons. We find that the Marine Corps currently retains smarter and fitter infantry Marines but not at the level of the Recon/MARSOC community. Because the desired Force Design 2030 infantry is fitter and smarter, possessing traits resembling reconnaissance or special operations personnel (Berger 2020), we created a mature standard derived from BRC minimum standards. Though the conventional infantry is not physically and cognitively comparable to Recon/MARSOC, superior career Marine performance suggests that there is a pathway to increase physical and cognitive standards while maturing the infantry.

G. ORGANIZATION OF STUDY

Chapter II provides the background on Force Design 2030, the mature force concept, and an overview of the Marine Corps manpower system. Chapter III is a literature review featuring an overview of Markov theory and examples of Markov models application in civilian and military contexts. Chapter IV describes the data, methodology, and implements a Markov model to answer the primary research question. Chapter V addresses the secondary research question and uses data visualization and inferential statistics to determine the impact of increased physical and cognitive standards on achieving a mature state. Chapter VI includes the conclusion, recommendations, and proposals for further research.

II. BACKGROUND

The Marine Corps is organized and equipped to support the infantry Marine. Every Marine, regardless of military occupation specialty (MOS), is first a “rifleman.” Every officer is trained and educated as provisional rifle platoon commanders at The Basic School (TBS). The infantry is central to Marine Corps identity and culture. Efforts to reform, or transform, the infantry not only affect service readiness but also impact Marine culture. Analyzing the impact of changing the infantry empirically and culturally requires placing the pursuit of a mature infantry force within context of a larger Marine Corps transformation. Indeed, the infantry maturity quotient is best understood in the context of General David H. Berger’s *Force Design 2030*.

In the summer of 2019, newly appointed 38th Commandant of the Marine Corps, General Berger, released his *Commandant’s Planning Guidance* (CPG). The CPG is the Corps’ strategic direction, serving as “the authoritative document for Service-level planning and provides a common direction for the Marine Corps” (United States Marine Corps 2019, p. 1). Aligned to the 2018 Defense Planning Guidance (DPG) and 2018 National Defense Strategy (NDS), the CPG was meant to posture the Marine Corps for the post Global War on Terror (GWOT) operating environment. The principal focus of the Marine Corps, as directed by the NDS, shifted from violent extremism to Great Power Competition with peer-level adversaries, with a “special emphasis on the Indo-Pacific” (United States Marine Corps, 2021). The Peoples Republic of China would be the Corps’ pacing threat in the region. Such a dramatic shift in mission priority requires internal assessment. Indeed, twenty years fighting inland in places like Iraq, Afghanistan, and Syria yielded a Marine Corps that was “not organized, trained, equipped, or postured to meet the demands” of the future operating environment (United States Marine Corps, 2019). To operate in the Indo-Pacific demands that the Marine Corps reclaim its historic maritime character, integrate with the Navy, and fight from and at sea. The primary vehicle for this transformation is *Force Design 2030*.

A. OVERVIEW OF FORCE DESIGN

Since assuming the office of the Commandant, General Berger's top priority is *Force Design*. *Force Design* 2030 is both a practical modernization initiative and a conceptual vision aimed at optimizing the Marine Corps for its future role. The impetus for change balances the unpredictability of the future and the return of Great Power Competition. Though the future is unknown, reasonable assumptions about the character of future conflict inform design decisions. The proliferation of advanced sensing technologies and precision munitions portend a battlefield characterized by dispersion and the absence of massed formations. Adaptive and innovative forces will compete for marginal technological gains relative to nuclear armed adversaries. To remain an expeditionary force, the Marine Corps, together with the U.S. Navy must transform.

The future operating environment requires a Marine Corps with new equipment, weapons, doctrine, and techniques. According to General Berger (2019b), the new Marine Corps will be "purpose-built to facilitate sea denial and assured access in support of fleet and joint operations." Employment concepts such as Expeditionary Advanced Base Operations (EABO), Littoral Operations in Contested Environment (LOCE), and Distributed Operations (DO) are the conceptual aimpoints for *Force Design 2030*. Both General Berger and Chief of Naval Operations (CNO), Admiral Mike Gilday published service guidance affirming the necessity of Navy and Marine Corps integration, with Admiral Gilday stating that to

> maintain the maritime competitive advantage…we will ensure the wholeness of combat capable and lethal forces maximizing the benefits of Distributed Maritime Operations, Expeditionary Advanced Base Operations, and Littoral Operations in a Contested Environment. (United States Navy, 2019).

To build this new Marine Corps—and pay for it—the service would divest of legacy systems and force structure to invest in the emerging technologies and weapons systems deemed relevant for the future fight. Notably, the Marine Corps divested tanks, law enforcement, and heavy bridging assets while reducing the number of infantry battalions and towed artillery formations (United States Marine Corps, 2021, pp. 3–4). Simultaneously, the service conducted internal reviews to determine future divestment options and mechanisms to reduce traditional and legacy structures. The divestment efforts are fiscally necessary to "generate the resources needed to invest in future capabilities" (United States Marine Corps, 2021). These future capabilities promised to preserve the Marine Corps' status as the "'force of choice' for the President, Secretary, and Combatant Commander" (United States Marine Corps, 2019, p. 1).

Beyond procuring equipment and applying new employment concepts, the Marine Corps of 2030 demands a new type of Marine: "Our desired end state also requires elite warriors with physical and mental toughness, tenacity, initiative, and aggressiveness to innovate, adapt, and win in a rapidly changing operating environment" (United States Marine Corps, 2019, p. 12). Because the Marine Corps would not lose its infantry character, central to modernizing the Marine Corps is modernizing the infantry. Modernization efforts range from restructuring the infantry battalion to transforming training and education pathways to match capabilities with the demands of the future battlefield. In parallel, planners envisioned the new infantry Marine needed to achieve the future mission - one with more maturity and higher competence levels. The remainder of this chapter describes the present state of the Marine infantry, the driver for modernization, and present the Marine Corps vision for the future 03xx.

B. MARINE INFANTRY STATUS QUO

The Marine Corps' active component infantry formations are organized into 1st, 2nd, and 3rd Marine Divisions (MARDIV). The 1st MARDIV is headquartered in Camp Pendleton, California and includes the 1st, 5th, and 7th Regiments. The 2nd MARDIV, headquartered in Camp Lejeune, North Carolina, contains the 2d and 6th Regiments. The 3rd MARDIV, headquartered in Okinawa, Japan, contains the Marine Littoral Regiment, and is based on Marine Corps Bases, Hawaii. Regiments typically contain three infantry battalions, though regiments in 1st and 2nd MARDIV contain four due to ongoing reorganization. As of writing, there are 23 active component infantry battalions are in the Fleet Marine Force (FMF) with a plan to reduce the total battalions to 21 by 2027.

Infantry battalions are comprised of three rifle companies, a weapons company, and a headquarters company. Each rifle company contains three rifle platoons and a weapons platoon. Weapons company contains an anti-armor platoon, heavy machine gun platoon, and the 81mm mortar platoon. Rifle platoons consist of three rifle squads and there are 27 rifle squads in an infantry battalion.

The mission of the Marine rifle squad is to "locate, close with, and destroy the enemy by fire and maneuver or repel his assault by fire and close combat" (United States Marine Corps, 2020). A rifle squad has 13 Marines, comprised of three 4 Marine fire teams and a squad leader. Figure 1 depicts rifle squad composition.

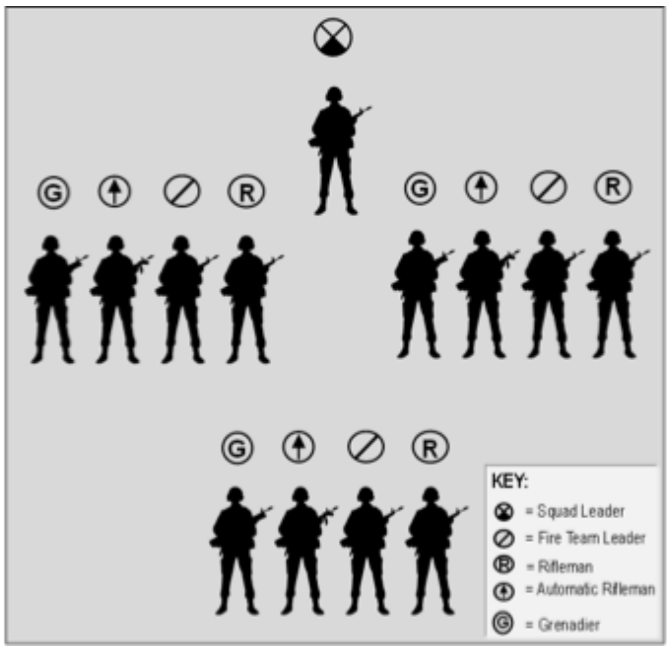


Figure 1. Marine Rifle Squad. Source: United States Marine Corps (2020).

Per Marine Corps Interim Publication (MCIP) 3–10A.4i, *Marine Rifle Squad*, the rifle squad is the "fundamental maneuver force of the Marine Corps infantry" (United States Marine Corps, 2020, p. 7). The rifle squad is designed to provide offensive, defensive, and combined arms effects on the battlefield. The rifle squad leader, a 0311 Sergeant by task organization, is responsible for the discipline, appearance, training, control, conduct and welfare of their squads. The squad's three fire team leaders, 0311 Corporals by task organization, have the same responsibilities as the squad leader for the three Marines in their fire teams.

Most of the rifle squad, to include some fire team leaders, is comprised of first-term Marines. These are Marines "serving on their initial active duty Marine Corps enlistment contract to include any extensions to that contract" (United States Marine Corps, 2010, A-1). The squad leader is a career Marine, one who is "serving on their second or subsequent contract in the Marine Corps including any extensions to that contract" (United States Marine Corps, 2010, A-1). Rifle squad leader is synonymous with the infantry Sergeant.

C. THE INFANTRY MARINE OF FORCE DESIGN 2030

The focus of this research relates to the implications of a redesigned infantry on the infantry Marine. Specifically, we are concerned with the force structure required to complete missions assigned to the Force Design infantry battalion. Though structural changes imply manning changes, the roles and responsibilities of individual infantry Marines and infantry unit leaders inform what the future infantry force is. To describe this future force in this thesis, we emphasize the Marine, not the function, capability, or missions of the future force.

1. Framing the Problem

Any adjustments to the status quo—be it minor adjustments or large-scale transformation—follow a similar path within the Marine Corps. Generally, the Marine Corps Warfighting Laboratory (MCWL) and the Futures Directorate (FD) develop conceptual warfighting capabilities the Marine Corps needs to satisfy wartime missions and national security objectives. Marine Corps Combat Development Command (MCCDC) integrates these concepts, capabilities, and force development requirements and, working with the Capabilities Development Directorate (CDD), produce a list of tasks units and personnel must accomplish (Annunziata, 2018, pp. 5–7).

2. Problem Statement

The integrated planning team (ITP) tasked with redesigning the Marine infantry battalion stated the problem this way: The status quo infantry battalion is not "organized, trained, or equipped to compete against a pacing threat" (Integrated Planning Team, 2020, p. 3). There were four strands of needed modernization, according to MCWL: a restructured infantry, improved capabilities, improved entry level training, and increased maturity in small unit leaders (Marine Corps Warfighting Laboratory, 2020).

3. The Force Design 2030 Infantry

The Marine Corps envisioned the 2030 infantry battalion as "smaller, more technologically enhanced, Marine Corps Special Operations Command (MARSOC)—like, with an associated longer training program" (Integrated Planning Team 2020). Distributed operations require a higher degree of trust and competence in subordinate units. Legacy employment models assumed massed formations that are no longer survivable on a battlefield saturated with sensors and precision munitions. To solve this problem, future infantry formations, down to the squad level, would be equipped with "resilient, networked communications and precision fire capabilities" and be "light, mobile, and capable of distributed operations" (Headquarters Marine Corps, 2021). Smaller, better equipped and more capable formations increase survivability and lethality. Furthermore, employment concepts such as EABO, LOCE, and DO leverage speed, trust, and autonomy of small units to contribute sea-denial and sea control to the Navy and Marine Corps team.

4. 2030 Infantry Marine: Mature, Competent, and SOF-like

The individual infantry Marine is the building block for the infantry. An organizing principle for designing the future battalion is to make the formations better, not bigger. To make better infantry formations, the infantry needs better Marines. The increased demands on small units envisioned by *Force Design* and the CPG require mature, competent, highly educated and trained Marines (Integrated Planning Team, 2020, pp. 3–4). Leveraging increased training standards, longer training pipelines, and rigorous screening tools in selecting the future infantry Marine will contribute to a *better* unit.

The future infantry Marine will be multi-dimensional, possessing the training and competence to employ a varied array of weapons systems and equipment (Integrated Planning Team, 2020, pp. 6–9). According to Major General Alford, Commanding General of Training Command, the future infantry Marine must "have a higher physical standard than the rest of the Corps" and "possess a raw intelligence similar to those in reconnaissance, the Rangers, or special forces" (Alford, 2021). Echoing comparisons to the

United States of America's elite and special operations forces, General Berger, in testimony to the Senate Armed Services Committee in 2020 stated the Marine Corps was modernizing the infantry "in accordance with units traditionally associated with special forces and commando units" (Berger, 2020). In short, the future infantry Marine must be smarter, fitter, and trustworthy to operate independently across the distributed future battlefield.

