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PLANNING AND INVESTING FOR A MARITIME RECONNAISSANCE STRIKE COMPLEX: THE U.S. NAVY IN THE 21ST CENTURY

by

Paul F. Healy

June 1994

Co-Advisors: Gregory G. Hildebrandt
Jan S. Breemer

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Currently, three factors are re-shaping the U.S. Navy as it enters the 21st Century. First, as a result of the end of the Cold War, a new strategic direction has been mapped out by the Navy in "... From the Sea." Secondly, with the dramatic advances in microcomputers and information technologies, the Navy has the opportunity to embark on a "Military Technological Revolution." Lastly, significant resource constraints will limit the Navy's ability to develop, procure, and maintain forces.

This study considers the implications of these three factors for the development of a Maritime Reconnaissance Strike Complex (MRSC). Forces incorporated within an MRSC are then analyzed and compared in terms of capital value and operating and support costs. The results provide one approach to developing an investment strategy for future forces in an era of limited resources.

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by

Paul F. Healy
Lieutenant Commander, United States Navy
B.S., U.S. Naval Academy, 1982

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Author: ______________________________
Paul F. Healy

Approved by: ______________________________
Gregory G. Hildebrandt, Co-Advisor

____
Jan S. Breemer, Co-Advisor

____
David R. Whipple, Chairman
Department of Systems Management

ABSTRACT

Currently, three factors are re-shaping the U.S. Navy as it enters the 21st Century. First, as a result of the end of the Cold War, a new strategic direction has been mapped out by the Navy in "... From the Sea." Secondly, with the dramatic advances in microcomputers and information technologies, the Navy has the opportunity to embark on a "Military Technological Revolution." Lastly, significant resource constraints will limit the Navy's ability to develop, procure, and maintain forces.

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I. INTRODUCTION

A. BACKGROUND TO THE RESEARCH

Over the past three years, the United States Navy has had to dramatically shift its vision of how the service will contribute to the future defense of the country. In an era of unfolding world events only recently thought highly unlikely or altogether impossible, the Navy is having to completely re-evaluate its purpose, missions and force structure. Enemies that for years, presented a formidable, yet predictable, challenge to the national security of the United States, have ceased to exist. In their place, less formidable but also less predictable foes have attracted the attention of defense planners.

In addition to the dynamic changes occurring on the geopolitical scene, domestic concerns over the burgeoning federal debt have prompted a significant decline in funding for the armed forces. Programs and weapons systems deemed necessary only a few years ago are being dramatically reduced or cancelled altogether. Personnel drawdowns are occurring at a rate few believed possible only a short while ago. Military bases and facilities, whose existence seemed permanent in the communities in which they were located, are being closed down.

Technology, too, is changing rapidly. The conduct of Operation Desert Storm portends what many believe is a

Military Technological Revolution (MTR). This MTR is expected to completely reshape the way the military will fight its next war. The MTR will produce advances in sensors, communications, "smart weapons" and electronic warfare, that will provide commanders with abilities and "force multipliers" never before available. Missions that took hundreds of aircraft sorties to complete may now be accomplished by a single highly accurate cruise missile or precision guided munitions (PGMs). The implication of these advances is that traditional measures of military strength (mass, mobility, reach and firepower) are being replaced by new criteria that aim at "information dominance." This will dictate, in turn, the tempo and timing of operations with highly lethal and accurate weapons. (Wolfert, 1993, p. 6)

B. OBJECTIVE OF THE RESEARCH

Faced with a dynamic geopolitical world, fiscal constraints, and a MTR, how should the U.S. Navy proceed to plan for and invest in the force of the future? What should be the size, composition and cost of the future Navy and how might it be streamlined? Needed is a long-range resource investment plan. This thesis hopefully contributes some insights into developing such a plan.

One military organizational concept, originally developed by the Soviet military leadership, and discussed in the next chapter, is to build forces around a "Reconnaissance-Strike

Complex" (RSC). Composed of a "highly integrated and automated system of reconnaissance, control systems and firing platforms," the RSC way of envisioning naval forces of the future seems to suit the needs of military planners in an era of diminished resources, dynamic world geopolitics and rapid technological change. (Hazlett, 1993, p. 2) As is analyzed in Chapters V and VI, forces organized as a RSC can be more cost-efficient and effective. Their mission will be to "turn inside the enemy's decision cycle" and prevail in combat in the five battle space environments of the future-air, land, sea, space, and the electromagnetic spectra. (Tuttle, 1992, p. 9)

C. RESEARCH QUESTIONS

This thesis addresses these specific questions:

1. How might the U.S. Navy of the early 21st century differ from today's force with regard to size and composition, and how much will it cost in capital investment and operating and support costs?

2. What is the range of capital and operating and support costs for a U.S. Navy configured around the concept of an "maritime" RSC (MRSC)?

3. Assuming a continuing trend of diminished resources for procurement and operating and support costs, how might the ratio of operating and support costs to capital value change?

4. What challenges are encountered in attempting to estimate costs for an MRSC, and how might these challenges be resolved to promote a better understanding of the relationships between the size, composition, and cost of an MRSC?

D. SCOPE, LIMITATIONS, AND ASSUMPTIONS

This thesis limits consideration of the potential components of a MRSC to Navy and Marine Corps afloat assets that typically forward deploy. It does not include any land-based forces, but operating and support costs of shore-based support infrastructure of afloat assets are included. Two MRSCs are reviewed: one called MRSC-Desert Storm (MRSC-DS), and a projected force in the year 2015, called MRSC-2015. Forces organized around an MRSC are designed to cope with a Major Regional Conflict (MRC), and do not address other contingencies, e.g., strategic deterrence, peacekeeping/special operations, or peacetime forward presence; all could place additional requirements on ship types and numbers. In addition, this research does not consider the contributions of Maritime Prepositioning Ships, Allied forces, or Military Sealift shipping.

This thesis does not attempt to determine spending levels for individual service appropriation accounts, but rather provides a Department of Defense-wide view of the funding needs in the broad areas of capital investment (e.g., procurement and research and development) and operating and support costs to field an MRSC. However, the discussion includes references to these individual accounts. Cost data generated in determining costs associated with the space-based portion of an MRSC are of a rough order of magnitude;

estimates are not considered to be as accurate as the costing associated with Navy and Marine Corps forces.

It is assumed that the reader of this thesis has a working knowledge of Navy programming and budgeting concepts, and the current (1994) size and composition of the U.S. Navy, and that he/she is familiar with the Navy's contribution during Operation Desert Storm.

E. APPROACH AND METHODOLOGY

This research is limited to unclassified sources only. Data are gathered from Department of Defense (DOD) documents, trade journals, books, articles, and various studies and reports. Sources also include input from National Defense University personnel, the Congressional Budget Office, Air Force Space Command and the Center for Naval Analyses. In determining operating and support costs, the Quick Cost Model is utilized.

F. RECENT U.S. NAVY STRATEGIC CONCEPTS

Over the past several years, the Navy's strategic concept has changed at a bewildering pace. In the 1970s, the concept stressed defense of the transatlantic "seabridge" in support of a conventional NATO-Warsaw Pact war in Europe. The "Maritime Strategy" of the 1980s emphasized "forward operations" by a 600-ship fleet against the Soviet fleet in home waters. Since then, "The Way Ahead" and finally "... From the Sea" have taken the Navy away from a preoccupation with a "global blue-water engagement" with the Soviets, to planning for regional conflicts in littoral waters. Some people claim that "land control" has replaced "sea control" as the Navy's principal task. (Breemer, 1994, p. 49) The DOD document "The Bottom Up Review," completed in September 1993, has reaffirmed the Navy's role in projecting power "... From the Sea."

1. The Maritime Strategy (MS)

This strategic concept of the 1980s originated with the efforts of Chief of Naval Operations (CNO) Admiral Thomas B. Hayward, in the 1970s, to develop an offensive naval strategy aimed at forward operations in Soviet home waters. The classified version of the MS was published in 1984; its unclassified counterpart appeared in January 1986. (Hattendorf, 1988, p. 17) It portrayed an "era of violent peace," in which conflict could rapidly escalate from peace-time naval presence, to a crisis, and ultimately, global war. The "threat" was a Soviet Navy designed to protect the Soviet homeland and its ballistic missile submarines, while Soviet ground and air forces staged a massive offensive against NATO-Europe. The MS called for U.S. Navy forces to respond through a series of successive phases: first, deterrence; next, taking the initiative should deterrence fail; thirdly, taking the fight to the enemy; and finally, war termination. (Watkins, 1986, pp. 9-13)

The MS was to have been built around a U.S. Navy of 600 ships, including 15 aircraft carrier battle groups (CVBGs), 100 nuclear powered attack submarines (SSNs), and four battleship surface action groups (SAGs). Then-Secretary of the Navy John Lehman emphasized this point when he defended the 600 ship Navy as a means to support a strategy that was ..."global, forward deployed and superior to our probable opponents." (Lehman, 1986, p. 36)

2. The Way Ahead

With the collapse of communism in Eastern Europe and the crumbling of the Berlin Wall in late 1989, a fundamental shift in the balance of military power occurred. In an effort to adapt to this change, the Navy promulgated "The Way Ahead." It was designed to support President Bush's National Security Strategy of deterrence, forward presence, crisis response, and force reconstitution. The Navy recognized that it had to shift its focus away from a single global threat to a multi-threat regional environment, and that the MS emphasis on oceanic operations had become incompatible with the shallow water, confined operating environments that were likely to characterize future regional conflicts. (Garret, 1991, p. 38). The presence of nuclear powered aircraft carriers in the Persian Gulf and Red Sea during "Desert Storm" exemplified the Navy's dramatic departure from the open ocean engagement scenarios of the MS.

3. From the Sea

In September 1992, the Navy completed its doctrinal disengagement from the MS, and embraced an entirely new concept entitled "...From the Sea" (FTS). Focused on "littoral warfare" and "operational maneuver from the sea," FTS's "strategic direction" represents a fundamental shift from the open-ocean warfighting on the sea toward joint operations conducted from the sea. (O'Keefe, 1992, p. 2) This shift means, among other things, direct instead of indirect participation by naval forces with other forces in penetrating land defenses.

The Navy's new focus on war on land has brought an entirely new set of challenges. Problems such as "piercing the littoral fog" and trying to "remove the fog of battle" in a totally new environment with far more numerous contacts and additional complexities (e.g., shallow, small bodies of water, land based threats such as short-range missiles, friendly as well as unfriendly forces etc.) need to be resolved. This will require improved battle management and interoperability, command, control and communications (C3), etc. Near-land capabilities, and Theater Ballistic Missile Defense (TBMD) are among the many challenges and opportunities that need to be appreciated and built into naval warfare forces of the future.

Another different direction for the Navy centers around its historic role as a forward-deployed expeditionary "presence" force. The traditional building block of the U.S.

Navy, the aircraft carrier battle group (CVBG), will henceforth serve as the centerpiece of a new afloat organization, called the Naval Expeditionary Task Force (NETF). An NETF can be broken down further into smaller Task Groups (TGs), centered about either a large amphibious ship or a large deck aircraft carrier. Joint Expeditionary Force "packages," with a mix of different assets, are to be "tailored" to provide commanders with the right type of forces for different missions. The direct link between the aircraft carrier and its air wing has been softened to allow a broader mix of embarked capabilities (i.e., Marine Corps aviation). New initiatives to ensure air superiority in and about littoral waters, including long-range precision strike or standoff weapons, have come into focus. SSNs that were previously employed in mostly an independent manner against the Soviet blue-water fleet, are to be integrated into task forces, and are to be capable of shallow water anti-submarine warfare (ASW). Surface combatants which have thus far principally been employed in support of the carriers, will be used more flexibly in new roles. All in all, the Navy is set for a new direction in operational capabilities, notably in the areas of command, control, and communications, battlespace dominance, power projection and force sustainment.

4. Force 2001

FTS's vision has been translated into a programmatic framework, entitled "Force 2001: A Program Guide to the U.S.

Navy", published in July 1993. Besides incorporating the new concept of expeditionary warfare, it also details the reorganization of the Navy staff, notably the subordination of the three platform "barons" (CVs, surface combatants, and submarines), under a single "Navy voice." (Kelso, 1993, p. 21) Along with the staff reorganization, a Joint Mission Area (JMA) Assessment process has been established. It is designed to ensure that six mission and two support areas are matched more efficiently and effectively in terms of required capabilities and fiscal limitations. New programmatic thinking is also evident, notably in the areas of standoff and sensor-fuzed weapons, shallow water anti-submarine and mine warfare, naval surface fire support, surveillance, and TBMD.