5. The Maturity Quotient and Future Rifle Squad

In June 2021, Colonel Eric Reid, a Marine Corps infantry officer completing a fellowship with the Brookings Institution, published "Courage to Change: Modernizing U.S. Marine Corps Human Capital Investment and Retention." Colonel Reid (2021) took a holistic view of the Marine Corps' enlisted manpower management to suggest a change from a "recruit and replace" to "invest and retain" model. He argues that the since the advent of the All-Volunteer Force in 1973, the Marine Corps reduces personnel costs by relying on a force predominantly comprised of first-term volunteers. This results in an inexperienced force with a "bottom-heavy" grade structure that is "less fit, less proficient, and less cohesive than a slightly more mature and stable alternative" (Reid, 2021, p. 2). A modernized manpower system would retain the skilled Marines and invest in their further development. Reid argues that "invest and retain" model is not only economically advantageous relative to total cost but also increases lethality. Colonel Reid catalogues past Marine Corps efforts to modernize the enlisted management system and suggests that bold action by senior leaders is required to transition to the "invest and retain" model. Reid specifies that to satisfy the goals of *Force Design 2030*, the Marine Corps must embrace an alternative manpower model based on "increased retention of human capital which would lead to elevated force maturity, experience, and stability" (Reid, 2021, p. 6).

In November 2021, mere months after the publication of Colonel Reid's paper, the Marine Corps released *Talent Management 2030*. *Talent Management 2030* "charts a new course for [Marine Corps] personnel system" intended to modernize manpower management to fulfil the requirements of *Force Design 2030* (United States Marine Corps, 2021, p. 1). Though the report contains multiple service initiatives ranging from increasing career flexibility to implementing new recruiting models, it principally advocates for the "invest and retain" model described by Colonel Reid.

Talent Management 2030 presents three primary outcomes of maturing the force: increased physical fitness, better cognitive function and decision-making, and increased readiness. Collectively, these outcomes produce the lethality required for "success on future battlefields" (United States Marine Corps, 2021).

The Integrated Planning Team tasked with redesigning the infantry invoked a "maturity quotient" as the metric for assessing the correct experience and rank mix. This is an effort to place the right Marine in the "rank-appropriate" billet. The maturity quotient is the ratio between career and first term enlisted Marines within a squad. Given that the rifle squad is the foundational maneuver force in the infantry, the rifle squad is the unit of measure associated to the maturity quotient. "The current squad has a 1:12 quotient—that is one 2d term Marine (the Sgt squad leader), and 12, first term Marines" (Integrated Planning Team, 2020). Though experimentation is ongoing, one model for the future infantry squad is 14 Marines, rather than the current 13. The squad leader, formerly a Sergeant, will be a Staff Sergeant. Two six Marine fire teams, led by Sergeants, replace the three four Marine fire teams led by Corporals (Integrated Planning Team, 2020). The 2030 infantry squad has a 3:11 quotient, given that the Staff Sergeant squad leader and two Sergeant fire team leaders are career-Marines.

The focus on maturity extends beyond increasing the amount of career Marines in rifle squad. Indeed, retaining experienced Marines and reducing the proportion of first-term Marines is an institutional goal described in General Berger's *Talent Management 2030*: "Maturing the force by retaining a greater percentage of qualified first-term Marines will improve decision-making, problem solving, and risk assessment among our junior leaders, with immediate positive effects on our performance in competition and combat" (United States Marine Corps, 2021). Specific to the infantry population, implementing a maturity quotient disrupts the status quo infantry battalion. Prioritizing the retention of career Marines over recruiting replacements requires manpower management adjustments.

D. HUMAN RESOURCE DEVELOPMENT PROCESS

The Marine Corps must navigate multiple lines of effort to modernize. One of these lines of effort is the manpower management of the infantry population. The process of identifying future requirements, generating the personnel structure to meet those requirements, and delivering qualified Marines to units is complex and beyond the scope of this thesis. What follows is a summary of the manpower management functions critical to understanding the creation of the Force Design 2030 infantry.

Manpower managers must translate future force requirements into Marines and units. This is the Human Resource Development Process (HRDP). The HRDP is an iterative process involving multiple stakeholders whose goal is translating the conceptual requirements into force structure. Combat Development and Integration (CD&I) and Marine Corps Combat Development Command (MCCDC) translate the conceptual requirements into the number of required personnel known as the Table of Organization (T/O) (Annunziata, 2018, p. 5-6). MCCDC then produces the Authorized Strength Report (ASR), which “calculates the budgetary constraints placed on the service and optimizes the personnel requirements outlined in the T/O against the allocation of authorized end strength” (Annunziata, 2018, p. 6). The ASR is released to Manpower and Reserve Affairs (M&RA), which produce the Grade Adjusted Recapitulation (GAR) analysis. Though the ASR is the list of billets the Marine Corps can afford to fill, it does not account for every Marine - the GAR does. Marines in the Transient, Training, Patient, and Prisoner (T2P2) status are accounted for in the GAR (Moeller, 2019, p. 8). The GAR reports the total of Marines by MOS and grade within a population, representing an ideal inventory by grade and MOS.

In pursuit of realizing the demands of Force Design 2030, planners and manpower managers developed the force structure and manning requirements for the future infantry. The 2030 infantry battalion ASR represents the desired mature state for the infantry battalion. A comparison between the status quo ASR and the 2030 ASR is contained in Chapter III.

E. CHAPTER SUMMARY

The overview of concepts and initiatives described in this chapter explain why the Marine Corps is pursuing a matured infantry force. The 2019 *Commandant's Planning Guidance* and *Force Design 2030* are modernization initiatives aimed at transforming the service, so it is ready, relevant, and lethal on the future battlefield expected to be distributed, maritime, and saturated with advanced technology. To meet these future demands, the Marine infantry must be fitter, smarter, and more experienced. The Marine Corps needs a mature force.

III. LITERATURE REVIEW

A. INTRODUCTION

This chapter combines an overview of Markov model theory, relevant predicative manpower research, and an overview of literature focused on identifying the physical and cognitive attributes that predict success in special forces and Marine reconnaissance.

B. MARKOV THEORY

A Markov model uses probabilities to describe the behavior of a system. Introduced by Andrey Markov in 1907 to describe the behavior of random processes, named Markov chains, the theory is applicable in multiple forecasting and predictive domains (Dausman 2016). Markov models enable planners to forecast the aggregate behavior of a system. This is of particular importance to manpower systems analysis. Within manpower planning, the system can refer to inventory, promotion, attrition, and end strength of a given group. For example, Markov models can be applied to specific categories within a military occupation specialty (MOS) or tailored to specific pay grades.

The utility of Markov models in manpower planning was advanced by D. J. Bartholomew. According to Bartholomew, manpower planning "aims to make the best use of…human resources" (Bartholomew, 1971). While the goal is to balance inventory demands with the supply available, planners mitigate inherent uncertainty by applying probabilistic modeling to describe a system's behavior. For example, factors such as budget reductions to war impact the demand for Marines; supply is determined by an "individual's freedom to choose, and in particular, to leave his job" (Bartholomew, 1971).

A Markov model applied to manpower analysis can predict the aggregate system behavior based on the observed historical flow of personnel. The total size of the system is assumed to be fixed, meaning that additions—or accessions—into the system are determined by attrition or planned changes to system, such as increasing or decreasing total inventory (Bartholomew 1971). There are a fixed number of states within the system an individual may flow through, namely, individuals may be promoted, demoted, remain in the same state, or leave the system (attrite). Simply, measuring past behavior forecasts future behavior.

Markov models are used for manpower and staffing analysis globally. Trivedi et al. (1987) applied a semi-Markov formulation to model the flow of nurses, physicians, practitioners, and physician assistants within a geographic area to forecast the supply of primary care providers within a specified window of time. Momoh and Salihi (2009) use Markov to determine ideal staffing and workforce requirements in a Nigerian petrochemical refinery. They used historical workforce data showing promotion, attrition, and internal staff movement to arrive at the ideal number of workers to be recruited or laid off. Saad et al. (2014) applied Markov to determine the appropriate manpower model for lecturers at a Malaysian university. The research arrived at ideal numbers by rank status (lecturer, senior lecturer, and associate professor) and budgetary constraints.

C. PREVIOUS PREDICTIVE MANPOWER STUDIES

Markov models are used for manpower and staffing analysis globally. Trivedi et al. (1987) applied a semi-Markov formulation to model the flow of nurses, physicians, practitioners, and physician assistants within a geographic area to forecast the supply of primary care providers within a specified window of time. Momoh and Salihi (2009) use Markov to determine ideal staffing and workforce requirements in a Nigerian petrochemical refinery. They used historical workforce data showing promotion, attrition, and internal staff movement to arrive at the ideal number of workers to be recruited or laid off. Saad et al. (2014) applied Markov to determine the appropriate manpower model for lecturers at a Malaysian university. The research arrived at ideal numbers by rank status (lecturer, senior lecturer, and associate professor) and budgetary constraints.

Raymond (2006) forecasts the number of annual re-enlistments required to achieve the optimal grade targets within a given population. This work was in fulfillment of a request by Manpower and Reserve Affairs (M&RA) to combine First-Term Alignment Plan (FTAP) and Subsequent Term Alignment Plan (STAP) models. Raymond uses Markov chain models and the Grade Adjusted Recapitulation (GAR) to demonstrate that a single model is capable of forecasting reenlistment requirements for both FTAP and STAP populations.

Dausman (2016) applies Markov chain forecasting to determine the future state of the Selected Marine Corps Reserve (SMCR) inventory by grade and military occupational specialty. The intent of his research is to build the SMCR a retention model using Markov modeling. Dausman equips manpower planners with forecasted continuation rates to "shape initiatives and prioritize resources" within the SMCR. Though SMCR manpower requirements diverge from the Marine Corps' active component, Dausman demonstrates the utility of applying Markov chain models to manpower management, specifically when used in combination with grade and MOS inventory targets.

Taylor (2019) uses fixed inventory Markov chain models to analyze the effects of applying a mixed-accession model to the Marine Corps emerging cyber community. The mixed-accessions model incorporates both regular and direction officer accession. Taylor used a grade adjusted recapitulation (GAR) analysis to set inventory targets and modeled how long it would take for the Cyber community to reach a mature—or desired—state. Taylor used the UAS community as proxy to generate a transition matrix. Taylor concluded that that the cyber community would not reach a mature state within the desired five-year time horizon without using a mixed-accessions model. One of the limitations of this work is the small recruiting population and the lack of universal standards to determine cyber expertise. Because of this, Taylor did not recommend utilizing the mixed-accession model to grow the cyber community.

D. PREDICTORS OF SUCCESS FOR BASIC RECONNAISSANCE COURSE

This section provides an overview of relevant scientific research in the predictive measures of success at Basic Reconnaissance Course (BRC). Though the future infantry will not replace reconnaissance Marines, the demands for fitter and smarter infantry Marines parallel the reconnaissance attributes.

Nowicki (2017) applies multi-variate logistic regression models and survival analysis to evaluate the minimum physical and cognitive requirements to complete the Marine Corps Basic Reconnaissance Course. Given the constrained fiscal environment and the high cost of producing reconnaissance Marines, this research aimed to identity the individual attributes that predict success to improve selection criteria. The data is from active-duty Marines attending BRC from FY 2013 through FY 2016. Nowicki concludes that the Marine Corps Physical Fitness Test (PFT) is the most significant predictor of success at BRC, with every one-point increase above the minimum score—225 at thesis publication— increasing probability of graduating by 1.2 percent. General Test (GT) score, which Nowicki uses as a proxy for cognitive ability, is similarly statistically significant in predicting success at BRC. Every one-point increase in GT score above 105, the minimum requirement for candidates, increasing the probability of graduating by 2 percent. Nowicki recommends increasing the minimum PFT and GT requirements for BRC to reduce attrition rates at the school.

I will use Nowicki (2017) as the baseline to address the secondary research question: How will increased physical and cognitive requires impact the timeline to reach a mature state?

E. CHAPTER SUMMARY

The relevant research presented in this chapter provide the necessary foundation to apply Markov chain models to manpower applications. The extensive body of literature related to applying Markov chain models to fixed inventory manpower systems is reinforced by sufficient applications within military-specific research. The published research highlighted in this chapter provide the methodical foundation to apply Markov chain models to the enlisted infantry population. Furthermore, the impetus for applying these forecasting models is relevant to recent research and policies advocating a change in enlisted manpower management. Lastly, I will use Nowicki (2017) as the baseline to assess the impact of increasing physical and cognitive standards on achieving the mature infantry force.

IV. QUANTITATIVE ANALYSIS: MARKOV MODEL

This chapter traces the development of a mathematical model to forecast future inventory levels and impacts to time in grade and promotions.

A. DATA SOURCE

The Marine Corps' Total Force Data Warehouse (TFDW) provided end of the fiscal year (FY) snapshots of the enlisted infantry community from 2011 to 2021, amounting to over 350,000 observations. The four key variables used to build the forecasting model are individual identifier, fiscal year, MOS, and grade. These variables enable the measurement of promotion, attrition, and retention rates — referred to as transition— across grades— referred to as states.

Manpower and Reserve Affairs (M&RA) provided the FY 2022 GAR and a forecasted FY2027 GAR. The FY 2022 GAR is the status quo, and the FY 2027 is the desired future state. To supplement both GARs, M&RA provided a status quo ASR and the future infantry battalion ASR, we refer to as the Force Design 2030 ASR.

B. ANALYSIS TOOLS

R and Microsoft Excel are the primary analysis tools. We use R to calculate flows and export the results to Excel, where we build transition, check for stationarity and cross-validate models. We create the data visualizations in R and Excel.

C. ENLISTED INFANTRY POPULATION

1. Initial Observations

This section compares the status quo infantry and the proposed future infantry. This comparison is limited to enlisted 03xx personnel. The FY 2022 GAR and FY 2021 ASR represent the status quo infantry while the FY 2027 GAR and Force Design 2030 ASR are the mature state. This analysis represents a potential future state, as experimentation is ongoing, and the final Force Design 2030 infantry battalion ASR is not known. Lastly, this comparison is MOS agnostic. All MOS' are treated identically as 03xx.

The status quo infantry population, reflected in the FY 2022 GAR, has a total of 27,348 enlisted 03xx Marines. Not all the Marines serve in infantry units. Per the GAR, approximately 25 percent of these Marines are in a T2P2 status or serving in varied billets such as drill instructors, Marine Security Guards, or recruiters. The FY 2027 GAR has a total of 22,903 03xx Marines, with similar proportion serving outside of operational infantry units. Table 1 compares the FY 2022 GAR with the FY 2027 GAR.

Table 1. FY 2022 versus FY 2027 GAR Comparison

FY 2022 vs FY 2027 GAR			
Rank	**FY22**	**FY27**	**% Diff**
E3 or below	15214	10672	-30%
E4	5050	5071	0%
E5	3995	3666	-8%
E6	1745	1900	9%
E7	905	1094	21%
E8	331	393	19%
E9	108	107	-1%
Total	27348	22903	-16%

Adapted from source material outlined in Chapter IV, Section A.

The net reduction of 4,445 infantry Marines is not uniform across grades. The FY 2027 reduces the E3 and below population by 4,542 Marines, which is 102 percent of the infantry population's total reduction. The career-Marine grades increase the share of total population, representing *Talent Management 2030s* "retain and invest" approach to manpower management. Figure 2 depicts the transformation in net enlisted infantry population.

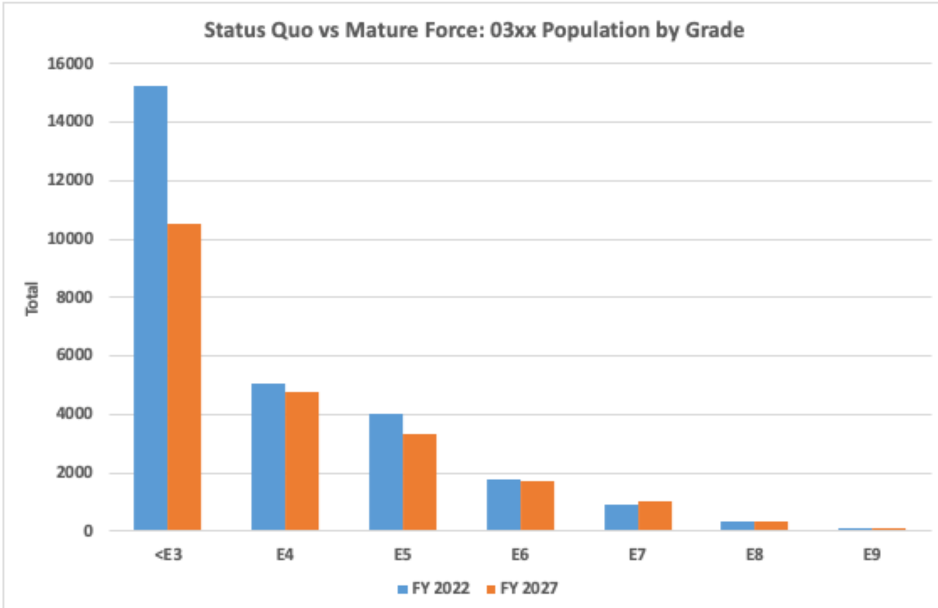


Figure adapted from source material outlined in Chapter IV, Section A.

Figure 2. Status Quo versus Mature Force

2. Infantry Battalion: Status Quo versus Mature Force

The transformation of the 03xx enlisted population is in service of manning the Force Design 2030 infantry battalions. Recalling the Human Resource Development Process outlined in Chapter II, M&RA completes the GAR in fulfillment of the requirements listed in the T/O and ASR. Table 2 compares the 03xx manning levels in the FY 2021 infantry battalion ASR and the Force Design 2030 infantry battalion ASR.

Table 2. Infantry Battalion 03xx manning: FY 2021 ASR versus FY 2030 ASR

Infantry Battalion: 03xx totals			
Rank	FY21 ASR	FD2030 ASR	% Diff
E1	149	0	-100%
E2	4	0	-100%
E3	232	211	-9%
E4	147	165	12%
E5	48	66	38%
E6	42	27	-36%
E7	12	15	25%
E8	1	4	300%
E9	1	1	0%
Total	634	489	-23%

Adapted from source material outlined in Chapter IV, Section A.

The ASRs compare the enlisted 03xx manning levels and do not account for the diversity of MOSs required for an infantry battalion to complete assigned missions. Of note, there are no E1s or E2s on the 2030 infantry battalion's table of organization. Additionally, the twenty-seven E6s in the future battalion—a reduction from the 2021 ASR—is the number of rifle squad leaders required to fulfill the maturity quotient. Figure 3 depicts the manning changes between the status quo and future infantry battalion.

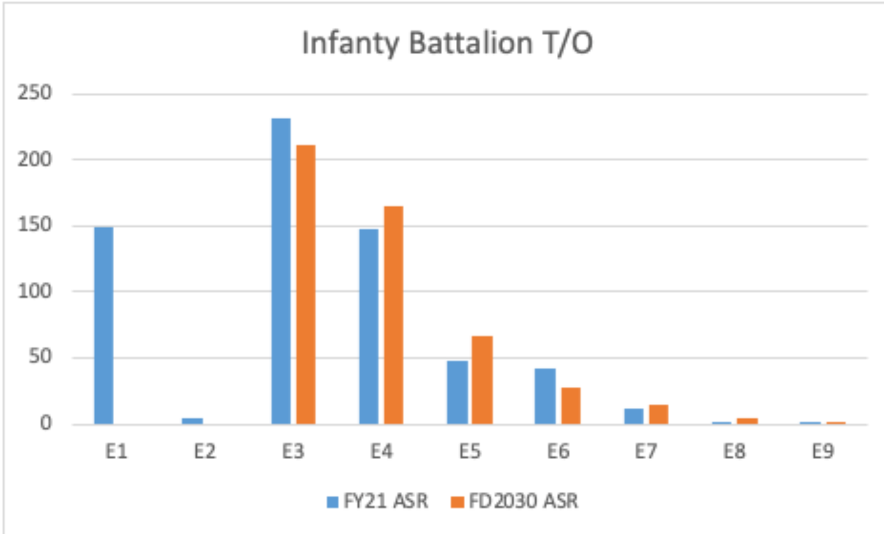


Figure adapted from source material outlined in Chapter IV, Section A.

Figure 3. FY 2021 ASR versus Force Design 2030 ASR

The purpose of this section is to describe difference between the status quo and the steady state envisioned by Force Design 2030. To mature the infantry and implement the maturity quotient in battalions, the infantry force structure requires transformation at the population level.

D. CONCEPTUAL MODEL

After visualizing and describing the status quo infantry, we turn to modeling how to achieve the future mature state envisioned to satisfy the requirements of Force Design 2030. The Markov model state-spaces are finite and mutually exclusive in this thesis. Three fundamental Markov assumptions are applied to this work:

1. The system has a countable number of states
2. The Markovian Property: the probability of a state of the system transition to the future state only depends on its current state
3. Stationary Transition Probabilities: the transition probabilities remain the same over time

To create the state-space, we partition the enlisted infantry population in the USMC by grade. We combine the ranks of Private through Lance Corporal (E1-E3) into a single state, “E3,” to account for inconsistency in rank at accession (some Marines are awarded the rank of Private First Class, “E2,” at recruit training) and extended training time before reaching the Fleet Marine Force (FMF). The states of the system are, E3, E4, E5, E6, E7, E8, E9, and attrite. The path—or flow—of every enlisted infantry Marine is represented in Figure 1. This is a conceptualization of the system to be modeled. Marines “flow” through the system in three ways. They get promoted to the next rank, remain at their present rank, or get out of the Marine Corps.

Because it is a rare occurrence, we do not consider Marines demoted for disciplinary infractions. For the sake of the model—assume no one is demoted. Marines that attrite from the system may be both voluntary and involuntarily separated.

Additional external constraints impact enlisted promotion in the Marine Corps, such as Time in Service (TIS), Time in Grade (TIG) and professional military education (PME) requirements for promotion to the subsequent rank. Similarly, there are separate TIG and TIS constraints for meritorious promotion. The Markovian Property does not account for these requirements, given that the probability of state transition to the future state only depends on the present state.

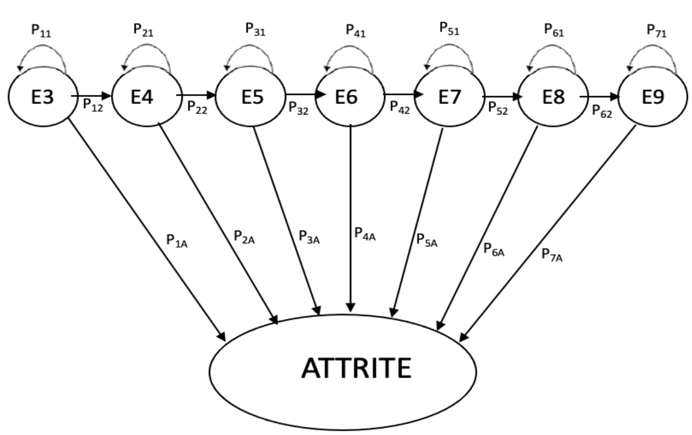


Figure 4. Markov model for ranks E3 to E9

The Markov model allows us to know the location of every Marine and their transition probability between states. Figure 4 illustrates all the possible states and allowable transitions. For example, the transition probability for P_{32} represents the probability that a "E5" is transitions to "E6" in a FY. P_{3A} is the probability that the "E5" leaves the system in the next time step. Combining the TFDW data and the R software enabled us to observe the behavior of all infantry Marines and how they transitioned within the system.

Table 3 displays the total number of enlisted infantry Marines by grade across all FYs within the data set. Table 4 is the number of enlisted infantry Marines who promoted during the given year. We construct additional tables in Excel that measure the total number of Marines who attrite in each FY, total number of Marines who stayed the same rank in each FY, and total number accessed in each FY. These tables are combined to create flowcharts that measure the yearly "flow" from "*i* to "*j*" – from, for example, E4 to E4, E4 to E5, or E4 to attrite.

Table 3. Total number of enlisted infantry Marines at FY end

These are the totals at the END of the years shown. That is, these are the totals on Sep 30 of the year shown.												
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
E3 and below	20243	18309	18104	17385	15260	15359	14966	14904	15505	15325	14903	15445
E4	6305	6289	5882	5811	6456	5958	6038	5939	5770	5830	5794	4966
E5	4551	4604	4411	4094	3943	3776	3658	3863	3756	3988	3891	3797
E6	1912	1995	2013	1774	1646	1494	1531	1575	1605	1772	1792	1598
E7	1029	1089	1012	942	888	863	917	935	987	909	911	1000
E8	309	325	335	348	320	311	319	339	319	328	353	335
E9	101	100	103	107	102	94	104	100	109	111	110	115
Totals	34349	32611	31757	30354	28513	27761	27429	27555	27942	28152	27644	27141

Adapted from source information detailed in Chapter IV, Section A.