5. The Bottom Up Review

Initiated in March 1993, "The Bottom Up Review" (BUR) provides a blueprint for planning and implementing a national military strategy for the 21st century. It incorporates three fundamental principles. First, U.S. forces, alone or allied with friendly countries, are to be able to fight and win two nearly simultaneous Major Regional Conflicts (MRCs). Second, the U.S. is to retain its status as a world power, and not return to isolationism. And finally, the United States will maintain the fighting readiness of its armed forces. (Aspin, 1993, pp. 1-2)

According to the BUR, the threats that face the U.S. now and in the near future are the dangers posed by nuclear weapons and other weapons of mass destruction (WMDs), regional dangers, dangers to democracy and reform, and economic dangers. The BUR proposes a balanced force mix for addressing each of these challenges at a cost that will not undermine the nation's ability to bolster its economy as it faces more aggressive competition on a global scale. Using a "building block" methodology, the BUR defines four broad classes of potential military operations: MRCs, smaller scale conflicts or crises, overseas presence, and deterring attacks by WMDs.

For each of the major threats, the BUR offers a vision on how the Navy will structure its future forces. It echoes and reinforces FTS, by highlighting the service's re-orientation away from "blue water" towards the initiatives for coping with sea, air, land, and space threats in near-land areas. In addressing new nuclear dangers, counterproliferation efforts are to include upgrading of general purpose and special operation forces, as well as the development of cruise missiles and TBMD to protect forward-deployed forces. In order to deter regional dangers, overseas presence, including the permanent stationing or long-term deployment of U.S. maritime forces, joint training with allies, and prepositioning of equipment are emphasized.

U.S. maritime forces have the ability to quickly deploy and concentrate and engage in most any area of the world. They therefore seem well-suited to carry out the BUR's four phases of sea-land combat. These include:

Phase 1: Halting the invasion. This would include delaying and disrupting of enemy ground forces by land and sea-based strike weapons, including aircraft armed with "smart munitions" and unmanned standoff weapons. TBMD of friendly forces, possibly from surface ships or submarines, and establishment of air superiority by carrier-based aircraft, are to allow other maritime forces to engage and destroy high value targets, and achieve and maintain sea-air-land-space superiority.

Phase 2: Isolation and destruction of enemy forces.

Phase 3: Counteroffensive operations, including flanking maneuvers, Marine amphibious invasions, and use of air power with PGMs for deep interdiction strikes, complemented by special forces operations and sea-based fire support.

Phase 4: Underwrite the post-hostility stability of the region by, for example, the continued presence of naval forces.

In planning forces for the future, the MRC "building block" approach was developed to also include force "enhancements," which upgrade the carrier's strike potential through modification of aircraft and PGMs.

6. Global Presence

As the Navy's carrier force levels have declined, much concern has been expressed over the possible negative impact on regional stability, notably the U.S. ability to respond to or deter Third World crises. (O'Rourke, 1991, p. 1) Traditionally deployed in the three "hub" areas, i.e., the Mediterranean Sea, Indian Ocean, an the Western Pacific, carriers have been the mainstay of U.S. presence and influence in these regions. Questions are: What areas will be least affected by the carriers' departure? Can surface or amphibious ships be adequate substitutes, etc. Possible solutions, such as relocating carriers to overseas homeports, increasing personnel tempo, added reliance on land-based aircraft or ground forces, or increased allied participation, have all been considered. (O'Rourke, 1991, pp. 2-3)

In an effort to solve the problem and adhere to fiscal constraints, a force level of 11 active and one reserve/training carrier has been agreed upon. Aviation-capable amphibious ships with AV-8B attack jets and attack helicopters, and Aegis-equipped surface ships, will play a more prominent role. These forces are to be complemented by SSNs and maritime patrol aircraft. "Adaptive Joint Force Packages" are being developed in an effort to take greater advantage of the assets of other services. (Aspin, 1993, p. 25)

7. Forces for the Future

Traditional military force structures and organizations may not be suitable for the post-Cold War geopolitical environment. In order to remain effective, the U.S. needs forces that can not only win wars, but also, and even more important, deter conflict.

Forces of the future will need to exhibit less raw military strength (mass, firepower, etc.), but be tailored instead to influence the direction of geopolitical events. (Rothrock, 1993, p. 2). Issues such as the guerilla war in Bosnia and the Iraqi repression of the Kurds are as likely to occur in the future as "conventional" military aggression. If the Cold War could be thought of as a "heavyweight boxing match" between the United States and Soviet Union, today's situation is analogous to a "kickboxing match," with more ways to attack, or be attacked, by far more numerous potential opponents. (Rothrock, 1993, p. 2)

Simply downsizing the forces of the 1980s and early 1990s will not be the answer to present and future challenges. Instead, the smaller forces fielded need to be more effective and provide "leverage," if the United States is to remain credibly engaged on the world scene. Leverage depends not only the explicit displays of wealth and military power, but also includes the implicit concerns of a nation's political tolerance for risk and suffering. (Rothrock, 1993, p. 3) In the "Information Age" the United States is more exposed and vulnerable, and has more to lose strategically than a third world aggressor. Even minor enemy military successes (e.g., the tragic loss of 28 lives at the Army Reservist's barracks during the Persian Gulf War) can have disproportionate consequences for the image of U.S. military prowess. Rather than trying to provide an "arithmetic" response of simply assigning additional units to a battle the United States may not want to fight, the Nation should concentrate on trying to "shape the conflict" to its advantage with forces available, and thus avoid the "pitiful giant" syndrome. (Rothrock, 1993)

New political, economic and technological realities... especially sensitivity to casualties (even the enemy's), undermine the credibility of U.S. traditional "strength" (attrition) strategy. (Rothrock, 1993) As a result, stealthy platforms such as submarines and aircraft will continue to be needed in the implementation of U.S. defense planning designed to minimize exposure of forces while still effectively carrying out assigned missions.

What then, are the implications for U.S. force structure of the future? As downsizing occurs, how does the United States "rightsize" its forces? Useful initiatives should include:

- limit the density of forces that are exposed to enemy lethality by achieving through standoff platforms many of the objectives traditionally achieved in situ.
- limit the logistics presence exposed.
- increase the spectrum of non-lethal options to deal with situations where the conflict itself is the enemy (e.g., Balkans).
- assure continued U.S. supremacy in space. (Rothrock, 1993)

Strategy and force planning initiatives viewed from an Air-Land-Sea perspective will evolve towards an Air-Land-Sea-Space-Electromagnetic Spectrum. Although innovations through technology, doctrine and organization on earth will partially answer the "rightsizing" questions of the future military, U.S. forces are still subject to highly lethal enemy capabilities (as the result of technology transfers). It is in space where the United States will be technologically able to achieve the effects of mass without the vulnerabilities of density. (Rothrock, 1993)

8. Summary

In this introductory chapter, recent U.S. Navy strategic concepts have been discussed. In the next chapter, the MTR is discussed and the concept of the MRSC is introduced. Chapters III and IV present force structures illustrating the MRSC concept. Chapter V contains a detailed analysis and comparison of the two MRSCs with regard to capital value and operating and support costs. Chapter VI is a summary, recommendations, and conclusion.

II. THE U.S. NAVY AND THE MTR

A. INTRODUCTION

U.S. military forces stand on the brink of what many specialists have described as a Military Technological Revolution (MTR). (Goure, 1993, Mazarr, 1993) Some characteristics of this MTR include the following:

- "real time" exploitations of battlespace information;
- small, lightweight, extremely powerful microcomputers;
- stealth technologies;
- spaced-based assets.

Military forces can exploit a MTR only through appropriate organizational and doctrinal changes, and not by relying solely on technological advancements.

Insofar as the U.S. military adopts the MTR model for force development, the U.S. Navy will play a significant role. In an era of fiscal restraint, that role will be limited by the cost of the resources associated with Navy participation. This chapter spells out the potential of the MTR, and sets the groundwork for the cost estimating process pursued in the following chapters.

B. IMPLICATIONS

What are the implications of the MTR, and what influence will it have on the U.S. military of tomorrow? A recent study defined an MTR as "...a timely combination of innovative technologies, doctrine, and military organizations that is reshaping the ways in which wars are fought." (Mazarr, 1993, p. 1). When hearing the term, one envisages military forces operating with technologically advanced weapons. Yet, a great deal more than weapons alone are involved. Take, for example, the German blitzkrieg in the opening days of World War II. By utilizing a weapon already known to the Allies, the tank (first introduced by the British during World War I), and organizing it into Panzer divisions together with close air support (the airplane had also been used extensively during World War I), the Germans achieved phenomenal success against France in 1940. (Goure, 1993, p. 175) The French owned roughly as many tanks as the Germans, some of which were superior to the German ones. The difference was that the French army had failed to grasp the "revolutionary capability" that could be attained by giving the tank its own "logic," i.e., a doctrine and an organization to maximize its potential as a combat weapon. Instead of employing the tank as a separate striking arm, the French used it as another infantry support weapon to be spread around the battlefield. (Arguilla, 1993, p. 163)

The current use of the term "Military Technological Revolution" can be traced back to Soviet military thought in the early-1980s (Fitzgerald, 1993, p. 3). Western interpreters have defined the MTR as involving "the innovative application of advancing technology in the form of new capabilities at the levels of doctrine, strategy, operational art, tactics, organization, and training in order to achieve significant improvements in military performance." (Goure, 1993, p. 178) More than just technological innovation and novel equipment is involved. A MTR implies a "quantum leap" in the utilization of military capability.

One way to look at the concept of an MTR is to consider the "catalytic" effect of technological advancement in weaponry on military doctrine and organization. In this sense, an MTR can be defined as a fundamental advance in technology which acts as an "engine of change" for the way wars are fought. (Goure, 1993, p. 177)

1. An Historical Perspective

Technological advancement is, by definition a prerequisite for a military-technological revolution. Technological innovation over the centuries has included gunpowder, muskets and cannons, the mechanization of war, wireless communication, and most recently, electronic and nuclear capabilities. All were true advances in technological capabilities, but only when they were combined with organizational and doctrinal changes did those technologies revolutionize the conduct of war.

In his book, From Gettysburg to the Gulf and Beyond, Richard J. Dunn provides some historical examples of how technological innovation, coupled with organizational and doctrinal changes, can dramatically change the nature and paradigm of warfare. Another example were the heavy battlefield casualties of the First World War, when as a result of dramatic improvements in the accuracy and lethality of artillery, barbed wire, and the machine gun, frontal assaults against a well-prepared defender became futile. (Dunn, 1992, p. 16)

These examples point out how technological innovation, when combined with changes in organization and doctrine, can overturn the way wars are fought. Three steps are involved:

- First, the technological "engine of change" must provide some new opportunity which can be exploited against an enemy on the battlefield.
- Second, technological innovation must be recognized and articulated. A "sponsor" with a vision as to how wars in the future will be fought needs to promote the concept.
- Third, an individual or body of individuals who is in a position of authority to change how things are done needs to grasp the opportunity, and re-orient current doctrine and organizations towards a new paradigm. (Dunn, 1992, p. 17)

Then, and only then, will evolutionary technological change be transformed into revolutionary change in warfare concepts, and become a "Military Technological Revolution".

2. The MTR on the Military Paradigm

In presenting the concept and implications of the MTR, one approach is to discuss its "elements." These include: (1) an integrating framework (doctrine and organization), (2) a set of enabling capabilities (information dominance, command and control, simulation, training and agility), and (3), an array of executing capabilities (strike systems, such as smart and exotic weapons and major platforms). (Mazarr, 1993, p. 18) These elements may be envisioned as constituting a "pyramid," in which doctrine and organization are the foundation, the enabling capabilities are the middle layer, and the executing capabilities are at the top. The importance of each element's revolutionary contribution can be envisioned in terms of the area of the pyramid which each element occupies. The point is that doctrine and organization are the most influential.

Doctrine and organization need to be tailored so that each technological advance can be employed to the maximum advantage. It requires leadership with the ability to look into the future and conceptualize how the next war will be fought. A new strategy based on "information dominance" can set the stage for new doctrinal approaches for all warfighters. (Wolfert, 1993, p. 2) These concepts and approaches will be framed by understanding and integrating reconnaissance, surveillance and target acquisition (RSTA) systems, developing new command and control options and strategies, and adopting new organizational structures. (Wolfert, 1993, p. 2) Service parochialism, proponents of specific platforms, and traditional roles and missions need to be completely re-evaluated if there is to be an honest effort in assessing how wars of the future will be fought. As one expert concluded recently: "...overcoming this parochialism may require strengthening further the joint elements of our armed forces so that both the unique and the overlapping capabilities of the services can be quickly accessed and utilized; i.e., ensuring that the most cost-effective mix can be effected rapidly when needed." (Krepinevich, 1994, p. 9)

Doctrine has traditionally lagged behind new weapon systems and technologies (Goure, 1993, p. 175). If doctrine and organization are the "horse" and technology advances in weapon systems the "cart," military planners have all too often put the cart before the horse. The French use of the machine gun as a field piece during the Franco-Prussian War is an example. (Arquilla, 1993, p. 153) Yet there may be good reasons why the cart is commonly placed before the horse: it is usually only in war, that the doctrinal implications of novel weapons become evident.