Table 4. Total number of enlisted infantry Marines promoted during FY shown

Promotions During FY shown												
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
E3 and below	0	3545	2602	3188	4228	3225	3928	4104	3443	4205	3572	2805
E4	0	1161	926	931	1195	1094	1345	1534	1258	1554	1302	1194
E5	0	465	301	243	282	337	532	400	440	461	419	311
E6	0	238	106	163	121	206	303	198	260	133	206	274
E7	0	70	91	71	30	69	100	78	68	84	73	64
E8	0	20	21	20	11	18	27	19	24	21	14	23
E9	0	0	0	0	0	0	0	0	0	0	0	0
Totals	0	5499	4047	4616	5867	4949	6235	6333	5493	6458	5586	4671

Adapted from source information detailed in Chapter IV, Section A

Yearly flow charts—"flows"—enable the creation of the transition matrix. A transition matrix is the transition probabilities that describe the behavior of a particular system, in this case, the transition matrix explains the probabilistic behavior of enlisted infantry Marines. Table 5 shows the creation of a transition matrix from a single year flow chart. Because the f_{ij} are binomially distributed, transition probability is calculated by: $\hat{p}_{ij=} {f_{ij}}/{n_i}$. These steps are created with each time step in the data to build aggregated flows and transition probabilities.

Table 5. Demonstration of building a transition Matrix

During FY20 — Flows

	E3	E4	E5	E6	E7	E8	E9	Attrite	Total
E3	14824	3572						2405	20801
E4		2244	1302					2297	5843
E5			2633	419				969	4021
E6				1371	206			196	1773
E7					706	73		130	909
E8						280	14	34	328
E9							96	15	111

During FY20 — Pijs

	E3	E4	E5	E6	E7	E8	E9	Attrite	Total
E3	0.712658	0.171723	0	0	0	0	0	0.115619	1
E4	0	0.384049	0.222831	0	0	0	0	0.39312	1
E5	0	0	0.654812	0.104203	0	0	0	0.240985	1
E6				0.773266	0.116187	0	0	0.110547	1
E7					0.776678	0.080308	0	0.143014	1
E8						0.853659	0.042683	0.103659	1
E9							0.864865	0.135135	1

Adapted from source information detailed in Chapter IV, Section A.

The third Markov model assumption is stationarity. Stationarity requires the probabilities in the transition matrix to remain relatively stable over time (Sales, 1971). The validation process requires the construction of confidence intervals matrices to confirm if the aggregate transition matrix is contained within the confidence intervals. We test the data for stationarity to arrive at the end goal of determining the appropriate numbers of years (t) and which years specifically produce the most accurate transition matrix. To confirm stationarity, we build ~70% confidence intervals around the annual transition rate estimates to confirm if it contains the aggregate transition rate. If the aggregate rates are contained in the confidence intervals, we conclude that transition rate is sufficiently stationary (Sales, 1971). Table 6 shows test results, with a positive integer representing a successful transition probability and zero indicating a failure because the transition probability fell outside the confidence interval.

Table 6. Model test results for two-year model

Summary Cointainment 2 Year Model								
	E3	E4	E5	E6	E7	E8	E9	Attrite
E3	0	0	0	0	0	0	0	2
E4	0	2	0	0	0	0	0	0
E5	0	0	2	0	0	0	0	2
E6	0	0	0	0	0	0	0	0
E7	0	0	0	0	2	2	0	2
E8	0	0	0	0	0	0	1	0
E9	0	0	0	0	0	0	2	2

Adapted from source information detailed in Chapter IV, Section A.

The percentage of accuracy for the containment matrix is determined by summing the total numbers of successful $\hat{p}_{ij}(t)$ combinations, represented by the yellow boxes in Table 6, and then dividing by the total number of transition opportunities. In this case, there were 19 successes in the two-year model and 40 transition opportunities, resulting in a 48% success rate. The ideal floor for stationarity is ~70%, meaning that the results from Table 6 are not optimal to build a forecasting model, requiring additional testing before model selection (Sales, 1971).

1. Model Selection and Validation

The next step is model selection. Given that the methodology is established, we constructed nine models from the TFDW data and tested each for stationarity. We selected the model with the highest stationarity level, a two-year model that spans from FY 2020 to FY 2021. Though it is below the threshold of 60% suggested by Sales (1971), we use a cross-validation to confirm forecasting viability.

Cross-validation applies the selected model to a set of known inventory levels to confirm forecasting accuracy (Sales, 1971). In short, we apply the model to historical inventory from the TFDW data. The basis for cross-validation is Bartholomew's inventory equation, which works for both inventory and recruiting cases.

$$\mathbf{n}(t+1) = \mathbf{n}(t)\mathbf{P} + R\mathbf{r}$$

where:

- $\mathbf{n}(t + 1)$ is the inventory vector of the next timestep,

- **n**(t) is the inventory vector at time *t*,
- ***P*** is a matrix of (transient) transition probabilities,
- *R*() is a scalar equal to the number of accessions, and
- ***r*** is a vector that describes how accessions are distributed across states.

The cross-validation process assumes that the model is applied in October of the predicted fiscal year and contains the previous two years of inventory observations. Given that actual inventory numbers at the end of the fiscal years are known, the inventory equation is applied to validate the two-year transition matrix model. We execute cross-validation two times in sequential order by stepping forward in time from FY 2020 to FY 2021. Tables 7 through 9 display these results.

Table 7. Two-year model cross-validation, predicting FY 2020

Cross-validation on FY18 - FY19 to predict starting FY20 inventory								
	E3	E4	E5	E6	E7	E8	E9	Total
FY19 Starting Inventory	15505	5770	3756	1605	987	319	109	**28051**
Predicted FY20 starting Inventory	17048	4570	3719	1541	993	332	110	28313
Actual FY20 starting Inventory	15325	5830	3988	1772	909	328	111	28263
Absolute Proportional Error (APE)	0.112	0.216	0.067	0.130	0.093	0.013	0.009	0.002
MAPE	0.080							

Adapted from source information detailed in Chapter IV, Section A.

Table 8. Two-year model cross-validation, predicting FY 2021

Cross-validation on FY19 - FY20 to predict starting FY21 inventory								
	E3	E4	E5	E6	E7	E8	E9	Total
FY20 Starting Inventory	15325	5830	3988	**1772**	**909**	**328**	**111**	**28263**
Predicted FY21 starting Inventory	16916.4	4564.96	3885.32	1687.259339	954.1651184	333.811	112.246	28454.1
Actual FY21 starting Inventory	14903	5794	3891	1792	911	353	110	27754
Absolute Proportional Error (APE)	0.135	0.212	0.001	0.058	0.047	0.054	0.020	0.025
MAPE	0.069							

Adapted from source information detailed in Chapter IV, Section A.

Table 9. Two-year model cross-validation predicting FY 2022 inventory

Cross-validation on FY20 - FY21 to predict starting FY22 inventory								
	E3	E4	E5	E6	E7	E8	E9	Total
FY21 starting Inventory	14903	5794	3891	1792	911	353	110	27754
Predicted FY22 starting inventory	16608.9	4486.41	3813.42	1693.257946	958.431181	354.189	112.754	28027.4
Actual FY22 starting inventory	15445	4966	3797	1598	1000	335	115	27256
Absolute Proportional Error (APE)	0.08	0.10	0.00	0.06	0.04	0.06	0.02	0.03
MAPE	0.05							

Adapted from source information detailed in Chapter IV, Section A.

The results of cross-validation confirm a successful forecasting model. The mean absolute proportional value (MAPE) values are progressively lower from Table 5 to 7, which correspond to the high degree of stationarity in the model while stepping forward in time.

We compared performance of the two-year model with a one-year model against the same test sets depicted in Tables 7 through 9. The MAPEs for the two-year model (.08, .07, .05), though similar, are preferable to the one-year model (.11, .10, .03). Simply, the two-year model is better at forecasting. We select the two-year model for this reason.

E. INVENTORY FORECAST

The validated model enables the forecast of future inventory levels in the enlisted infantry population (03xx). Using the inventory equation, aggregated transition matrix, the FY 2027 inventory vectors provided by MM&RA, the optimal accession pathway is identified to achieve the matured infantry force end strength.

1. Fixed Inventory

Fixed inventory models rely on predetermined end-strength targets to determine the number of recruits needed to achieve inventory goals. Knowing the total enlisted infantry population at the end of a fiscal year enables us to determine the number of new infantry Marines required. In addition to data from TFDW, which we used to construct and validate the aggregate transition matrix (Table 10) and determine the initial inventory vector (Table 11). For our model, all accessions enter the system as E3s. Additionally, we were provided the 2030 Infantry Battalion Authorized Strength Report (ASR) and the FY2027 GAR. Given that the Marine Corps' implementation of Force Design 2030 ranges between experimentation and implementation, the future planning documents represent a possible future and are subject to change. For our purposes, they provided the necessary inventory targets to apply our model.

Table 10. Enlisted 03xx aggregated transition matrix

	E3	E4	E5	E6	E7	E8	E9	Attrite	Total
E3	0.728507333	0.153825743	0	0	0	0	0	0.117666924	1
E4	0	0.378658224	0.21358891	0	0	0	0	0.407752867	1
E5	0	0	0.662010822	0.091858563	0	0	0	0.246130615	1
E6	0	0	0	0.745444351	0.13456686	0	0	0.119988786	1
E7	0	0	0	0	0.78736264	0.07527473	0	0.137362637	1
E8	0	0	0	0	0	0.80910426	0.05433186	0.136563877	1
E9	0	0	0	0	0	0	0.85067873	0.149321267	1

Adapted from source information detailed in Chapter IV, Section A.

Table 11. Initial inventory vector of 03xx in October 2021

	E3	E4	E5	E6	E7	E8	E9	Total
n(21)	15445	4966	3797	1598	1000	335	115	27256

Adapted from source information detailed in Chapter IV, Section A.

2. Setting End Strength Targets

The map the inventory path for the infantry community requires a start point and an end point. The initial inventory vector, **n(**21**)**, is derived from the TFDW data, **n**(22***)*** is from the FY22 GAR, and the FY2027 vector, **n(**27), is from the FY 2027 GAR. To account for FY23 through FY26, we assumed a gradual and consistent reduction in total end-strength and assigned missing inventory values by reducing annual inventory by 889, the difference between FY22 and FY27 divided by the sum of missing years (5). This assumption, that a gradual and consistent reduction in end strength, provides the basis for determining the number of enlisted infantry accessions. End-strength vectors are provided in Table 12.

Table 12. 03xx end-strength inventory targets FY21to FY27

n(21)	27235
n(22)	27348
n(23)	26459
n(24)	25570
n(25)	24681
n(26)	23793
n(27)	22903

Adapted from source information detailed in Chapter IV, Section A.

3. Model Demonstration—Accessions from FY21 to FY27

Utilizing Microsoft Excel's *solver* tool, we apply the fixed inventory model to forecast annual accessions, or R, to move from the status quo **n(**21**)** of 27235 enlisted 03xx to the target inventory vector, **n(**27**)**, 22903 enlisted 03xx. Additional binding constraints are added to ensure any reduction in annual accessions is no more or no less than 10 per cent of the previous year's accession total. This added constraint ensures the gradual reduction of recruits, avoiding disruptively large cohorts from destabilizing future promotion or retention missions. The results, shown in Table 13, account for accessions directly into the infantry and do not include any lateral transfers in the 03xx population. Beginning in FY22, annual accessions are reduced between 9% and 9.5% until the target end-strength vector is reached, **n(**27). This represents ~ 30% reduction in annual infantry accessions between the status quo and FY 2027.

Table 13. 03xx fixed-inventory Accessions, FY21 to FY27

	FY22	FY23	FY24	FY25	FY26	FY27
Accessions Only	4899	4409	3968	3601	3564	3403

Adapted from source information detailed in Chapter IV, Section A.

Critically, this initial model demonstrates a way for manpower planners to reduce the overall size of the infantry—from initial to target inventory vectors—yet does not represent the matured infantry population desired by Force Design 2030. Beginning with the assumption that achieving the matured infantry population envisioned by Force Design 2030 requires a net reduction in the total infantry population, we can forecast the impact on annual accessions, attrition, promotion, time in grade, and total population by grade

F. APPLYING THE MODEL TO SCENARIOS

At this point, we have all the information and tools required to address the primary research question. The model is effective at forecasting accession levels when the target is the desired end strength. As discussed in Chapter II and shown in the 2030 ASR and FY2027 GAR, the composition of a matured infantry force departs from the status quo in both net population size and in rank distribution. The infantry is matured by reducing the total population and proportion of E3s and below while increasing the noncommissioned and staff noncommissioned officer populations. We built two scenarios to answer the primary research question:

- Given the 3:9 infantry squad maturity ratio, what is the timeline to reach a mature state?

a. Scenario 1: Targets by Grade

In this scenario, we apply the Fixed Inventory formula to achieve specific grade levels outlined by the 2027 GAR. Rather than target total end-strength—the sum of all states in the 03xx inventory— we drive the model to achieve specific targets by grade. The FY 2022 GAR provides the initial inventory vector, **n(**22**)** while the FY 2027 GAR provides each grade target. Table 14, adapted from the FY2022 and FY2027 GARs, shows the initial inventory by grade and the desired grade target. We use Microsoft Excel's Solver to find the optimal solution.

Table 14. Inventory targets by grade - FY2022 and FY2027 GAR

FY 22 Targets

Paygrade	Target
<E3	15214
E4	5050
E5	3995
E6	1745
E7	905
E8	331
E9	108

FY 27 Targets

Paygrade	Target
<E3	10520
E4	4740
E5	3299
E6	1689
E7	996
E8	359
E9	98

Adapted from source material outlined in Chapter IV, Section A.

The use of a flows table is the pathway to by grade targets. To enable Solver to arrive at an optimal solution we first tie the FY 2021 flows to a transition matrix so that if the flows are adjusted, the transition rates change. We apply constraints in excel to the flows so that all elements (attrite, promote, continue) are greater than zero and that the elements sum to the total. The attrite and total columns are fixed. Promotion is calculated by subtracting the continue and attrite from the total, leaving the continue column as one of our decision variables for Solver. Table 15 shows the FY 21 flows.

Table 15. FY 21 Flows

FY21 FLOWS	Attrite	Promote	Continue	Total
E3	2473	2805	15377	20655
E4	2468	1194	2181	5843
E5	987	311	2628	3926
E6	232	274	1288	1794
E7	120	64	727	911
E8	59	23	271	353
E9	18	0	92	110

Adapted from source material outlined in Chapter IV, Section A.

The initial inventory vector, **n(**22), and estimate **n(**27), represents a by grade total. Each grade from the FY 2027 GAR is targeted. Continue from the flows and R, the annual accessions, are the decision variables. We minimize the objective value function, which is the sum of squared errors between the estimated inventory, **n(**27), and the target inventory levels. This action results in by-grade inventory results from **n(**22) to **n(**27) (Table 16) and annual accessions (Table 17). It also adjusts the transition matrix to correspond with the optimal continuation and promotion rates required to meet the desired inventory.

Table 16. Targets by Grade inventory results

	E3	E4	E5	E6	E7	E8	E9	Total
n(FY22)	15214	5050	3995	1745	905	331	108	27348
n(FY23)	14301	5750	3636	1778	933	335	105	26837
n(FY24)	13248	5761	3566	1759	960	340	102	25735
n(FY25)	12157	5491	3524	1737	978	346	100	24333
n(FY26)	11249	5111	3438	1715	990	353	99	22954
n(FY27)	10520	4740	3299	1689	996	359	98	21701
TARGET	**10520**	**4740**	**3299**	**1689**	**996**	**359**	**98**	**22903**

Adapted from source material outlined in Chapter IV, Section A.

Table 17. Targets by Grade annual accessions

Annual Accessions	FY22	FY23	FY24	FY25	FY26	FY27
	5485	4936	4443	3998	3703	3504

Adapted from source material outlined in Chapter IV, Section A.

(1) Scenario 1 Inventory Results

The results, depicted in Tables 16 and 17, show that there is a feasible path to achieve the by grade targets vectors and the end strength vector of 22,903 enlisted infantry Marines by FY 2027. This model includes a ~9% annual decrease in the rate of accessions into the infantry community, consistent with the results of the end-strength only model. At this stage, the model provides a managerially relevant pathway to achieve the Force Design 2030 goals of a matured infantry population.

(2) Scenario 1 Time in Grade Results

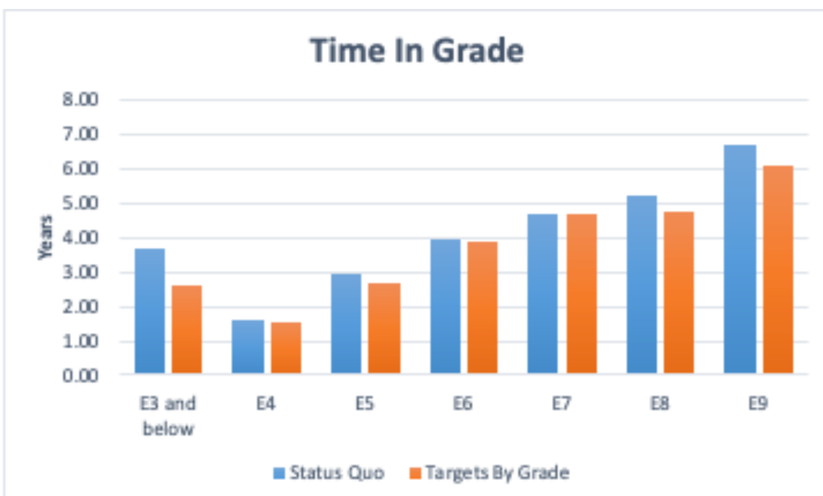
To drive the model to achieve the targeted vectors results in adjustment of the aggregated transition matrix. In short, to build the mature force with the grade specific targets envisioned by Force Design 2030 planners impacts the forecasted rates of promotion, attrition, or that a Marine stays the same rank. An effective way to measure potential impact of achieving the Force Design 2030 grade targets is to compare mean Time-in-Grade (TIG) between the status quo and the Target by Grade model. To see the impact on transition rates for each grade, we built fundamental matrices for our initial aggregated transition matrix (Table 10) and the aggregated transition matrix from the Target by Grade model. The results are depicted in Table 18 and visualized in Figure 5. The forecasted TIGs meet the Marine Corps promotion timing targets outlined in the

Marine Corps Promotion Manual, Marine Corps Order P1400.32D, and the additional time constraints from MARADMIN 612/19. The forecasted TIG averages in the Targets by Grade model are lower than the status quo, and except for the E3 and below population, no TIG is reduced more than 10%.

Table 18. Time in Grade comparison: Status Quo and Targets by Grade

Rank	Status Quo	Targets By Grade	% Diff
E3 and below	3.68	2.63	29%
E4	1.61	1.55	4%
E5	2.96	2.69	9%
E6	3.93	3.91	1%
E7	4.70	4.70	0%
E8	5.24	4.75	9%
E9	6.70	6.11	9%

Adapted from source material outlined in Chapter IV, Section A.



Adapted from source material outlined in Chapter IV, Section A.

Figure 5. TIG comparison: Status Quo versus Targets By Grade model

(3) Scenario 1 – Summary

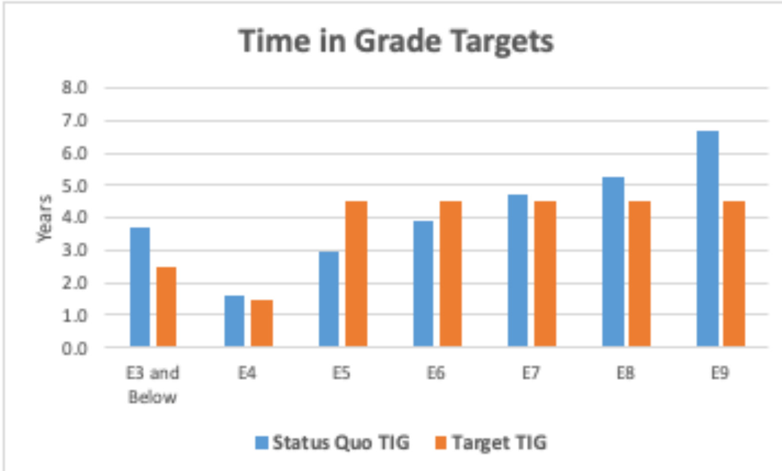
Scenario 1 demonstrates the feasibility of achieving the Force Design 2030 goal of maturing the infantry. Using the grade targets from the 2027 GAR, we built a model that achieved ends strength and by grade targets. Average TIG decreased for most ranks, with the E3 and below population seeing a ~30% reduction. Effectively, to achieve a matured infantry requires the promotion of lance corporals (E3) to corporal one year sooner than the status quo.

b. Scenario 2: Targets by Time in Grade

The second scenario explores whether the Marine Corps can achieve its matured infantry population and the TIG targets as per the Enlisted Career Force Controls (United States Marine Corps 2010). Effectively, if the Marine Corps is to mature its population, is it possible to do so without accelerating promotion? This scenario is managerially relevant to manpower planners because it reveals a tradeoff associated with Force Design 2030.

(1) Targets by Time in Grade Model

This scenario is an extension of scenario 1. Rather than drive the model to forecast the impact of achieving targets by grade, this model optimizes the transition rates to achieve desired Time in Grade targets. To do this, we begin with the status quo TIG and drive the model towards a new vector, the standard TIG targets of 2.5 years for E3 and below, 1.5 years for E4, and 4.5 years for E5 through E9. Driving the model to a TIG vector transforms the aggregated transition matrix because achieving TIG targets adjusts transition probabilities. This allows us to forecast the impact of prioritizing Time in Grade requirements over by grade targets while still achieving the desired population end strength of 22,903 enlisted infantry Marines by FY 2027. Figure 6 compares the status quo and target TIG.



Adapted from source material outlined in Chapter IV, Section A.

Figure 6. Scenario 2: Status Quo versus TIG Targets

(2) Targets by Time in Grade inventory results

The results show that if manpower planners prioritize TIG requirements instead of Targets by Grade, the population can achieve the end strength goal of 22,903 enlisted infantry Marines, it will not meet rank distribution goals. In short, this scenario does not meet the 2027 GAR grade targets, crucial for fielding a mature infantry force. Table 19 shows the inventory results of the model. Of note, the E5 is 71% greater than desired and E6 and E7 populations are 79% and 52% below targeted levels. Though annual accessions, shown in Table 20, decrease by approximately 10% per year and are consistent with previous models, the Targets by TIG model requires 9% more accessions from FY 2021 to FY 2027 (28,506) than the Target by Grade model (26,068).

Table 19. Targets by Time in Grade inventory results

	E3	E4	E5	E6	E7	E8	E9	Total	Target
n(FY21)	15445	4966	3797	1598	1000	335	115	27256	
n(FY22)	14647	5984	4166	1243	926	351	108	27426	27348
n(FY23)	13631	6100	4702	967	836	357	103	26696	26459
n(FY24)	12951	5854	5147	752	740	353	100	25897	25570
n(FY25)	12432	5581	5433	585	645	342	97	25116	24681
n(FY26)	11965	5345	5589	455	556	324	94	24329	23792
n(FY27)	11523	5135	5653	354	475	302	91	23533	22903
TARGET	10520	4740	3299	1689	996	359	98	22903	22903

Adapted from source material outlined in Chapter IV, Section A.

Table 20. Targets by Time in Grade annual accessions

Annual Accessions	FY22	FY23	FY24	FY25	FY26	FY27
	5380	4842	4773	4662	4506	4344

Adapted from source material outlined in Chapter IV, Section A.

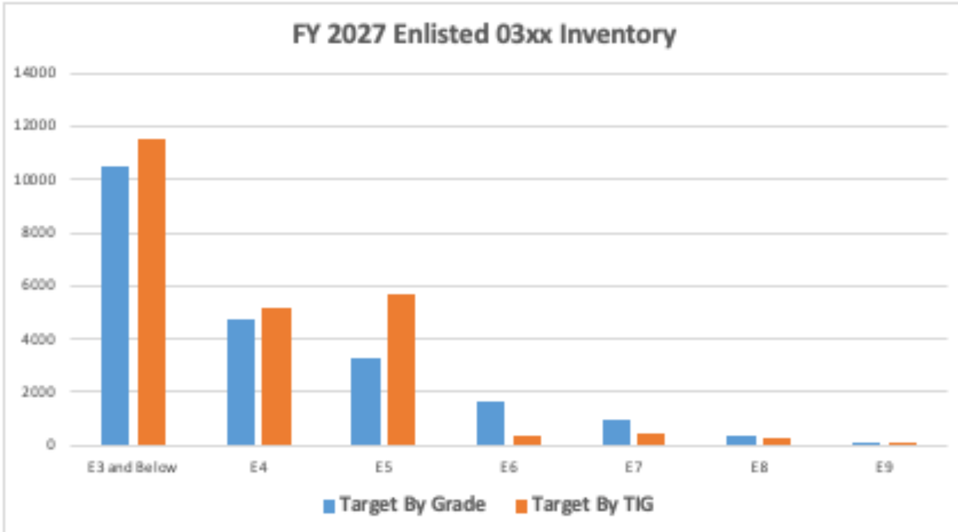
(3) Scenario 2 - Summary

Given that the analysis relies on an initial assumption that manpower managers will reduce the infantry population in line with Force Design 2030, with the specified goal of 22,903 enlisted infantry Marines by FY 2027, prioritizing Time in Grade over Targets by Grade is not a viable pathway for manpower planners. Table 21 and Figure 7 compare the results of scenario 1 and 2.

Table 21. Comparison between Scenario 1 and 2

Rank	Target By Grade	Target By TIG	% Diff
E3 and Below	10520	11523	10%
E4	4740	5135	8%
E5	3299	5653	71%
E6	1689	354	79%
E7	996	475	52%
E8	359	302	16%
E9	98	91	7%

Adapted from source material outlined in Chapter IV, Section A.



Adapted from source information detailed in Chapter IV, Section A.

Figure 7. Comparison between Scenario 1 and 2

G. RESULTS AND DISCUSSION

The primary research question asks how long it would take the infantry population to reach the maturity quotient, defined as a 3:9 ratio of FTAP to STAP Marines within rifle squads. We find that the enlisted infantry community will reach maturity by FY 2027. These results are built on several assumptions, the first being that the infantry will reduce its population end strength from approximately 27,000 to 23,000 Marines from FY2022 to FY2027. The second assumption is that manpower managers will seek gradual and consistent reductions in annual accessions to prevent overly large or small cohorts from destabilizing the system. Our final assumption is that the 2027 GAR and the 2030 Force Design ASR are reliable source documents to forecast future population behavior.