The true challenge comes in trying to develop doctrine and an organization that recognize and keep up with technological change. In his book Race to the Swift, Richard Simpkin discussed this problem. He found a 50-year cycle of innovations in battlefield mobility and theorizing, and compared this with an organizational inertia of 30-50 years, i.e., it was 30-50 years between the time a radical change in equipment appeared and its full-scale employment. (Simpkin, 1985, p. 5) He attributed most of this to the time it takes for "innovating officers" to rise through the ranks to a position of influence and leadership. Perhaps this is also partially due to the episodic demands placed on the military environment compared with the steady demands for change in the commercial sector. (Goure, 1993, p. 177)

With the technological capabilities envisioned in the MTR, shifts in emphasis are occurring that need to be appreciated. "Precision warfare" is expected to emerge as the successor to maneuver warfare, not making it obsolete, but incorporating into the maneuver concept new forms of battlefield lethality and visibility. (Dunn, 1992, p. 39) New technologies will further erase the sharp boundary between sea and land. (Odom, 1993, p. 53) The result will be for the Navy to further project power inland, as envisioned in FTS.

Space and electronic warfare (SEW), and the destruction or neutralization of enemy SEW targets in the five environments (space, air, land, sea, and the electromagnetic spectrum) will continue to gain importance. (Tuttle, 1992, p. 7) In broad terms, warfare support and warfare disciplines will help maintain control of space to enhance battle management capabilities. If an enemy becomes deaf, dumb and blind, confusion results, and he becomes a relatively easy target for precision interdiction and strike. (Goure, 1993, p. 180)

Joint operations and a joint doctrine will continue to grow in importance. Extended strike campaigns may emerge, with round-the-clock operations, using a wide range of joint capabilities, and providing the ability to strike at a wide variety of targets. (Mazarr, 1993, p. 34) Mobility and flexibility of forces will need to be considered, and their proximity to weapons of mass destruction must be minimized. As a result, lighter equipped forces, tailored to existing lift capabilities, will need to be incorporated into doctrine. (Mazarr, 1993, p. 34)

With dramatic improvements in communication and command and control, a temptation on the part of commanders far from the front may be to "micromanage" local and tactical operations. Doctrinal changes will need to be incorporated to address these issues. (Odom, 1993, p. 50)

Organizational challenges occur as a result of the MTR. Military organizations have traditionally resisted change. Unlike the commercial world, where both technical and organizational innovation occur more rapidly, the military environment is slow to change. (Goure, 1993, p. 182) Part of the reason is that commercial organizations, which maximize output for a given input, are inherently efficient. Military organizations concentrate predominantly on effectiveness, rather than efficiency. Mission accomplishment, "victory at any cost", has been the norm. One of the challenges of the MTR is for the military to become <u>both</u> efficient and effective.

The traditional, vertical or pyramidal organization of the past will become unworkable. Rather, a "Hi-Flex" organization may evolve, providing tactical commanders (line managers) with a molecular vice pyramid-shaped hierarchy, allowing them to operate more freely. (Ross, 1990, p. 25) This would allow for many traditional headquarters level decisions to be deferred to field commanders, thus empowering the latter with added flexibility, efficiency, and effectiveness. The result would be to put control where the operation is, to enhance "real time" decision-making, and to encourage the ability to contribute. (Ross, 1990, p. 25)

Innovative force packages and composite air wings symptomize the emergence of force structures with more flexible, multiple combat teams. (Mazarr, 1993, p. 35) This trend will continue as the four services combine assets to conduct attack operations with the maximum efficiency and effectiveness. (Kendall, 1992, p. 26)

Special operations forces, lightly equipped and non-traditional in make-up, will probably play a larger role in future operations. Less reliant on logistics and supply, they will have enhanced ability to seize key objectives or prepare the battlefield for future operations in a quick and covert manner. More technologically current equipment, with a reduced development and production cycle, will provide frontline units added capabilities in a more timely manner.

3. Information Dominance and Command and Control

No area of modern warfare is experiencing such as dramatic a change as information systems, and command and control. With the technological advances of the microchip, large processors and microcomputers, capabilities previously thought unimaginable are now coming to fruition and into practical use. Sea changes are occurring in how information is collected, stored, processed, and how organizations are designed to take advantage of increased information. (Arquilla, 1993, p. 143) The revolution in data processing and communications capabilities is now reducing the entire series of activities involved in information transfer to near real-time proportions, and is expanding the availability to users. (Kendall, 1992, p. 25) These advances have the capability of providing the commander with the means to "dispel the fog and friction of war" described by Clauswitz. The ongoing revolution in military affairs is rooted firmly in the Information Age. (Franck and Hildebrandt, 1993, p. 2)

Technology has now made it possible to provide near-real time situational awareness and information to all warfighters, providing them with a degree of confidence and detail only dreamed of by past commanders. (Wolfert, 1993, p. 1) Future developments will provide a commander the opportunity to view the entire theater's battle space instead of the area bounded by the visual and tactical radar horizon. The Navy's SEW architecture will be constructed as an interactive framework that ties together the command and control process of afloat tactical commanders, such as the Naval Tactical Communication System Afloat (NTCS-A), with the CINCs (Commander-In-Chiefs) and supporting shore establishment. (Tuttle, 1992, p. 23)

Creation of an "Information Combat" Based Strategy, including the establishment of common formats, protocols and standards of information, optimal approaches to information fusion, and development of a strategy for the fusion and dissemination of information and knowledge, will be essential. (Wolfert, 1993, p. 14) Perhaps the creation of an "Information Corps," designed to accommodate these advances will be appropriate. (Hazlett and Libicki, 1993, p. 88)

Great strides in intelligence collection capability have been made and will continue to occur. Sensor systems, such as ground and airborne radars, forward-looking infrared, long-range electroptics, and satellites, will have the ability to peer over distances and through the night, smoke, fog, clouds and camouflage to lay bare the smallest details of an enemy's disposition. (Dunn, 1992, p. 31) With these capabilities, integration of intelligence collection with target sensing platforms will occur, providing a set of battlefield-wide "virtual forward observers," able to direct fire on targets immediately. (Kendall, 1992, p. 26) This capability can do a lot to remove uncertainty in warfighting, in that it allows the warfighter to move quickly through the decision cycle of observing, orienting, deciding and acting. (Wolfert, 1993, p. 8)

By providing real-time information useful to the attacker, ambiguity and uncertainty are reduced, allowing quicker and more lethal action on the part of the warfighter by allowing him to "turn inside the enemy's decision cycle." While enhancing this effort, attention will need to be paid to denying this capability to adversaries through the manipulation or disruption of the enemy's information loop.

Space will play an increasingly large role in information dominance, and command and control. Handheld navigational devices, utilizing data from Global Positioning System (GPS) satellites, allow forces to accurately navigate over unfamiliar or foreign terrain. "Space lines of communication" will be established and will need to be sustained and defended. (Rothrock, 1993) Reconnaissance, surveillance, target acquisition (RSTA) assets in space, combined with Airborne Warning and Control (AWACs), Joint Surveillance Target Attack Radar Systems (JSTARs), and Unmanned Aerial Vehicles/Remotely Piloted Vehicles (UAVs/RPVs), will need to be horizontally and vertically linked so that better cross-cuing and immediate identical displays can be used by air, ground and sea-base command centers. (Wolfert, 1993, p. 12)

4. Simulation and Training

Due to the more complex and involved technologies with which military forces must deal with, training will become even more important. Advances in simulation technology will afford forces the opportunity to conduct training previously requiring expensive field exercises. Simulation technologies, including the evolving technology of virtual reality, will allow mechanized units, from platoon to battalions, to practice moving and fighting together as cohesive units; naval elements to work together as a battle group; and special operations forces to rehearse a mission in minute detail. (Mazarr, 1993, p. 39) One lesson of the Gulf War was that military personnel must be more intensively trained than ever before. (Odom, 1993, p. 54)

5. Agility

Agility can be defined as the ability of a force to act faster than the enemy. (Dunn, 1992, p. 64) Existing problems with the new C-17 aircraft, the advancing age of the C-141 transport, and a reduction in amphibious and sealift capability, have created a movement issue with the potential for serious consequences. (Mazarr, 1993, p. 40)

Solutions include the design of smaller, lighter weapons, capable of being transported in large numbers. (Mazarr, 1993, p. 40) More radical would be a change in the composition of forces that would be deployed to fight the next conflict, by, for example, placing a heavier burden on afloat strike assets, and less on land-based assets (heavy armored units). (Rubright, 1992)

6. Strike Systems/Major Platforms

Critical advanced capabilities of sensors for broad area search with targeting quality resolution, combined with near real-time data processing and communications to support mission planning for attack execution, can provide a quantum improvement in the efficiency with which forces can be applied on the battlefield. (Kendall, 1992, p. 25) Utilizing these sensor inputs, weapons like the Joint Standoff Weapon (JSOW) (a navalized version of the Army Tactical Missile System (ATACMs)) with improved range, will greatly enhance precision strike capabilities against Critical Mobile Targets (CMTs), such as enemy air defenses, SCUD-like missile launchers, or artillery and coastal defenses. Older platforms, carrying precision guided munitions (PGMs) such as the Joint Direct Attack Munitions (JDAM), will be capable of destroying even mobile-point targets almost as soon as they are detected. (Dunn, 1992, p. 26)

In addition to ensuring destruction of key targets, such as command and control, logistics and supply points, advanced strike weapons maximize lethality, yet minimize the destruction to the surrounding area. This provides useful benefit for targets that are in an area of civilian population centers. (Mazarr, 1993, p. 41)

Along with the offensive striking power of precision weapons, emphasis must also be placed on the defensive benefit of providing TBMD from land as well as from sea. TBMD protection of the landing zone, port facility, or airhead will be essential in projecting U.S. military power ashore and inland.

C. WHY A MARITIME RECONNAISSANCE STRIKE COMPLEX?

The geopolitical outline of the present and future world scene was presented in the first chapter. This chapter has reviewed the potential impact of the MTR on the future. It is now time to turn towards the question as to how to best organize and employ U.S. naval forces of the future in support of the nation's military strategy in light of the MTR. One means is by organizing naval forces around the concept of a "Reconnaissance Strike Complex" (RSC). The concept of a RSC has been under study for several years, primarily by Soviet (now Russian) strategists. First, it is necessary to introduce and explain the concept of a RSC. Next, the question of why organizing naval forces around the concept of a Maritime RSC (MRSC) must be addressed.

Originally developed by the Soviet Navy in the late 1970s and early 1980s as a way to counter the U.S. Navy carrier battle groups, the RSC was envisaged as an "integrated and highly automated system of reconnaissance, control systems and firing platforms." (Vego, 1990, p. 518) Soviet Ground Forces introduced similar systems to strike battlefield targets. (Vego, 1990, p. 518) This change in strategy became the catalyst for the development of new programs and initiatives within the Soviet defense establishment. It entailed increased emphasis on the development of high-precision conventional weapon systems with the capability of performing tasks previously assigned to tactical nuclear systems. (Vego, 1990, p. 518)

The rationale for this development was twofold. First, advanced conventional weapons were becoming as destructive as tactical nuclear weapons, but, because they were non-nuclear, were hoped to minimize the opponent's incentive to resort to nuclear weapons. (Vego, 1990, p. 518) Secondly, advances in highly capable microcomputers not only afforded the ability to use reconnaissance, command and control and strike systems effectively, but to also integrate and automate them into a high speed, high precision system. (Vego, 1990, p. 518) The objective was to be able to act and react in real time more quickly than the opponent, and thus provide the necessary edge to prevail.

It can be argued that MRSCs have existed before, for example RADM Spruance's carrier task force which engaged the Japanese fleet off Midway Island in 1942. In that battle, after land-based aircraft visually located and reported the position of the approaching enemy fleet, U.S. carrier air power was launched in the decisive strike of the Pacific War. U.S. forces also had the advantage of knowing where to look thanks to superb intelligence information provided by shore-based code breakers.

The organization of an RSC in the Soviet Armed Forces involved three elements; reconnaissance, strike, and command and control. Reconnaissance consisted of a wide variety of platforms, e.g., ocean surveillance satellites, manned reconnaissance aircraft, ships, submarines, merchants, to collect, evaluate and analyze information about the enemy fleet. (Vego, 1990, p. 518) Strike centered around cruise missile-equipped aircraft, ships and submarines, and coastal artillery and missile batteries. (Vego, 1990, p. 520) The command and control complex consisted of shipboard and land based "command posts" with automated control, target designation, navigation and communication systems. (Vego, 1990, p. 518) Primarily designed to operate up to 500 km and deeper into the enemy's area, the RSC was to be used for both defensive as well as offensive purposes. (Fitzgerald, 1993, p. 43) More recently, the Russians believe that the employment and integration of platforms like the E-8 JSTARs and E-3 AWACs by the United States in "Desert Storm" amounted to an operational RSC. (Fitzgerald, 1993, p. 45)

What is new about today's RSC is the speed, operating range and lethality with which targets can be engaged. (Franck, Hildebrandt, 1993, p. 4) With the advance of the MTR, a dramatic change in the effectiveness of the RSC becomes possible, creating an entirely different playing field for the forces of the future. The Russians evidently consider the RSC as the future of warfare, and that rapid collection of precise data on enemy targets, with subsequent real time target designation and immediate assignment of weapons platforms for strike (even deep inside enemy territory) is entirely possible. (Fitzgerald, 1993, p. 46) They look at the value of information, and how it can be used to speed up the "decision cycle", thereby dictating the timing and tempo of combat operations, and consequently the strategic and tactical paralysis of the enemy. (Wolfert, 1993, p. 18)

The dramatically different environment which forces of the future will face requires that military organizations be "re-framed." The uncertainty of future warfare requires the development of an entirely new perspective on strategy, organizations, sensors, networks and tactics. (Hazlett, 1993, p. 2) The challenge of geopolitical change and the MTR provide opportunities to employ future forces in a more effective and efficient manner. In their book, Reframing Organization, authors Lee Bolman and Terrence E. Deal explain how a shift in paradigm is accomplished by viewing experiences and events from multiple viewpoints, resulting in a reshaping of the organization. They write: "We need versatile and flexible leaders who are artists as well as analysts and who can reframes experience in the ways that allow them to discover and express new issues and possibilities. Reframing--the use of multiple lenses--is vital to effective leadership and management." (Bolman & Deal, 1991, pp. xiv-iv)

In his paper "Permanent White Water", CDR James A. Hazlett, USN, argues that a MRSC is a significant warfare concept that satisfies the "multiple lens view" when reframing present and future warfare. (Hazlett, 1993, p. 2) By historically examining the Soviet MRSC through the four "frames" presented in Bolman and Deal's book (structural, human resources, political and symbolic), Hazlett provides an example of how the concept of an MRSC is appropriate as a vehicle for naval strategist to address and overcome contemporary and future warfare challenges.