The mature force, barring alternative definitions, is best represented by the future infantry battalion proposed by Force Design 2030 planners. As a result, driving our model to optimize the total population to achieve targets by grade, rather than total end strength, is both more managerially relevant and prudent for further analysis. This approach affirms the HRDP, wherein force requirements are satisfied by manning, and not the inverse. We find that, as our results in Scenario 1 depict, the Marine Corps can gradually decrease infantry accessions—approximately 9% annually—and achieve both end-strength and grade targets. Except for the non-NCO population (E3 and below), the model shows minimal impacts to transition probabilities.

V. QUANTITATIVE ANALYSIS: SOF-LIKE INFANTRY

The focus of this chapter is to measure cognitive and physical characteristics within the enlisted 03xx community to infer the practicality of maturing the infantry into a fitter and smarter force—comparable to special operations forces (SOF) or reconnaissance Marines—by 2030. We seek to answer our secondary research question: How will increased physical and intelligence standards impact the timeline to reach a mature state? To answer this question, we compare the physical and cognitive performances by occupation type and career status. Finally, we assess these groups against a physical and cognitive standard designed to identify a fitter and smarter infantry.

A. APPROACH

The enlisted 03xx population is divided to assess performance trends since 2011. The first subset compares Marines by occupation and the second subset compares by career status. We use General Test (GT), Armed Forces Qualification Test (AFQT), Combat Fitness Test (CFT), and Physical Fitness Test (PFT) scores for comparisons. To measure by occupation, we compare reconnaissance and MARSOC Marines with conventional infantry Marines. For differences in career status, we compare first-term and career Marines. Finally, we compare the 03xx population by occupation and career status against a mature standard. Nowicki (2017) determined that the PFT and GT are the most significant predictors of successful completion of Basic Reconnaissance Course (BRC). We use the minimum requirements to attend BRC of a 235 PFT and a 105 GT score as the starting point for the mature standard.

B. DATA SOURCE AND DATA SAMPLE

As outlined in Chapter IV, the data is from TFDW and comprises FY snapshots of the enlisted infantry population from 2011 to 2021. We generated a data sub-sample with the key variables FY, MOS, PFT, CFT, AFQT, GT, MOS, Grade, and individual identifier. The GT is scored between 0 and 157; the AFQT is scored between 1 to 99; the PFT and CFT are scored between 0 to 300. This sub-sample contains the maximum performance scores by FY for each 03xx Marine and contains 80,406 observations.

Additional created variables include RECON, a binary variable combining 0321, reconnaissance Marine, and 0372, MARSOC critical skills operator. MATURE_STANDARD1 is a binary variable indicating if a Marine possesses a PFT score above 235 and a GT score above 104. Lastly, we created a binary variable, FTAP, to separate first enlistment and career Marines. For this study, FTAP is comprised of all E4 and below and career Marines are considered E5 and above.

C. RECON VERSUS INFANTRY

The first data subset compares by occupation. The mature infantry is envisioned as a fitter and smarter infantry with "a higher physical standard than the rest of the Corps" and "possess a raw intelligence similar to those in reconnaissance, the Rangers, or special forces" (Alford, 2021). Reconnaissance and special operations forces are recruited, assessed, and trained to complete tasks unachievable conventionally (Kiras 2006). The 3,109 Recon and MARSOC Marines represent 3.8 percent of the enlisted 03xx population, emphasizing quality over quantity. Figure 8 displays the mean GT, AFQT, PFT, and CFT scores of Recon/MARSOC Marines and conventional infantry from 2011 to 2021.

Figure 8. Mean Scores Comparison between Recon and Infantry

Although Recon and MARSOC clearly outperform the conventional infantry across the performance metrics in Figure 8, accession into the Recon and MARSOC community is voluntary and competitive. Marines must have the physical and cognitive attributes and possess the propensity to be Recon or MARSOC Marine.

Measuring the proportion of the 03xx population with the physical and cognitive requirements to serve in Recon and MARSOC—rather than those with the propensity and minimum requirements—provides insight for producing the fitter and smarter mature force envisioned in Force Design 2030. We use kernel density plots to compare the distribution of PFT and GT scores. Figures 9 and 10 represent the distribution of PFT and GT scores in the Recon/MARSOC and conventional infantry populations. The plots include the minimum standards for BRC and 03xx mean scores.

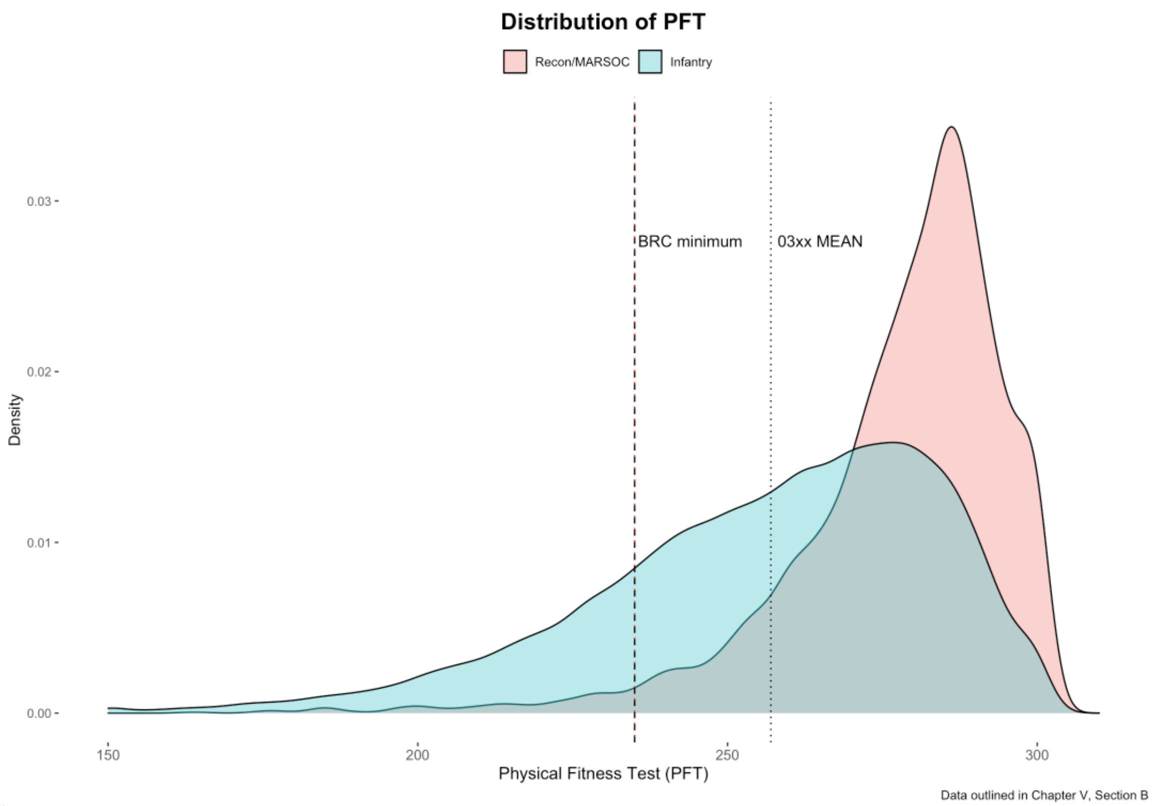


Figure 9. PFT: Recon/MARSOC versus Infantry

Figure 9 presents two left skewed density curves, showing that the mean PFT scores of both Recon/MARSOC and the conventional infantry are less than their median scores. Recon/MARSOC's mean PFT is 278 and median is 282. The infantry's mean PFT is 256 and median is 261. Fit Marines within each community outnumber the unfit, though the steeper and narrower Recon/MARSOC curve shows a higher concentration of fit Marines relative to the conventional infantry.

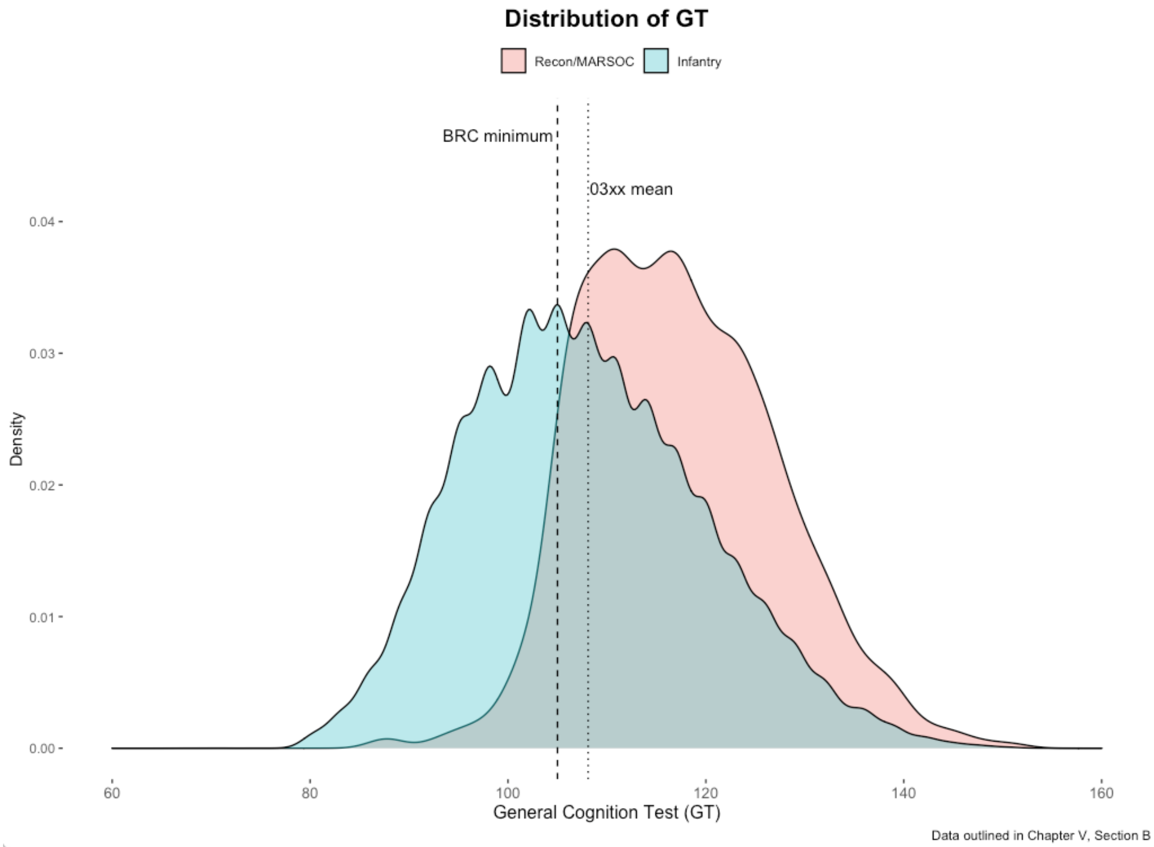


Figure 10. GT: Recon/MARSOC versus Infantry

Turning to the GT scores, Figure 10 displays density curves that are normally distributed. The lack of significant skew is evidence that the mean and median scores are nearly identical within each respective density curve. Recon/MARSOC's mean and median GT scores are 117.3 and 117 while the infantry's mean and median GT scores are 107.7 and 107. Though there are Recon/MARSOC Marines with GT scores below the minimum requirements for BRC, most Marines possess intelligence superior to the conventional infantry.

Lastly, we measure the percentage of the 03xx population who meet a mature standard to determine the feasibility of fielding a fitter and smarter force. The mature standard is the constructed from the minimum BRC standards (235 PFT and a 105 GT).

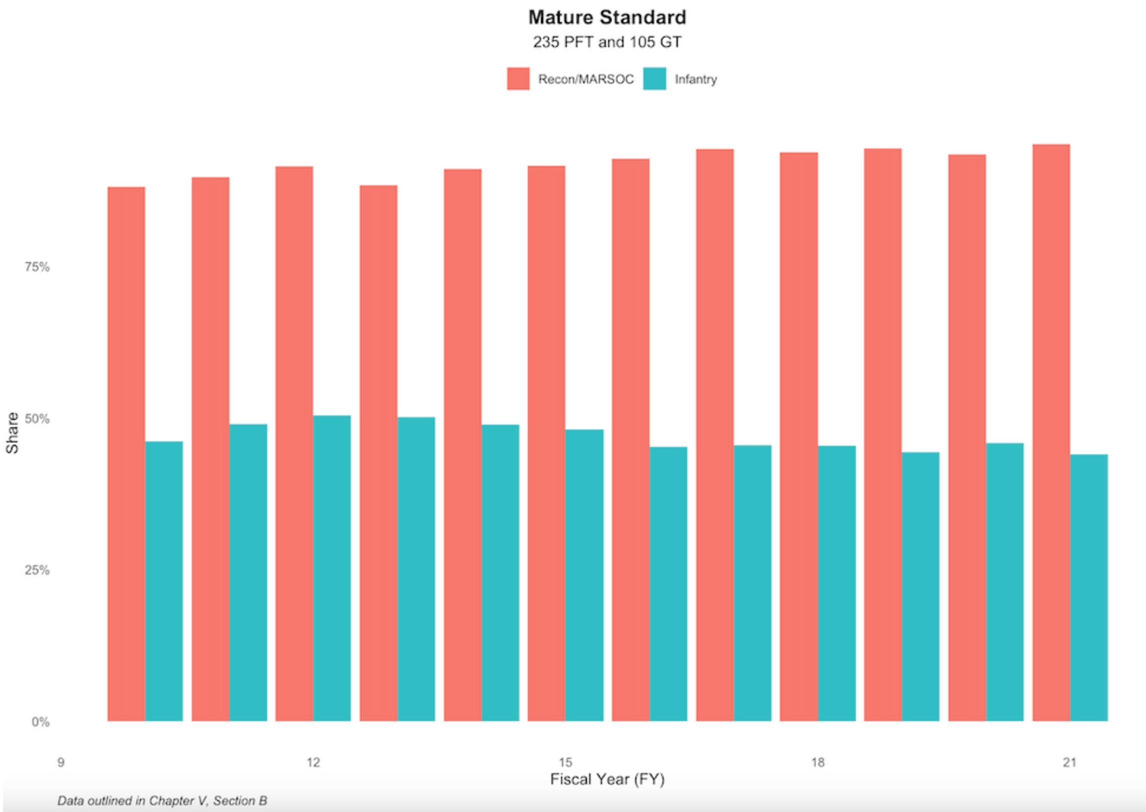


Figure 11. Mature Standard: Recon/MARSOC versus Infantry

Figure 11 reveals that approximately half of the conventional infantry fail to meet the mature standard, while nearly all of Recon/MARSOC meet them. There are some inferences to draw from these results. First, the PFT is an annual performance evaluation dictated by individual and unit training habits. Given that the infantry's mean PFT score, 256, is 21 points above than the 235 mature standard, increased standards and emphasis on physical training will impact fitness levels. Second, because the GT is used to determine MOS eligibility—with higher scores required for select occupations—it is commonly administered once prior to enlistment (United States Marine Corps 2014). Though Marines can retest to increase their GT score, we assume this is infrequent. Whereas Marine PFT scores may fluctuate, GT scores are locked and unlikely to improve. Selection of more cognitively able Marines will be needed to achieve a smarter infantry.

D. FIRST-TERM VERSUS CAREER MARINES

Comparing first-term Marines, labeled FTAP in the figures, with Marines on subsequent enlistments, labeled career in the figures, provides a window into historic retention trends. Indeed, given the Marine Corps' desire to shift to a retain and invest model, the mean performance metrics displayed in Figure 12 confirm the Talent Management 2030 claim that career Marines are physically fitter than the FTAP population (United States Marine Corps, 2021b). Furthermore, since FY 2015, career Marines possess higher mean GT and AFQT scores than the FTAP population, suggesting recent retention efforts produced a smarter infantry. Simply, career Marines are already smarter and fitter than the FTAP population.

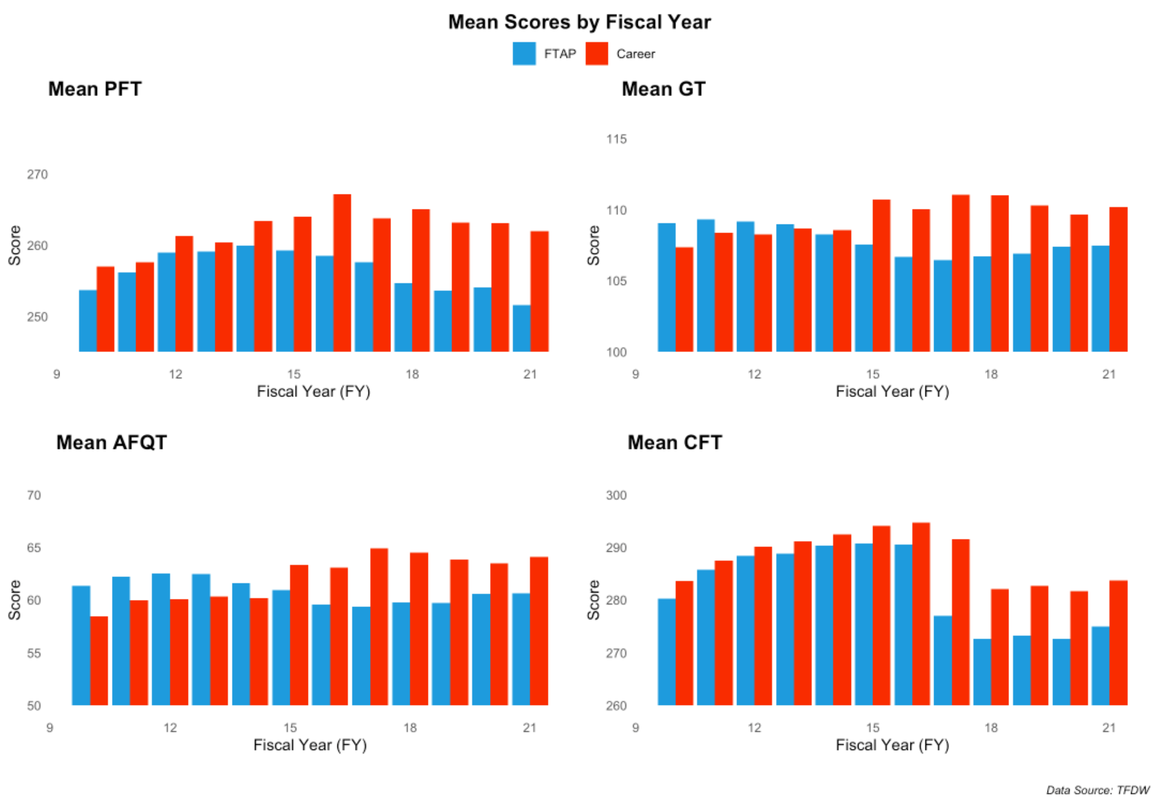


Figure 12. Mean Scores comparison between FTAP and Career 03xx

As with the Recon/MARSOC and infantry comparisons, we employ kernel density plots to visualize the distribution of PFT and GT scores. Figures 13 and 14 represent the distribution of PFT and GT scores amongst the FTAP and career infantry populations. The plots include the minimum standards for BRC and 03xx mean scores.

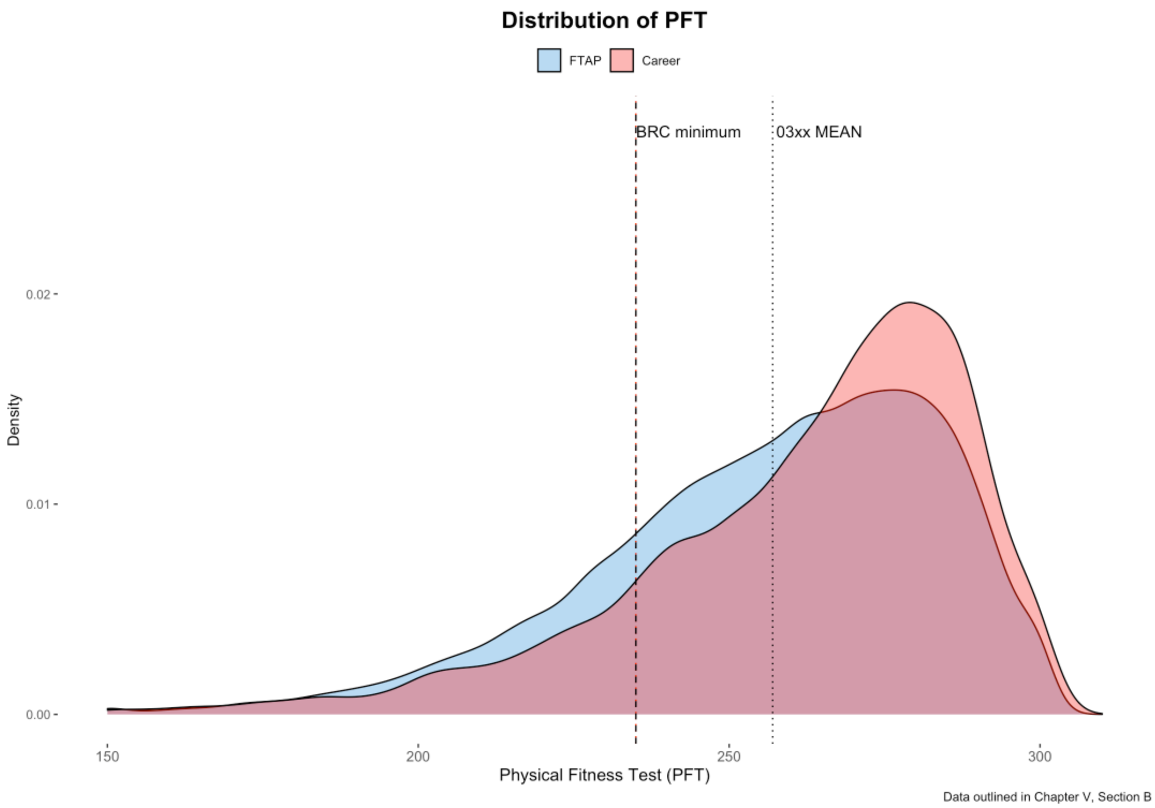


Figure 13. PFT: FTAP versus Career

Figure 13 presents two left skewed density curves. As with Figure 9 comparing Recon/MARSOC and conventional infantry, the mean PFT scores of both FTAP and career Marines are less than their median scores. The FTAP mean PFT is 256 and median is 261. The career mean PFT is 261 and median is 269.

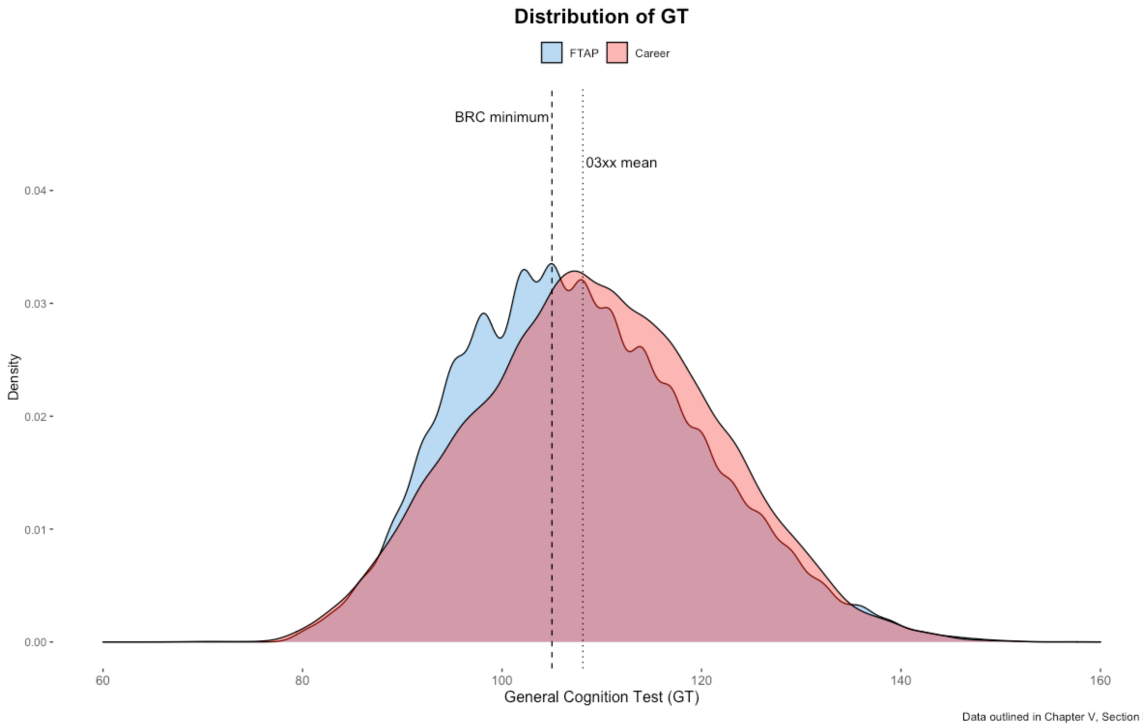


Figure 14. GT: FTAP versus Career

The GT score density curves, Figure 14, are largely normally distributed. The absence of significant skew is evidence of nearly identical mean and median GT scores within the respective density curves. The FTAP mean and median GT scores are 108 and 107, while the career mean and median GT score is 109.