Hazlett argues that the Soviet MRSC was a strong concept that provided the organizational and doctrinal cohesion necessary to counter what they perceived as the primary threat at the time--the U.S. carrier battle group. The Soviet MRSC satisfied the multiple lens analysis and allowed them to attempt to counter U.S. naval forces threatening the Soviet homeland. (Hazlett, 1993, p. 3), (Vego, 1990, p. 518) Applying this concept to the MTR, the MRSC is a tool that can help naval strategists visualize naval warfare in the early part of the 21st century.

The MTR's emphasis on information dominance, battle management and precision strike, fits well with the MRSC emphasis on integrated and highly automated systems of reconnaissance, control and firing platforms. Similarly, the U.S. concern for reducing force concentrations through the use of stand-off weapons is satisfied in a modern MRSC which emphasizes a few highly capable, mobile and agile platforms, capable of "real time" kill deep inside the non-linear battle-space.

The MRSC of the future stresses a highly efficient and joint organization that can react quickly to meet the threat in an era of "Just-In-Time" warfare where reaction time is minimal. (Hazlett, 1993, p. 3) By fully integrating capabilities, a synergy is created whereby the resulting product is a far more effective and efficient force. This force has the capability to "turn inside" the enemy's decision cycle, and direct lethal and precise firepower in a more rapid and devastating manner.

A modern scenario of the future might require a U.S. MRSC to engage an enemy consisting of mobile infantry, mechanized armor, self-propelled artillery, modern jet fighters and attack aircraft, fixed and mobile missile launchers with medium-range non-nuclear warheads, sea skimming cruise missiles and coastal surface combatants and diesel submarines. The enemy would have no capability to influence the battle from space, whereas the United States MRSC would have both national and theater assets at its disposal. In a highly aggressive and quick-paced campaign, rapid interdiction of advancing enemy land forces is necessary to stall an attack on a friendly country, and allow time for U.S. mainland reinforcements to be deployed to the area.

In such a scenario, the objective of the U.S. MRSC would be to project power "from the sea" to stall the enemy advance, and seize port and air facilities ashore to allow reinforcement. It can be assumed that Maritime Prepositioned Shipping would arrive within one week. Due to deteriorating political events, a large U.S. NETF would have had the opportunity to deploy beforehand, and would find itself about one to two days steaming time from the region. No land based U.S. forces are ashore, thus avoiding "threatening gestures" that might upset sensitive negotiations. As a result, no logistics support or tactical aviation capability would be present to assist the U.S. MRSC at the beginning of hostilities.

In the next chapter, afloat Navy and Marine Corps forces necessary to employ an MRSC (MRSC-DS) are presented to provide an opportunity for capital value estimations and operating and support cost analysis using the Quick Cost Model. Provided as a reference point, MRSC-DS is later compared to MRSC-2015, which is presented in Chapter IV.

III. MRSC-DESERT STORM (DS)

A. INTRODUCTION

In this chapter, the force structure of MRSC-DS is summarized. This force closely resembles the naval and afloat amphibious forces present during Operation Desert Storm. It is designed to represent a force that could be deployed for certain scenarios without other support requirements (e.g., Army and Air Force). Next, capital value for various force elements within the MRSC is calculated. Lastly, operating and support (O&S) costs are estimated using the Quick Cost Model. This allows a determination of O&S costs to capital value ratios.

B. FORCE STRUCTURE

The fundamental building blocks of MRSC-DS are six aircraft carrier battle groups (CVBGs), two Marine Expeditionary Brigades (MEBs), and applicable space assets. Each CVBG typically consists of one aircraft carrier and 6 or 7 ships, consisting of surface combatants, submarines and support vessels. (Cheney, 1992, p. 251) The afloat portion of each MEB consists of about 16 to 17 amphibious ships. (Kelso, 1991, p. A-13) Approximately three notional MEBs are equivalent to one Marine division. The space assets building block in MRSC-DS includes only that portion of the overall total inventory of space assets utilized to support maritime forces. Thus, the combination of sea, amphibious and space assets together constitute MRSC-DS, which is able to project power "from the sea." Table 1 contains the overall ship inventory of MRSC-DS, Table 2, the amphibious forces afloat, Table 3, the air assets, both fixed and rotary-wing afloat, Table 4, the space-based assets, and Table 5 the weapons and ordnance.

TABLE 1. MRSC-DS SHIPS

Carriers (CV/CVN)	6
Submarines	6
Surface Combatants	44
Large Amphibious Ships	7
Other Amphibious	27
Mine Countermeasure Ships	4
Combat Support/Replenishment Ships	5
Other Combat Logistics Ships	14
Support Ships	10
	123

TABLE 2. MRSC-DS AFLOAT AMPHIBIOUS FORCES

HQ Command Elements	2
Combat Service Support Elements	2
Infantry Battalions	7
Light Armored Infantry Companies	4
Tank Companies	2
Assault Amphibian Companies	2
Recon Companies	2
Combat Engineer Companies	1
Anti-Tank Platoon	1
Truck Company Det	1
Air Control Group (Rot. Wing)	2
	17,000 Marines

Note: Information for Tables 1 and 2 taken from "The U.S. Navy in Desert Shield, Desert Storm." (Washington, D.C., Department of the Navy, May 1991), "Conduct of the Persian Gulf War-Final Report to Congress." (Washington D.C., Department of Defense, April 1992), <u>From Shield to Storm: High-Tech Weapons, Military Strategy and Coalition Warfare in the Persian Gulf</u>. (New York. William Morrow, 1992), and author's estimate.

TABLE 3. MRSC-DS AIR ASSETS

Air-Fixed Wing Afloat		
F-14 Tomcat	104	(USN)
F-18 Hornet	134	(USN)
A-6 Intruder	50	(USN)
AV-8B Harrier	26	(USMC)
S-3 Viking	41	(USN)
E-2 Hawkeye	30	(USN)
EA-6B	27	(USN)
Air-Rotary Wing Afloat		
AH-1 Cobra	48	(USMC)
UH-1 Huey	48	(USMC)
CH-46 Sea Knight	86	(18 USN, 68 USMC)
CH-53 Sea Stallion	50	(USMC)
SH-2/SH-60	46	(USN)
SH-3	36	(USN)
OH-58	7	(USMC)

Note: Information for Table 3 taken from "Conduct of the Persian Gulf War-Final Report to Congress." (Washington D.C., Department of Defense, April 1992), From Shield to Storm : High-Tech Weapons, Military Strategy and Coalition Warfare in the Persian Gulf. (New York. William Morrow, 1992), and author's estimate. All tactical air assets are stationed aboard ship.

TABLE 4. MRSC-DS SPACE ASSETS

Communication Satellites	
Defense System Communication (DSCS)	4
Fleet Communication (FLTSATCOM)	5
Leased Satellites (LEASAT)	4
Mobile Area Comm. (MACSAT)	2
Missile Detection Satellites	
Defense Support Program (DSP)	2-4
Meteorological Satellites	
Defense Meteorological Sat. Prog. (DMSP)	3
Navigation Satellites	
Global Positioning System (GPS)	16
Other Agency Assets	several

Note: Information contained in Jane's Space Directory (JSD) (1993-1994) (Surrey, U.K. Jane's Information Group Inc. 1993), From Shield to Storm (New York. William Morrow. 1992), Defense Electronics (January 1993) and Wolfert, 1994. Numbers of satellites represent an estimate of assets used during Operation Desert Storm.

TABLE 5. MRSC-DS WEAPONS AND ORDNANCE

Type	CARs	BBs	CRUs	DDFF	DDGs	FFGs	SSNs	AMPB	Tot.
TMHK	----	64	286	55	----	----	66	----	471
HARP	300	32	128	64	40	64	24	----	652
SLAM	100	----	----	----	----	----	----	----	100
MAV	300	----	----	----	----	----	----	----	300
HARM	1500	----	----	----	----	----	----	----	1500
HELF	----	----	----	----	----	----	----	2000	2000
TOW	----	----	----	----	----	----	----	2000	2000
HAWK	----	----	----	----	----	----	----	200	200
STGR	----	100	----	----	----	----	----	400	500
PHXM	300	----	----	----	----	----	----	----	300
SWDR	1500	----	----	----	----	----	----	300	1800
SPRW	1500	----	----	----	----	----	----	624	2124
MK82	9600	----	----	----	----	----	----	1400	11 K
MK83	9600	----	----	----	----	----	----	1400	11 K
GBUs	1500	----	----	----	----	----	----	----	1500
STDM	----	----	1106	30	228	320	----	----	1684
16"	----	2800	----	----	----	----	----	----	2800
5"	----	12 K	6500	6500	----	----	----	3000	28 K
76mm	----	----	----	----	----	4000	----	----	4000
MK48	----	----	----	----	----	----	120	----	120
MK46	----	12	96	78	30	48	----	----	264
ASRC	----	----	98	78	30	----	----	----	234
TALD	300								300
UAVs		50							50

Note: Information taken from Jane's Fighting Ships (1991-92). (Surrey, UK. Jane's Information Group Inc. 1991), From Shield to Storm. (New York. William Morrow. 1992), CBO Navy Ship Weapons Load Database dated 10 Feb 1994, and author's estimate. (K represents thousands of units).

C. MILITARY CAPITAL

1. Concept

The next step is to estimate the capital value of MRSC-DS, including ships, planes, equipment, space assets and weapons. This is followed by a discussion of operating and support costs, and the calculation of pertinent ratios. In presenting the topic of military capital, five concepts need to be presented and understood. They are: investment, capital stock, capital services value, benefit, and the treatment of R&D costs.

a. Investment

"Investment" relates to the inflow of capital in a particular year to develop and acquire durable assets. (Hildebrandt, 1990, p. 160) Navy investment costs for development are detailed in the form of research and development accounts (e.g., Research, Development, Test and Evaluation, Navy-RDT&E, N). For ships, acquisition costs are spelled out annually under Shipbuilding and Conversion, Navy (SCN); for aircraft, Aircraft Procurement, Navy (APN); and for weapons and ordnance, Weapons Procurement, Navy (WPN).

b. Capital Stock

"Capital stock (or inventory) value" of durable assets can be considered a pool of capital goods that has been acquired during an earlier period, collected over time, and which is still in service. (Hildebrandt, 1990, p. 161) Capital stock is valued at replacement cost, which is the amount of money in constant dollars required to replace the asset. Because military assets are maintained very carefully, it is assumed that no physical deterioration occurs throughout the service life. Also, obsolescence of a military asset is assumed to occur suddenly at the end of its service life when it is replaced.[1]

c. Capital Services Value

The term "capital services value" refers to the implicit value of an asset in a particular year. (Hildebrandt, 1990, p. 161) In this analysis, capital services value takes into consideration both the capital stock value of the assets as well as their service lives. It may also give account to the time value of money. A discussion of the use of an interest rate to account for the time value of money appears in the next section.