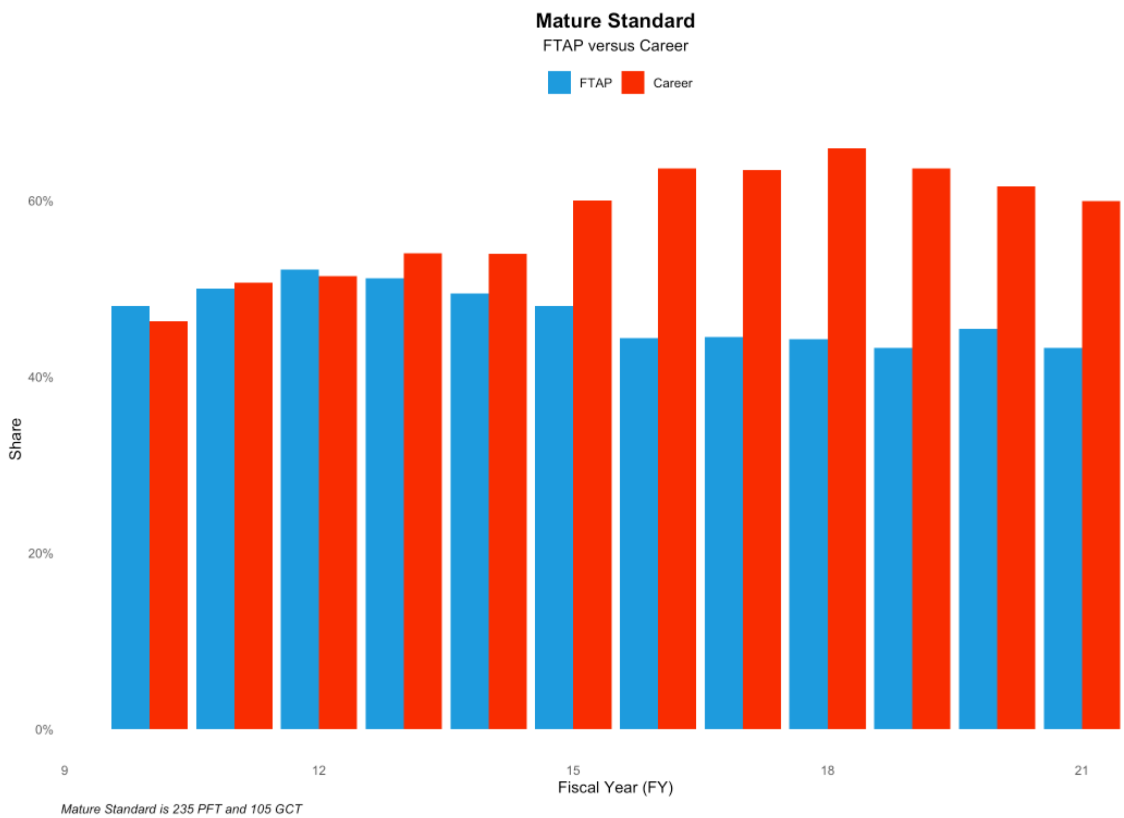


Figure 15. Mature Standard: FTAP versus Career

Lastly, we assess the FTAP and career populations against the mature standard of 235 PFT and 105 GT (Figure 15). Since FY 2014, career Marines possess a higher rate of meeting the mature standard than the FTAP population. This result is consistent with the output displayed in Figures 12–14, which showed a fitter and smarter population. Though beyond the scope of this thesis, the improved career performance after FY 2014 is likely the result of service wide force shaping measures, specifically end strength reductions. The Marine Corps reduced active-duty end strength from a peak of 202,000 in 2009—the height of combat operations in Afghanistan—to 178,500 by 2021 (Roaten 2021). Indeed, Figure 15 suggests that infantry retained fitter and smarter Marines through the force reduction process.

E. DISCUSSION

The secondary research question asks how increased physical and intelligence standards will impact the timeline to reach the mature state. In Chapter IV, we determined that the Marine Corps could reach the mature state by FY 2027, resulting in a smaller force that prioritizes career Marines over first term accessions. Applying increased physical and intelligence standards to the future force does not seem to impact the timeline to reaching the mature state, though actually producing a SOF-like infantry, as desired by senior leaders, requires further study beyond the scope of this thesis.

The descriptive figures above show the Recon/MARSOC population is fitter and smarter than the conventional infantry. These results are unsurprising due to occupational requirements, mission profiles, and the screening and selection process used within those communities. Though approximately half the conventional infantry meets minimum BRC requirements, Force Design 2030 prioritizes a mature force comprised of an increased proportion of career Marines. The differences between FTAP and the career infantry Marines are also apparent across varied performance metrics. Since the career population is already fitter and smarter than the FTAP cohort, applying a maturity quotient—as outlined in Chapter IV—will likely result in fitter and smarter force overall. Simply put, end strength reductions afford manpower planners and infantry stakeholders to institutional pathways to increase selectivity by raising physical and cognitive standards.

THIS PAGE INTENTIONALLY LEFT BLANK

VI. CONCLUSION AND RECOMMENDATIONS

The goal of this thesis is to determine if the future Marine infantry envisioned by Force Design 2030 is empirically feasible. The research seeks to answer the primary question about how the proposed 3:9 infantry squad maturity ratio—referred to as the maturity quotient—impacts the Marine Corps' timeline to reach a mature infantry. In support of the primary question, a secondary question is addressed to determine the impacts of reaching a mature state with increased physical and cognitive standards for the future infantry force.

The primary question is answered in Chapter IV, where the construction and cross-validation of a Markov chain model shows that the Marine Corps can reach the mature state by FY 2027. This requires gradual reduction in accessions from FY2022 to FY2027 and a total end strength reduction from approximately 27,000 to 23,000 03xx Marines. We generated these results using the Force Design 2030 infantry ASR and the 2027 GAR provided by Headquarters Marine Corps. In effect, our findings affirm the work conducted by manpower planners in support of Force Design 2030.

The secondary research question is answered in Chapter V. We find that the Marine Corps currently retains smarter and fitter infantry Marines but not at the level of the Recon/MARSOC community. Through data visualization and statistical inference, we identify a consistent performance gap between the conventional infantry and Recon/MARSOC and between FTAP and career Marines. Both Recon/MARSOC and career Marines possess higher AFQT, GT, PFT, and CFT scores. Critically, we find that career Marine performance improved during service-wide end strength reductions, suggesting that plans to shrink the total infantry will lead to a fitter and smarter career 03xx population. Lastly, career Marines meet a mature standard—derived from the BRC minimum standards—at higher rates than FTAP Marines, further suggesting that a mature infantry will be fitter and smarter.

A. RECOMMENDATIONS

We recommend that manpower planners prioritize gradual end strength reduction within the 03xx population to ensure consistent accession cohorts. Furthermore, we recommend the prioritization of by grade target vectors to realize the manpower requirements outlined in the Force Design 2030 infantry ASR and 2027 GAR. To develop an infantry capable of achieving the desired SOF-like label, we recommend increasing the minimum GT score for accession into the infantry. Given that the AFQT and GT scores are the common measure of cognitive ability, the Marine Corps should determine a new minimum requirement to be in the infantry.

B. FURTHER STUDIES

The following topics are recommended for future study:

- Identify the demographic impact of maturing the infantry. How will the increased emphasis on cognitive and fitness ability, coupled with end strength reductions, impact the demographic composition of the infantry?
- Analyze the impact of 03xx TIG reductions on entry, intermediate, and career level training and education.
- Analyze the impact of a SOF-like infantry on the existing MARSOC and Reconnaissance communities within the Marine Corps.
- Analyze the cultural impacts of maturing the infantry.

LIST OF REFERENCES

Alford, D. (2021, June). The Four-Block Littoral Force. *Marine Corps Gazette*.

Annunziata, M. B. (2018). Does the Marine Corps have a 'ready bench:' An analysis of the disparity between supply and operational demand. [Master's Thesis, Marine Corps University].

Bartholomew, D. J. (1971). The statistical approach to Manpower Planning. *The Statistician 20*(1): 3.

Berger, D. *Statement of General David H. Berger, Commandant of the U.S. Marine Corps before the Senate Armed Services Committee; Subcommittee on Readiness and Management Support*. (2020) (testimony of David Berger). https://www.armed-services.senate.gov/imo/media/doc/Berger_12-02-20.pdf.

Dausman, A. D. (2016). *Determine a retention model for the Selected Marine Corps Reserve.* [Master's thesis, Naval Postgraduate School]. NPS Archive: http://hdl.handle.net/10945/48510

Harkins, G. (2021, April 28). *The Marine Corps is known as a force of young warriors. That's about to change.* Military.com. https://www.military.com/daily-news/2021/04/28/marine-corps-known-force-of-young-warriors-thats-about-change.html.

Harper, S. A. (2021). *Marine infantry company lethality: An analysis of Force Design 2030 proposals*. [Master's thesis, Naval Postgraduate School]. NPS Archive: http://hdl.handle.net/10945/67734.

Headquarters Marine Corps. (2021). *2030 infantry battalions*. https://www.marines.mil/News/News-Display/Article/2708161/2030-infantry-battalions/.

Integrated Planning Team. (2020). *Infantry Battalion Design 2030*. USMC.

Kiras, J. D. (2006). *Special Operations and strategy from World War II to the war on terrorism*. Routledge.

Marine Corps Warfighting Laboratory. (2020). *Force Design 2030 infantry battalion experimentation plan assessment framework*. Marine Corps Warfighting Laboratory.

Moeller, J. E. (2019). *Optimization of the force generation process of Marine Corps infantry battalions*. [Master's thesis, Naval Postgraduate School]. NPS Archive: http://hdl.handle.net/10945/62856.

O.A. Momoh, A. Salihi. (2009). Application of markov analysis to manpower planning in a refinery: A case study of Kaduna Refining and Petrochemical Company Limited (KRPC). *Journal of Engineering and Technology* 4(2). https://www.bayerojet.com/wp-content/uploads/journal/published_paper/volume-4/issue-2/bjet_Pfwjvw69.pdf.

Nowicki, A. C. (2017). *United States Marine Corps basic reconnaissance course: predictors of success*. [Master's thesis, Naval Postgraduate School]. NPS Archive: http://hdl.handle.net/10945/53025

Reid, E. (2021). *The courage to change: Modernizing U.S. Marine Corps human capital investment and retention*. Brookings Institution. https://www.brookings.edu/wp-content/uploads/2021/06/FP_202106_28_courage_to_change_reid_v3-1.pdf.

Roaten, M. (2021, September 1). Marine Corps Commandant defends equipment divestment, end strength cuts. *National Defense Magazine*. https://www.nationaldefensemagazine.org/articles/2021/9/1/marine-corps-commandant-defends-force-size-divestment.

Saad, S.; Adnan, F.; Ibrahim, H. Rahim, R. (2013). Manpower planning using markov chain model. *AIP Conference Proceedings*. American Institute of Physics. https://libproxy.nps.edu/login?url=https://www.proquest.com/conference-papers-proceedings/manpower-planning-using-markov-chain-model/docview/1547471511/se-2?accountid=12702.

Sales, P. (1971). The Validity of the markov chain model for a class of the civil service. *Journal of the Royal Statistical Society: Series D (The Statistician),* 20(1): 85-110. https:/doi.org/10.2307/2987007

Taylor, J. E. (2020). *Direct officer accessions: Effecting the timeline for establishing a cyber-community within the Marine Corps*. [Master's thesis, Naval Postgraduate School]. NPS Archive: http://hdl.handle.net/10945/64886.

Trivedi, V. ; Moscovice, I.; Bass, R. ; Brooks, J. (1987). A semi-markov model for primary health care manpower supply prediction. *Management Science,* 33(2). https://libproxy.nps.edu/login?url=https://www.proquest.com/scholarly-journals/semi-markov-model-primary-health-care-manpower/docview/823567123/se-2?accountid=12702.

United States Marine Corps. (2010). *Enlisted retention and career development program (*Marine Corps Order 1040.31). Washington, DC: HQMC. MCO. https://www.marines.mil/Portals/1/Publications/MCO%201040.31.pdf.

United States Marine Corps. (2014). *Classification testing* (Marine Corps Order 1230.5C*)*. https://www.marines.mil/Portals/1/Publications/MCO%201230.5C.pdf.

United States Marine Corps. (2019). *Commandant's planning guidance*. Washington, DC: USMC. https://www.hqmc.marines.mil/Portals/142/Docs/%2038th%20Commandant%27s%20Planning%20Guidance_2019.pdf?ver=2019-07-16-200152-700.

United States Marine Corps. (2020). Marine Rifle Squad. https://www.marines.mil/Portals/1/Publications/MCIP%203-10A.4i%20wChg1.pdf?ver=2020-05-22-085455-150.

United States Marine Corps. (2021a). *Force Design 2030: Annual update*. Washington, DC: United States Marine Corps.

United States Marine Corps. (2021b). *Talent management 2030*. Washington, DC.

United States Navy. (2019). *Chief of Naval Operations FRAGO 01*. https://media.defense.gov/2020/Jul/23/2002463491/-1/-1/1/CNO%20FRAGO%2001_2019.PDF.

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