Capital services value directly relates to the ability to recapitalize force structure. "Recapitalization" is currently central to attempts of the Department of Defense and Navy to plan future forces. For example, during recent testimony before the Senate Armed Services Committee, Secretary of Defense William Perry used the example of maintaining a nuclear powered attack submarine force of 45 boats, each with a 30 year service life. This force would

[1]If replacement cost of achieving a certain level of military capability is employed, one takes into account obsolescence by using a properly constructed price deflator. (Hildebrandt, 1990, p. 165)

require an average construction rate of 1 1/2 boats/year over the long term. (Perry, 1994, p. 5) Assuming a unit cost of $1.5 billion per boat, then the capital services value for a given year would be $2.25 billion. This topic is discussed and analyzed further in Chapter V.

d. Benefit

An important link when discussing military capital is the relationship of cost versus benefit when acquiring additional assets. The unit cost of acquiring an additional asset must be balanced by the anticipated benefit over the life of the asset. (Hildebrandt, 1990, p. 161) Translating this into monetary terms requires consideration of the opportunity cost of capital or "discount rate," the concept of constant dollars, and the service life of the asset.

i. Discount Rate

The discount rate is a cost incurred by utilizing capital to invest in durable assets. It reflects the cost not only of raising capital, but also opportunity cost.

ii. Constant Dollars

Constant dollars refer to a monetary measure in which the effects of inflation are ignored. By valuing assets in constant dollars, a true comparison of capital value in two different time periods can be made. This is consistent with Office of Management and Budget (OMB)

Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. (OMB, 1992, p. 7)

iii. Annual Benefits

Integrating these factors with the service life of durable assets, the following relationship between one dollar of capital invested and benefits received exists:[2]

$$B=\frac{1}{\sum_{t=1}^{l}\frac{1}{(1+r)^{t}}}$$

where r is the discount rate, l is the service life, and B is the annual benefits per procurement dollar. (Hildebrandt, 1990, p. 162) In this analysis, to emphasize the annualized cost of acquiring a capital asset, discounting is ignored. Assuming r=0, the relationship simplifies to:

$$B=\frac{1}{l}$$

This indicates that the annual benefit received per dollar invested is inversely related to the service life of the asset.

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[2]The last dollar spent must equal the discounted annual benefits, or:

$$1=\sum_{t=1}^{l}\frac{B}{(1+r)^{t}}$$

Solving for B yields the indicated equation.

e. R&D Cost

Research and development (R&D) costs are not considered part of the capital services value of MRSC-DS. Rather, it is considered a "sunk cost" of a previous period. However, for MRSC-2015, R&D is amortized over the service life of the relevant asset and included with the capital services value. R&D is treated in this manner since it is a relatively "soft" number that is small when compared to the capital stock inventory. This is somewhat consistent with accounting texts that amortize R&D rather than expensing it, and thus assumes that future benefits will be received. (Hawkins, 1986, p. 600) Although amortizing R&D with capital services value for MRSC-2015 helps to simplify the analysis, it does affect the comparability of capital services values of MRSC-DS and MRSC-2015. In addition, by amortizing R&D and not treating it as a set-up or fixed cost, returns to scale are diminished when comparing the cost of maintaining more than one MRSC are considered in the capital services value.

2. Ships

Appendix C lists the capital stock value of ships of MRSC-DS. The "model" for MRSC-DS is the afloat forces available on the eve of Desert Storm in 1991.

3. Aircraft

Appendix D displays the capital stock value of aircraft in MRSC-DS. Planes used are the type and quantity available on aircraft carriers and ships that deployed during the Gulf War. Two separate quantities are presented in Appendix D. The "Req." column reflects the number of aircraft afloat. The column labeled "Inv." is the overall inventory of aircraft needed to support the numbers afloat. By multiplying the number of inventory aircraft required by the unit cost, a total cost for each aircraft type is obtained. An example of this calculation for the F-18 aircraft is shown at the bottom of Appendix D. The higher inventory numbers are justified for three reasons; training, maintenance and R&D.

a. Training

A certain number of aircraft is needed for training purposes. This is compensated for by a percentage factor to satisfy this requirement.

b. Maintenance

A number of extra aircraft is needed to allow for planes in maintenance status. This is the "pipeline" demand, and it is also compensated for by a percentage factor.

c. R&D Units

Additional aircraft acquired to support R&D (not the R&D expense itself) are added to the number of planes needed due to training and pipeline factors.

4. Marine Corps

The estimated capital stock value of Marine Corps amphibious assault equipment is provided in Appendix E. The force structure presented closely resembles the two MEBs that were assembled off Kuwait in February 1991. The capital stock value of this force does not include Marine Corps aircraft since they are included in the APN account, and are a part of the air component analyzed in Appendix D. In addition, calculations included the estimated cost of the 35 tanks, 100 Amphibious Assault Vehicles (AAVs), 150 Light Armored Vehicles (LAVs), 17 Landing Craft Air Cushion (LCACs) and 13 Landing Craft Utility (LCUs) that were available to afloat Marine Corps forces in the Gulf. (Cheney, 1992, p. 297) The capital stock value of ordnance carried by Marine Corps forces is estimated along with Navy ordnance in Appendix G.

5. Space Assets

Appendix F provides an estimate of the capital stock value of the space assets that were notionally available to U.S. theater commanders during the Gulf War. In developing cost estimates, it was assumed that the largest share of satellite capital cost is attributable to R&D and procurement. Additionally, overall capital value is assumed to have the following relative weights: 25 percent for ground control, 25 percent for user control, 30 percent for the cost of the satellite, and 20 percent for boosters. (SIS, 1993, p. 38), (Wolfert, 1994) Unclassified sources were consulted to arrive at an estimation of individual satellite costs. This data is presented in four columns representing the relative weights, and a summation of costs in the right hand column. The total cost summarized at the bottom is not intended to represent the capital value of all space assets in orbit, but only those that may have been directly associated with MRSC-DS in prosecuting the Persian Gulf War.

6. Weapons and Ordnance

Appendix G provides an unclassified estimate of the capital stock value of major ordnance stocks on Navy combatants and Marine Corps amphibious forces deployed during Desert Storm. Since MRSC-DS is assumed to be self-sufficient for approximately one week, capital stock value of ordnance on resupply ships was not estimated.

7. Summary

Table 6 is a summary of capital services values for various "force elements", or sections, which make up MRSC-DS. Force elements consist of: aircraft carriers, Navy tactical aircraft (F-14, F-18, and A-6), Navy support aircraft (S-3, E-2, EA-6B, SH-2/60, SH-3), surface combatants and submarines (which include minesweepers), amphibious ships, support and auxiliary ships, two MEBs without Marine Corps aircraft, Marine Corps logistics (CH-46 and CH-53) and tactical aircraft (AH-1, UH-1, AV-8B, OH-58), weapons and ordnance, and space assets. Definition of force elements is useful in determining ratios of operations and support costs to capital services value for MRSC-DS, and provides an opportunity to compare and contrast MRSC-DS with MRSC-2015 in Chapter V. Several different service lives are used in determining capital services value. All ships, with the exception of aircraft carriers, are assigned a service life of 30 years.

Aircraft carriers are assumed to have a 45 year service life thanks to the Service Life Extension Program (SLEP). Planes and vehicles, including Marine Corps equipment, have a 20 year service life. Finally, weapons and ordnance have a 15 year service life, while satellites service life is 10 years. (DOC, 1993, p. M-17)

TABLE 6. CAPITAL SERVICES VALUE (MRSC-DS)

Aircraft Carriers	284,351
Navy Tactical Aircraft	1,058,200
Navy Support Aircraft	409,100
Surface Combatants and Subs	990,134
Amphibious Ships	341,893
Support and Auxiliary Ships	409,364
2 MEBs w/o USMC Aircraft	66,450
USMC Log. Aircraft	159,250
USMC Tac. Aircraft	124,700
Weapons/Ordnance	362,567
MRSC-DS (w/o Space)	4,206,009
Space Assets	2,410,000
MRSC-DS (with Space)	6,616,009

Note: Costs in thousands of FY1990 dollars.

As can be seen for MRSC-DS, when comparing the capital services value of Table 6 with the capital stock value of Appendices C through G, to maintain a relatively large inventory of military assets requires a modest annual investment. For instance, the capital stock value of MRSC-DS aircraft carriers is $12.795 billion, while the capital services value is only $284 million.[3] The large difference in these two values is the result of a 45 year aircraft carrier service life. The $284 million represents the annual investment needed in procurement (i.e., SCN) for replacements to maintain this inventory. It does not include any operations and support costs, which are discussed in the next section.

Navy tactical aircraft have a capital stock value of $21.164 billion. However, when considering a 20 year service life of aircraft, the capital services value is only $1.058 billion per year. Again, this would represent the annual investment (i.e., APN) needed for replacements to maintain this inventory. It is interesting to compare the capital services values of aircraft carriers with Navy tactical and support aircraft. Navy tactical and support aircraft replacement costs are five times that of carrier replacement costs on a yearly basis!

Another interesting comparison is that of aircraft carriers to space assets. The capital stock value of aircraft carriers is approximately 1/2 that of space. However, due to the large difference in service lives (45 years for carriers versus 10 years for space assets), the capital services value of the aircraft carriers is approximately 1/8 th the capital

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[3]The capital stock value of aircraft carriers includes the value of major upgrades, including the Service Life Extension Program (SLEP). (NAVSEA, 1994, encl. 1)

services value of the space assets. It is apparent that the cost of an individual carrier must be kept in perspective. Because their service life is so long, the annual capital services value is moderately low.

D. OPERATING AND SUPPORT (O&S) COSTS

O&S can be considered the price needed during peacetime to maintain the readiness of U.S. forces to fight a war. It includes costs such as salaries of personnel, fuel, maintenance, and other recurring expenses. The next step is to discuss O&S costs for MRSC-DS using the Quick Cost Model.

1. Quick Cost Model

The Quick Cost Model takes as inputs changes in Primary Defense Forces (e.g., numbers of ships or airplanes etc.) and provides costs in terms of Budget Authority (BA) or Total Obligation Authority (TOA), and end strength resources. (Vassar, 1989, p. 3) This model is quite similar to the Defense Resources Model used by the Congressional Budget Office (CBO) in that it utilizes an unclassified file obtained from DOD generated from the budget year data of the Future Years Defense Program (FYDP). Various Program Elements (PEs) are broadly grouped into Aggregate Elements (AEs), and Resource Identification Categories (RICs) into Resource Identifiers (RIs) to a level suitable for declassification. This processed is referred to as a "roll-up." (Vassar, 1989, p. 3)

a. **Aggregate Elements (AEs)**

AEs are broken down into primary AEs, which are directly related to changes in force structure; related AEs, which are proportional to certain resource changes of the primary AEs; auxiliary AEs, which are proportional to changes in certain resources of all primary and related AEs; and other AEs. All are listed in Appendix A. For the purposes of this paper, AEs are grouped in three categories: primary, related, and support (with support consisting of auxiliary and other AEs).

This model relies on a hierarchal structure, in which changes in one category depend on changes to resources in higher level categories (e.g., support AEs are dependent on both related AEs and primary AEs). (Vassar, 1989, p. 8) The resources or "proxies" which directly influence changes in a particular AE are divided into seven categories. Basically, how a AE changes is a function of what allocation variable(s) or "proxies" effect it. How the proxies change is based on a change in the force structure, which is the input to the model. A point of note is that the proxy resources appear at the top of the left hand side table in Appendix A, and the higher categories over which they are summed appear in the middle table. A related AE does not support all primary AEs, but instead only certain ones to which it is "linked." (Vassar, 1989, p. 9)

b. Fixed-Variable Percent

When resource levels for a certain AE are changed, there is a factor known as the "fixed/variable percent." This factor represents the percentage by which an AE would decrease if the resources of the higher category in the hierarchal structure were removed. For the primary AEs it is assumed to be 100 percent. For instance, if there were no platforms in the model, there would be no primary AE resources needed. The related AEs are typically between 80 and 100 percent variable, and support AEs from 0 percent to an appropriate value. (Vassar, 1989, p. 10) The fixed-variable percent factors are derived from an historical estimate of how force structure changes have effected O&S costs in the post-World War II era. For the purposes of MRSC-DS, this relationship will hold true. However, some adjustments to the fixed-variable percent relationships need to be developed when the cost of MRSC-2015 is calculated. This is discussed in the next chapter.

c. Internal Factors

Each AE has 13 internal factors which are listed in Appendix B. Each internal factor is a linear combination of at least one RI, and as many as seven. The complete internal factor for one combination of resources (i.e., one of the 13 internal factors) for a specific AE is as follows;

Primary AE:

$$\frac{\textit{Linear Combination of RIs}}{\textit{Numbers of Forces}}$$

Related AE:

$$\frac{\textit{Linear Combination of RIs}}{\textit{Proxy resources summed using all linked primary AEs}}$$

Support AE:

$$\frac{\textit{Linear Combination of RIs}}{\textit{Proxy resources summed using AEs of higher categories}}$$

For example, Internal Factor 10 (Primary AE) for Military Construction is:

$$\textit{Internal Factor } 10\ (\textit{Primary AE}) = \frac{4410\,(\textit{MCN}) + 4450\,(\textit{MCNR})}{\textit{Numbers of forces of the str}}$$

The significance of internal factors is that they are part of the Force Cost Equation for primary, related, and support AEs. The formula for a change in the cost of a particular AE is listed below:

Primary AE:

(Change in Force Level) x (Internal Factor) x (Fixed/Var. %)

Related AE:

(Change in Proxy Resource summed over all Primary AEs to which it is linked) x (Internal Factor) x (Fixed/Variable %)

Support AE:

(Changes in Proxy Resources summed over AEs in higher categories) x (Internal Factors) x (Fixed/Variable %)

As discussed before, the hierarchal order of the model results in primary AEs being calculated first, followed by related AEs, and then support AEs. To obtain a change in total O&S costs due to a change in force structure, the primary, related and support AEs computed for the new force structure are summed together.

2. Cost Presentation

The major focus of this analysis is to present the ratios of O&S costs to capital services value (Table 6) for a force structure. Below is a "macro" view of the relationship that is developed:

$$\frac{\textit{Operating + Support Costs}}{\textit{Capital Services Value}}$$

O&S costs are broken down into the three basic AEs discussed earlier: primary, related and support. These costs can be broadly defined as the cost of supporting forces during peacetime, and can be considered a major factor in maintaining military readiness. The primary AEs for a platform (e.g., ship or plane) consist of that portion of manning (MPN, RPN, MPMC, RPMC), and operating (O&M, N, O&M, MC, APN and/or OPN) required for direct support (e.g., to operate a ship underway). The APN contribution is not for individual aircraft procurement, but for direct support items which are funded in the APN account. The related AEs for a platform include the accounts listed above (MPN, RPN, MPMC, RPMC, O&M, N, O&M, MC, APN and/or OPN), but pertain to indirect rather than direct supporting roles (e.g., command and control). The support AEs include the accounts listed above, and also the remainder of the appropriations accounts (e.g., MCON, MCNR, FH, N&MC, etc.) that are needed to house dependents, build and operate refit facilities, etc. Investment, RDT&E, N, National Intelligence and Communications are not estimated by this model. For the purpose of this analysis, the National Defense Sealift Fund (NDSF) and the Base Realignment and Closure (BR&C) accounts are excluded. Referring to Table 7, a summary of the Quick Cost results is provided. On the left hand margin are force elements of MRSC-DS. Space assets, which are a part of MRSC-DS, are included separately since their O&S costs were not calculated using the Quick Cost Model. Listed across the top of Table 7 is a breakdown of primary, related, and support AEs, as well as a total.

3. Development of Ratios

In analyzing this data, several ratios need to be developed so MRSC-DS can be compared with MRSC-2015. A tabular presentation of ratios is provided in Table 8. On the left hand margin of Table 8 are the various components or force elements of the overall MRSC as presented in Appendices C through G. The capital services values of these force elements were presented in Table 6, and the O&S costs in Table 7.

TABLE 7. O&S COSTS (MRSC-DS)

Element	Primary AE	Related AE	Support AE	Total AEs
Carriers	933,395	75,763	541,089	1,550,247
Navy TacAir	495,654	25,747	408,245	929,646
Navy Support Air	397,107	78,975	385,725	861,807
Surface & Subs	1,150,978	296,391	454,154	1,901,523
Amphibio us Ships	711,114	66,897	340,302	1,118,313
Support & Aux. Ships	593,954	557,847	377,312	1,529,113
2 MEBs w/o USMC air	407,125	207,604	298,188	912,917
USMC Log. Air	107,218	51,941	52,621	211,780
USMC TacAir	146,847	46,019	44,482	237,348
MRSC (w/o Space)	4,943,392	1,407,184	2,902,118	9,252,69
Space	---------	---------	---------	2,410,000
MRSC (with Space)	---------	----------	----------	11,662,694

Note: Space asset O&S costs are not included in the Quick Cost Model and are estimated to be 10 percent of space capital stock value. (SIS, 1993, p. 38), (Wolfert, 1994) All costs in thousands of FY90 dollars.

Along the top of Table 8 are two ratios that relate O&S costs to capital services values, and a third ratio that relates capital services value to total capital services value. The first item is the ratio of the O&S cost of a particular force element to its capital services value (CapSvcVal). The second item is the ratio of the O&S cost of a particular force element to the total capital services value (TCSV) of the overall MRSC. The third item is the ratio of the capital service value (CapSvcVal) of a particular force element to the total capital services value (TCSV) of the overall MRSC.

The purpose of these ratios is to gain an appreciation of how the ratios of MRSC-DS might change with MRSC-2015, and as a result, how that might influence an investment strategy of the future. This is discussed further in Chapter V.

TABLE 8. O&S TO CAPITAL VALUE RATIOS (MRSC-DS)

Element	O&S/CapSvcVal	O&S/TCSV	CapSvcVal/TCSV
Aircraft Carriers	5.452	.370	.068
Navy TacAir	.878	.222	.253
Navy SupAir	2.107	.206	.098
Surface & Subs	1.921	.454	.236
Amphib Ships	3.271	.267	.082
Support & Aux.Ships	3.735	.365	.098
2 MEBs w/o USMC air	13.738	.218	.016
USMC Log. air	1.330	.051	.038
USMC TacAir	1.903	.057	.030
Space Assets *	1.000	.364	.364
Weapons & Ordnance	------	------	.083

Note: Capital services value to total capital services value ratio may not add to 1.00 due to rounding. *Indicates numbers are an approximation only. (Recall that for space assets, O&S is considered to be 10 percent of capital stock value, and capital services value is equivalent to capital stock value divided by a service life of 10 years. Thus, the O&S to CapSvcVal ratio is approximated at 1.00).

In the next chapter, the force structure of MRSC-2015 is presented, as well as its associated O&S costs and capital services values.

IV. MRSC-2015

A. INTRODUCTION

The cost calculation of MRSC-2015 follows the same approach used in Chapter III for MRSC-DS. First, an estimated force structure is presented. Next, the capital services values and O&S costs are estimated. Finally, ratios are developed so as to facilitate further analysis and comparison of MRSC-2015 with MRSC-DS in Chapter V.

B. FORCE STRUCTURE

MRSC-2015 looks somewhat similar to MRSC-DS. With technological change however, comes a change in the size and composition of the force structure. Discussed below are some of the probable changes in the composition and size of MRSC-2015.

The MRSC of 2015 is somewhat smaller in numbers, using four NETFs, consisting of four aircraft carriers, and one MEB. Aircraft carriers are all nuclear powered, with four vice six carriers sufficient to conduct near-continuous air operations in a regional conflict. One MEB is available for a precision strike or a flanking assault vice the "opposed landing" scenario planned for in Desert Storm of 1991. (Hall, 1992, p. 7) Recall from Chapter II, that an MRSC is designed to operate for approximately one week without reinforcements. As a result, additional Marine forces would be expected to rapidly deploy to the theater of operations. The one MEB initially employed in MRSC-2015 does not suggest any reduction in the overall size of the Marine Corps from MRSC-DS, but rather an afloat amphibious force tailored for a particular mission.

1. Aircraft

Manned aircraft still take off from carriers, although the "force package" wing contains 50 rather than the traditional 60 fighter and attack aircraft in the MRSC-DS carrier air wing. (O'Rourke, 1993, p. CRS-18) The Navy maintains the deep-strike role for its tactical aircraft, having a fully-operational stealth attack plane before 2015. A navalized version of the F-117A Stealth aircraft assumes this role, and, along with the F/A-18 E/F (which enters the fleet in 2001), is the striking arm of the carriers. (Morrocco, 1993, p. 96) The F-14 Tomcat is retired from the fleet by this time, while supporting airframes (such as E-2s, S-3s, etc.) remain in service and are fewer in number proportional to the reduction in the number of MRSC aircraft carriers.

2. Submarines

The submarine component of MRSC-2015 consists of Ohio-class submarines (capable of launching conventional-warhead Trident ballistic missiles), the Seawolf (or New Attack Submarine), and improved Los Angeles-class submarines. The Seawolf and Los Angeles-class submarines are capable of firing

Tomahawk cruise missiles and MK 48 ADCAP torpedoes, neutralizing minefields, as well as inserting and extracting special operations forces (SOF) ashore.

3. Surface Combatants

Surface combatants include new 21st century strike destroyers with increased Vertical Launch System (VLS) capacity for missiles, Ticonderoga-class cruisers, and Burke-class destroyers. A Minesweeper Command Ship with helicopters and accompanying minesweepers should round out the surface force. Other classes of cruisers, destroyers, and guided missile frigates are retired by 2015. This change in the surface force reflects the change in emphasis on inland strikes and provision it for theater ballistic missile defense.

4. Amphibious Forces

Amphibious forces are reduced by approximately one-half when compared with MRSC-DS, reflecting the requirement to support only one MEB for precision strike in MRSC-2015. A new amphibious ship, the LX, is added to replace older amphibious ships. Additional amphibious force readiness is achieved with a new medium-lift capable aircraft, designated the V-22, (replacing the CH-46), and an increase in the number of Landing Craft Air Cushion (LCACs).

5. Logistics and Support Ships

The numbers of logistics and support ships should show a decline with the reduction in the size of the overall force.

However, some additions are made. Auxiliary Dry Cargo Ships (ADC-Xs) and three minesweeper transport ships (dubbed "MX"), are added to provide improved logistics and open-ocean "piggy-back" transit to the minesweepers, respectively. (Kelso, 1993, p. 46) (CBO2, 1993, p. 5)

Table 9 shows MRSC-2015 ships; Table 10, the afloat amphibious forces; and Table 11, the air assets.

TABLE 9. MRSC-2015 SHIPS

Carriers (CVN)	4
Submarines	10
Surface Combatants	22
Large Amphibious Ships	3
Other Amphibious Ships	14
Mine Countermeasure Ships	11
Combat Support/Replenishment Ships	11
Other Combat Logistic Ships	3
Support Ships	6
	84

Note: Information for Table 9 taken from Ships for Peacetime, Crises and Regional Conflicts (CRM-92-112). (Alexandria VA. Center for Naval Analyses. September 1992), and author's estimate.

TABLE 10. MRSC-2015 AMPHIBIOUS FORCES AFLOAT

HQ Command Elements	1
Combat Service Support Element	1
Infantry Battalions	2
Light Armored Infantry Companies	2
Tank Companies	1
Assault Amphibian Companies	1
Recon Companies	1
Combat Engineer Companies	1
Anti-Tank Platoon	1
Truck Company Det	1
Air Control Group (Rot. Wing)	1
	8,500 Marines

TABLE 11. MRSC-2015 AIR ASSETS

Air-Fixed Wing Afloat		
F-117N	56	(USN)
F-18 Hornet	144	(USN)
AV-8B Harrier	28	(USMC)
S-3 Viking	28	(USN)
E-2 Hawkeye	20	(USN)
EA-6B	22	(USN)
Air-Rotary Wing Afloat		
AH-1 Cobra	17	(USMC)
UH-1 Huey	17	(USMC)
V-22	45	(13 USN, 32 USMC)
CH-53 Sea Stallion	52	(USMC)
SH-2/SH-60	24	(USN)
SH-3	24	(USN)
OH-58	7	(USMC)

Note: Information for Tables 10 and 11 taken from "Navy Carrier-Based Fighter and Attack Aircraft: Modernization Options for Congress." (Washington, D.C. Congressional Research Service, U.S. Congress. 1 October 1993), "Integrated Amphibious Operations & USMC Air Requirements Study." (Washington, D.C., Department of the Navy. 26 September 1993), and author's estimate.

6. Weapons and Ordnance

The most noticeable change occurs is the types of weapons and ordnance MRSC-2015 employs. Reflecting the need to strike inland and provide for theater ballistic missile defense (TBMD), several innovative systems, discussed below, are fully operational.

a. Surface-to-Surface Weapons

A limited number of Trident missiles carried on Ohio-class submarines are armed with conventional warheads, capable of destroying deep underground targets, such as command centers. The Tomahawk Baseline Improvement Program (TBIP) has developed a submarine and surface-launched Tomahawk land attack cruise missile that uses real-time Global Positioning System (GPS) updates, and is capable of discriminating between wider target sets. Targeting includes a "man-in-the-loop" capability that makes this weapon more effective against critical mobile targets (CMTs). (Kelso, 1993, p. 30)

A navalized version of the extended range, all-weather, day-or-night Army Tactical Missile System (ATACMs) is employed on surface combatants and newer amphibious ships for deep inland strike. The weapon is capable of destroying tanks and armored vehicles that are beyond the range of artillery or rockets. (Kelso, 1993, p. 30)

An extended range, advanced lightweight gun, capable of firing precision guided munitions (PGMs), guided by GPS, and with ranges over 70 nautical miles, is employed. It replaced some of the 5 inch guns on Ticonderoga-class cruisers and Burke-class destroyers. It also arms the 21st century Strike destroyer, and provides more effective and useful Naval Gunfire Support to forces ashore. (CBO2, 1993, p. 11)

b. Surface-to-Air Weapons

Strike destroyers provide the capability for an endo-atmospheric TBMD "umbrella," using the upgraded Standard Missile 2 Block IVA. (Kelso, 1993, p. 76, Soofer, 1994, p. 64, Bush, 1994, p. 40) Ticonderoga-class cruisers and Burke-class destroyers continue to rely on the Aegis weapon system for defense against the air threat. However, VLS capacity is somewhat more evenly distributed between land attack and air defense weapons than was the case with the destroyers and cruisers in the MRSC-DS. (Rubright, 1992) An improved Rolling Airframe Missile (RAM) and a new laser weapon, designated "HELLWEPS," are available to defend against low-flying cruise missiles and close-aboard air attacks. (CBO2, 1993, pp. 16-17, Atwal, 1993, p. 19) The laser weapon replaces the traditional 5 inch gun mounts that were not converted to fire PGMs.

c. Air-to-Surface Weapons

Following its successful employment in MRSC-DS, the Standoff Land Attack Missile (SLAM) is improved and remains in service after the introduction of the Tri-Service Standoff Attack Missile (TSSAM). These weapons provide a

Standoff Outside Area Defense (SOAD) capability for attack aircraft. (Kelso, 1993, p. 30)

The Joint Direct Attack Munition (JDAM) is employed as a replacement to the MK-80 series bombs as a low cost, all-weather, precision-guided weapon. The Joint Standoff Weapon is the single replacement for numerous Standoff Outside Point Defense (SOPD) weapons in MRSC-DS inventory. (Kelso, 1993, p. 31)

d. Air-to-Air Weapons

The Advanced Medium Range Air-to Air Missile (AMRAAM) replaces the Sparrow, having improved capabilities against both low and high-altitude targets. (Kelso, 1993, p. 46)

e. UAVs/RPVs

One other noticeable change in the weapons load-out for MRSC-2015 is a much more versatile and capable inventory of Unmanned Aerial Vehicles (UAVs) and Remotely Piloted Vehicles (RPVs). Three different types exist: a Short Range UAV, a Close Range UAV for use by ground troops, and a Vertical Take-Off UAV stationed onboard large-deck ships (Lesser, 1993, pp. 36-44). The weapons and ordnance of MRSC-2015 are tabulated in Table 12.

TABLE 12. WEAPONS AND ORDNANCE (MRSC-2015)

Type	CVNs	CGs	DDGs	DDGXs	SSBNs	SSNs	AMPB	TOTAL
TRDT	----	----	----	----	12	----	----	12
TBIP	----	272	64	----	----	122	----	458
SLAM	200	----	----	----	----	----	----	200
ATCM	----	238	150	50	----	----	56	496
TSSM	150	----	----	----	----	----	----	150
HELF	----	----	----	----	----	----	2000	2000
TOW	----	----	----	-----	-----	----	2000	2000
HARM	1000	----	----	----	----	----	----	1000
JSOW	240	----	----	----	----	----	----	240
STDM	----	380	378	----	----	----	----	758
TBMD	----	----	----	488	----	----	----	488
SWDR	1000	----	----	----	----	----	200	1200
AMRM	800	----	----	----	----	----	----	800
JDAM	10 K	----	----	----	----	----	2000	12 K
RAM	192	----	----	192	----	----	672	1446
HELW	----	2000	390	----	----	----	----	2390
MK50	----	60	48	24	----	----	----	132
MK48	----	----	----	----	20	180	----	200
AVGN	----	3000	2400	----	----	----	----	5400
ASRC	----	160	128	----	----	----	----	288
TALD	240	----	----	----	----	----	----	240
SRUV								30
CRUV	----	----	-----	----	----	----	48	48
VTOL								24

Note: Information for Table 12 taken from "Navy Ship Weapons Load Database" (Washington, D.C., CBO 10 Feb 94), "Selected Options for Enhancing Naval Capability in Regional Conflicts" (Washington, D.C., CBO, June 1993) "Information Warfare Brief" (Washington, D.C., NDU, 7 Dec 92), "Naval Anti-Missile Laser Readied for Sea."

Defense Electronics (April 1993), "Unmanned Aerial Vehicles-Still a Top DOD Priority." Defense Electronics (March 1993) and author's estimate.

7. Space

MRSC-2015 displays a significant capability from space in supporting power projection from the sea and onto land. Platforms such as AWACS, JSTARS, and more capable satellites, give MRSC-2015 a highly integrated organization of assets that create an "information fusion hierarchy" of data, thus maximizing its potential use for combat. (Wolfert, 1993, p. 16) Real-time mission updates, with pin-point localization information, greatly enhance the effectiveness of tactical air, land, and sea operations. (Wolfert, 1993, p. 17)

C. MILITARY CAPITAL

As discussed in Chapter III, present and future R&D costs need to be accounted for when attempting to predict the capital services value of MRSC-2015. The vast majority of this force structure includes platforms already developed for MRSC-DS. As a result, the difference in capital services value between MRSC-DS and MRSC-2015 is only modestly affected by two factors: first, a change in the number of existing assets in the capital stock inventory between MRSC-DS and MRSC-2015, and secondly, the addition of new assets developed and acquired to replenish capital stock inventory for MRSC-2015.

1. Changes in Existing Capital Stock

Assuming that service lives remain constant, assets no longer maintained in the inventory result in a reduction in the capital services value for a future force (with everything else held constant). A smaller number of assets cause a reduction in the capital stock (inventory) value.

2. New Capital Stock

New capital stock developed and acquired for MRSC-2015 includes ships, submarines, planes, weapons and space assets. Two major costs are associated with new capital stock: R&D, and procurement. The difference in the value of capital stock from MRSC-DS to MRSC-2015 is due to the change in force structure, as well as modernization efforts. Force structure changes due to inventory changes result from the procurement of new military assets as well as the retirement of assets which have reached the end of their service life. Modernization of existing forces comes about by replacement of existing forces with improved assets and through expenditures of R&D. Thus, both procurement and R&D affect the new value of capital stock. Presently, R&D costs continue to increase as compared to procurement costs. For FY 1993, a 1.5:1 ratio between procurement and R&D existed for all defense programs. (Carlisle, 1992, p. 309) Over the past 30 years, the ratio averaged 2.5:1, and if present trends continue (with only a 2 percent increase in R&D per year as planned), the ratio will fall to 1:1 by the year 2000. (Carlisle, 1992, p. 309)

As a result, for the purposes of this study, new capital stock value of aircraft, ships, weapons and space assets developed after the year 2000 for MRSC-2015 is assumed to be approximately 50 percent R&D costs and 50 percent procurement cost. For some new platforms already under development (such as the LX), or for which there is already a similar airframe in service (such as the V-22, F/A-18 E/F, and F-117N), the procurement to R&D ratio "stabilizes" at the FY 1993 level of 1.5:1.

Presented in Appendices H through K are the capital stock values of the ships, aircraft, amphibious forces, and weapons for MRSC-2015. R&D costs of new platforms are added to the capital stock value of existing platforms and assets in the Appendices to determine the new capital stock value for MRSC-2015.

3. Capital Services Value

Provided for in Table 13 is a summary of the capital services value for each of the force elements of MRSC-2015. The service life estimates utilized for the MRSC-DS were also applied in calculating the capital services value for MRSC-2015. (The capital services value for space assets in the MRSC of 2015 is a rough approximation only of capital stock replacement costs divided by a service life of 10 years using current information, and should only be considered in very broad terms). (Wolfert, 1993, p. 23, DOC, 1993, p. M-17)

TABLE 13. CAPITAL SERVICES VALUES (MRSC- 2015)

Aircraft Carriers	325,914
Navy Tactical Aircraft	1,426,300
Navy Support Aircraft	398,650
Surface Combatants and Subs	1,271,967
Amphibious Ships	405,757
Support and Auxiliary Ships	268,101
1 MEB w/o USMC Aircraft	51,925
USMC Logistics Aircraft	197,150
USMC Tactical Aircraft	92,200
Weapons (Ordnance)	992,685
MRSC (w/o Space)	5,430,649
Space	10,000,000
MRSC (with Space)	15,430,649

Note: All costs in thousands of FY 1990 dollars.

It may be helpful to review the capital services value concept. As shown in Appendix H, the capital stock value of MRSC-2015 aircraft carriers is $14.666 billion, while Table 13 indicates that the capital services value is only $325 million. The large difference in these two value is the result of a 45 year aircraft carrier service life. The $325 million represents the annual investment needed in procurement (i.e., SCN) for replacements to maintain this inventory. It does not include any operations and support costs.

As shown in Appendix I, Navy tactical aircraft have a capital stock value of $28.520 billion. However, when considering a 20 year service life of aircraft, the capital services value is only $1.426 billion. Again, this would represent the annual investment (i.e., APN & RDT&E, N) needed for replacements to maintain this inventory. It is interesting to note when comparing the capital services values of aircraft carriers with Navy tactical and support aircraft. Aircraft replacement costs are approximately six times greater than carrier replacement costs on a yearly basis!

Another interesting note is a comparison of aircraft carriers to space. The capital stock value of aircraft carriers is approximately 1/7th that of space. However, due to the large difference in service lives (45 years for carriers versus 10 years for space), the capital services value is approximately 1/30th the cost!

D. O&S COSTS

In determining the O&S costs of MRSC-2015, the Quick Cost Model is used again. With the continued downsizing of forces since the end of the Cold War, significant changes in the defense infrastructure occur. As a result, a closer examination of the suitability of the Quick Cost Model is appropriate.

1. Fixed-Variable Percent

When the historical fixed-versus-variable factors in the Quick Cost Model are examined (the historical percentage by which a related and/or support AE changes if resources of a higher category in the hierarchy changes), it becomes obvious that they were based on the experience of the Cold War force structure. These factors, based on historical data, were designed to accommodate relatively small fluctuations in an already large and relatively stable force structure. This approach cannot be used with the significantly downsized force that started with the Base Force concept and continues with The Bottom Up Review. Accordingly, modification of these factors by utilizing more recent data than that historical data base is appropriate.

Discussions with CBO indicate that the Quick Cost Model predictions closely follow post-Cold War budget expenditures when support AEs maintain a 50 percent fixed versus variable cost relationship in the aggregate. (Myers, 1994) This is a heavier weighting of the variable component as compared to the historical data base, and is an appropriate response of the cost relationship as more fixed cost infrastructure is eliminated in the drawdown. An assumption is made that this relationship holds true after the drawdown is complete for MRSC-2015. As a result, these adjustments are made in predicting O&S costs for MRSC-2015, which appear in Table 14.

2. Development of Ratios

Table 15 presents ratios of capital services values and O&S costs to provide for further analysis. In Table 15, force elements are listed on the left hand margin. Along the

TABLE 14. O&S COSTS (MRSC-2015)

Force Element	Primary AE	Related AE	Support AE	Total
Carriers	496,062	54,566	346,407	897,035
Navy Tacair	555,481	47,848	435,118	1,038,447
Navy SupAir	380,544	74,531	369,644	824,719
Surface & Subs	914,987	189,615	300,563	1,405,165
Amphibious Ships	334,642	31,481	193,083	559,206
Support & Aux. Ships	415,295	362,885	261,550	1,039,730
1 MEB w/o USMC air	203,563	103,802	149,094	456,459
USMC Log. Air	130,132	61,114	62,165	253,411
USMC TacAir	122,919	39,982	39,402	202,303
MRSC (w/o Space)	3,553,625	965,824	2,157,026	6,676,475
Space	---------	----------	---------	10,000,000
MRSC (with Space)	---------	----------	---------	16,676,475

Note: Space O&S costs are not included in Quick Cost Model and are assumed to be 10 percent of Space capital stock value. (SIS, 1993, p. 38, Wolfert, 1994) All costs in thousands of FY90 dollars.

top are ratios of O&S costs to capital services value (CapSvVal), O&S costs to total capital services value (TCapSvVal), and capital services value to total capital service value, respectively.

TABLE 15. O&S TO CAPITAL SERVICES VALUE RATIOS (MRSC-2015)

Element	O&S/CapSvVal	O&S/TCapSvVal	CapSvVal/ TCapSvVal
Aircraft Carriers	2.752	.056	.020
Navy Tacair	.692	.065	.094
Navy SupAir	1.945	.051	.026
Surface & Subs	1.092	.088	.079
Amphibious Ships	1.251	.035	.025
Support & Aux. Ships	4.476	.065	.017
1 MEB w/o USMC air	.440	.028	.003
USMC Log. air	1.225	.016	.013
USMC TacAir	2.085	.012	.006
Space *	1.000	.624	.624
Weapons & Ordnance	-----	-----	.093

Note: Capital Services Value to Total Capital Services Value may not add to 1.00 due to rounding.

* Indicates numbers are an approximation only.

In the next chapter, a comparison is made of O&S costs and capital services values for MRSC-DS vs. MRSC-2015.

V. MRSC-DS vs. MRSC-2015

A. INTRODUCTION

The last two chapters outlined the estimated characteristics and cost of MRSC-DS and MRSC-2015. Each MRSC was broken down into force elements (e.g., Navy Tactical Aircraft), so that a useful set of ratios of capital services values and O&S costs could be developed. In addition, by summing up each of the respective force elements, overall O&S costs and capital services values for each MRSC were determined. This chapter is an in-depth comparison of MRSC-DS and MRSC-2015.

First, the O&S cost (specifically the fixed-to-variable cost relationships in the support AEs) of two MRSCs is analyzed and discussed. An effort is made to predict an overall O&S cost curve with regard to force structure that accurately reflects the dramatic drawdown that is currently underway in the Navy and defense establishment.

Secondly, the individual force elements of each MRSC are examined to determine their O&S costs and capital services values relative to the total cost of the MRSC. This is done in two sections: the MRSC without the space force element (Figures L-2A through L-7A), and the MRSC including space (Figure L-8). A distinction is made since the space force element capital services value and O&S costs are considered to be only broad estimates, and as a result, do not contain the same accuracy as other data. By determining and adding together the capital services values and O&S costs, a yearly total cost is determined to support each MRSC.

Third, the costs associated with fielding two MRSC-2015s are examined. This analysis includes the concepts of force availability and economies of scale, in the event of two near-simultaneous Major Regional Contingencies as envisioned in the BUR. In addition, opportunity cost associated with designing the foundation of MRSC-2015 using four aircraft carriers is presented and analyzed. This opportunity cost is "benchmarked" to the cost of four aircraft carriers.

Finally, the concept of a "tooth-to-tail" ratio is introduced and analyzed. This concept is a way of comparing the cost of the MRSC's "precision strike power" (tooth) with that of the necessary support required to maintain the MRSC (tail). This can be a useful measure to determine if the investment strategy of the Navy and DOD in supporting the concept of a MRSC can effectively promote power projection "from the sea" with the force of the future.

B. FIXED-VARIABLE COST RELATIONSHIP

In determining the O&S costs of the two MRSCs, three general categories consisting of primary, related, and support AEs were introduced in Chapters III and IV. In MRSC-DS, historical cost relationships were used as input in determining each category's costs. This historically large and relatively stable Cold War defense establishment is in the process of a dramatic downsizing. As infrastructure and faci..ties fixtures are being closed down, the cost of MRSC-2015 is distributed differently. As a result, an update to the Quick Cost Model is being developed in an attempt to capture the effect of this infrastructure reduction on total O&S costs. (Myers, 1994)

Over the past four years (FY1990-93), DOD has experienced an approximately 25 percent force reduction under Secretary of Defense Cheney's "Base Force" concept. Actual budget expenditures associated with this downsizing have been compared with a modified Quick Cost Model that assumes a 50 percent fixed-variable cost relationship in the aggregate among support AEs. Results so far indicate a close comparison exists between actual and estimated budget expenditures, apparently reflecting the trend towards a more variable behavior in support AE cost while force infrastructure is reduced.

Utilizing the O&S cost data determined from Table 7 for MRSC-DS, and Table 14 for MRSC-2015, as well as the overall size of each MRSC (using MRSC-DS as the 100 percent Notional Force Level), a plot of Notional O&S Costs versus Notional Force Level was developed. Also included on the plot were the historical and 100 percent fixed-variable O&S cost relationships. In Appendix L, Figure L-1, the data point for MRSC-2015, using the updated support AE cost relationship, appears below the historical cost line. This reflects the increasingly variable (and less fixed) nature of support AE cost behavior as infrastructure is reduced. Extending this line further, a projected fixed-variable cost relationship can be plotted. If one to include the 0 percent Notional force level, a total O&S cost curve as a function of force level, represented by the dashed line, can be sketched. This line decreases at a increasing rate, reflecting the economies of scale that occur in the production of O&S activities. (Franck and Hildebrandt, 1993, p. 23)

C. CAPITAL SERVICES VALUE AND O&S COSTS

1. Comparing MRSCs

A useful examination is to compare and contrast MRSC-DS with the MRSC-2015 with regard to O&S costs and capital services values. Presented in Chapters III and IV were various force elements (i.e., aircraft carriers, Navy tactical air, Navy support air, surface combatants and submarines, amphibious ships, support and auxiliary ships, MEB(s) without air, USMC logistics air, USMC tactical air, weapons/ordnance and space assets). In those two chapters, ratios relating force element O&S cost to force element capital services value, force element O&S cost to total MRSC capital services value, and force element capital services value to total MRSC capital services value were developed.

Presented in Appendix L, Figures L-2A through L-7F, summaries of the O&S and capital services value results are displayed and compared between the MRSC-DS and MRSC-2015.

a. Capital Services Values

Figures L-2A and L-2B display the contribution of force element capital services value to total MRSC capital services value (excluding space) for MRSC-DS and MRSC-2015 respectively. Some interesting conclusions can be drawn from comparing the data between the two MRSCs. For MRSC-1990, the four largest contributors to total capital services value are (in order) Navy tactical air (25.3 percent), surface combatants and submarines (23.6 percent), and Navy support air and support and auxiliary ships (9.8 percent). Comparing this result with the MRSC of 2015, the top four contributors were Navy tactical air (26.3 percent), surface and submarines (23.4 percent), weapons (18.3 percent), and amphibious ships (7.5 percent).

Analyzing this data, it is obvious that force elements such as ships and planes, which will be relied upon well into the next century, will continue to make up a large portion of each dollar invested in military capital stock for the MRSC of the future. Naturally, Navy tactical air will have some new programs such as the F-117N and the F/A-18 E/F, yet these should not absorb the amount of R&D costs that newer, unproven systems (e.g., space and weapons) may require.

As discussed, weapons and ordnance capital services value occupy a "larger share of the pie." Recall from Chapter IV, MRSC-2015 has a host of new weapons systems, not all of which will be operational until sometime after the year 2000 (due to the 15 year service life of weapons). As a result, the 1:1 procurement to R&D ratio holds true here, and thus contributes to the rise in cost of the capital services value.

In Figure L-3, a comparison between the capital stock value and capital services value for each of the MRSCs is displayed. First, it is important to note here the huge difference between the capital stock and capital services values for each of the MRSCs. This signifies the importance of factoring in service life when determining an appropriate level of yearly investment (procurement & R&D) to maintain this force. Secondly, the difference in capital stock value for MRSC-DS and MRSC-2015 represents additional costs to develop and procure new platforms and systems. Although smaller in number, R&D and procurement costs will cause the capital stock (as well as capital services) value to be higher for MRSC-2015.

b. O&S Costs

Figures L-4A and L-4B show the breakdown between force element of O&S costs for MRSC-DS and MRSC-2015 respectively. Figure L-5 compares overall O&S costs and also the breakdown between primary, related and support AEs. In analyzing Figures L-4A and 4B, it is clear that not much of a change in the weight of contribution of each force element occurs between the two MRSCs. Although decreasing in number, other force elements (e.g., Navy support aircraft) increase as a percentage of O&S costs due to the fact that more dramatic reductions occur in other force elements (e.g., support, auxiliary and amphibious ships). This reflects the need to support fewer overall ships and employ only one MEB, resulting in these force element O&S costs being reduced by more than one-third. Accordingly, as shown in Figure L-5, total O&S costs decrease by approximately 25% from MRSC-DS to MRSC-2015. This is in line with expectations for a MRSC that goes from 123 ships and six aircraft carriers to 84 ships and four aircraft carriers.

It is now worthwhile to bring together both the O&S costs and the capital services values of each MRSC to compare yearly cost. Total O&S cost is basically that amount of yearly appropriations required to man, operate and maintain the readiness of forces. Capital services value is basically the level of investment (procurement) needed each year to maintain military capital inventories, compensating for loss or retirement. It includes the costs of R&D for new platforms, as well as procurement costs. Recall that existing platform capital services values excludes the cost of R&D, considering that to be a "sunk cost."

In Figure L-6, a comparison is made between MRSC-DS and MRSC-2015 with regard to the O&S costs, capital services value, and total yearly cost. MRSC-2015 requires approximately 1.25 times the capital services value but only .75 times the O&S costs. In addition overall yearly cost of

MRSC-2015 as compared with MRSC-DS is approximately 10 percent less!

c. Ratio Analysis

As presented in Tables 8 and 15, a set of ratios was developed for each MRSC to analyze O&S costs and capital services values of the various force elements. Displayed in Figures L-7A through L-7E are graphic comparisons of this data.

Figure L-7A and L-7B compare O&S costs to capital services values between MRSC-DS and MRSC-2015, and show that the most dramatic changes occur in the following force elements; carriers, surface combatants and submarines, MEB(s), and amphibious ships. For carriers, this can be attributed to the high O&S cost conventionally powered platforms being replaced by a lesser number of more capital-intensive, yet efficient, nuclear powered ships. As a result, O&S costs are dramatically reduced, while capital services value increases slightly, thus providing for the decrease. Surface combatants and submarines display a similar relationship, with older steam-driven surface combatants being reduced in number and replaced by more capable and efficient gas turbine-powered ships, while submarine platform design remains fundamentally unchanged. The change in the MEB(s) force element reflects the reduction of two MEBs to one MEB with upgraded equipment. This results in substantially lower O&S costs due to manpower reductions, yet only a marginal decrease in capital services value due to having more capable equipment. Lastly, the amphibious ship force element reflects the dramatic reduction in the numbers of ships required, thus reducing O&S costs. Despite containing fewer vessels, amphibious ship capital services value actually increases with the acquisition of these more capable ships.

Figures L-7C and L-7D compare force element O&S cost to total capital services value between MRSC-DS and MRSC-2015. The force elements of carriers, surface combatants and submarines, MEB(S), and amphibious ships exhibit a similar relationship as previously discussed. This is expected, since the capital services value contribution for each force element as a percentage of total capital services value (as shown in Figures L-2A and L-2B) remained basically the same between MRSC-DS and MRSC-2015. The difference is primarily due to the change in O&S costs alone.

One added exception is the support and auxiliary ship force element. As shown in Figure L-7A, its O&S costs to capital services value ratio remains basically unchanged. However, when compared to the total capital services value, support and auxiliary ship O&S costs contribute significantly less (.191 vs .365). This is mainly due to this force element contributing only one-half as much (4.9 vs 9.8 percent) towards total capital value that increases between the two MRSCs. As a result, the smaller force element contribution is reflected in this ratio.

Figures L-7E and 7F reinforce the analysis conducted when comparing O&S costs to both capital services values and total capital services values. Support and auxiliary ships show the most dramatic reduction, which is due mainly to the fewer number of ships needed to support the MRSC-2015 without requiring a equivalent offset in an increase in force element capital value. The MEB(s) and USMC tactical air force elements show similar reductions in their ratios, reflecting the smaller numbers of these force elements without a corresponding increase in capital value.

2. Space

Now that an examination of the cost of each MRSC has been conducted without space, it is now appropriate to analyze space with regard to capital services value, O&S costs, and total yearly cost. Figure L-8 displays capital services value, total O&S and total yearly cost to support the space forces element for each MRSC. The MRSC-DS space force element required approximately $4.8 billion (FY 1990 dollars) to sustain on a yearly basis, while MRSC-2015, with a capability to engage in land warfare, would cost about $20 billion on a yearly basis. (Wolfert, 1993, p. 23, SIS, 1993, p. 38)

D. TWO MRSCs

In this section, two issues are developed: first, economies of scale evident when combining two MRSCs without space with the space force element, and second, the issue of aircraft carrier opportunity cost associated with organizing one or two MRSCs, and how that might affect other Navy global commitments.

1. Economies of Scale

Economies of scale occur when the average cost of a unit declines with increases in output. Even though the cost continues to increase with increasing production, it does so at a decreasing rate, so that on the margin, the unit cost is decreasing. Despite the significant investment in developing, procuring and operating a space force element, this element can be used for more than one MRSC, and as a result, the cost of a second MRSC, based around four aircraft carriers and one MEB, is much less expensive.

Figure L-9 puts into this perspective the concept of economies of scale. Listed on the horizontal axis is one MRSC-2015, two MRSC-2015s, and the total inventory of platforms and assets (space, ships, planes, weapons and equipment) required to sustain two MRSC-2015s. This last grouping assumes that 80 percent of all Navy and Marine afloat platforms and assets are involved, with the remainder being in transit off station, or unavailable due to maintenance or overhaul. (This infers that 20 percent of the overall inventory of platforms would not be available at any one time due to lengthy and complex maintenance already in progress, or having just completed extended overseas operations).

Figure L-9 shows that with the combination of a second MRSC to the original MRSC presented (twice the effectiveness), the cost increases by less than 50 percent. This takes into consideration that the space force element, as a fixed cost, can be utilized by both MRSC-2015s. (Each MRSC uses the same satellites for communication, navigation, intelligence etc.) (Wolfert, 1994) As a result, a decrease is experienced in the unit cost of acquiring and supporting an additional MRSC. The final category is the total inventory of Navy and Marine afloat platforms and assets needed to sustain the presence of two MRSC-2015s in different regions of the world. This shows only a 15 percent increase in cost when assuming that 80 percent of the Navy and Marine Corps assets are available for a short period of time. Reductions in ship and plane inventory requirements could be achieved if an opportunity arises where each MRSC-2015 could operate in the same general region of the world (e.g., Mediterranean Sea and Indian Ocean). If this were the case, yearly costs for two MRSC-2015s could probably be more closely estimated using the middle column.[4]

2. Aircraft Carrier Opportunity Cost

With the reduction in the force structure of the Navy, the question needs to be asked, "How does the employment of aircraft carriers organized around the concept of a MRSC affect the Navy's ability to address other global commitments?" Traditionally, the aircraft carrier has been

[4]For MRSC-2015, since R&D cost is amortized instead of being treated as a fixed or entry cost, economies of scale are less pronounced in these calculations.

seen as a stabilizing influence overseas, providing an symbol of U.S. resolve and commitment. As the number of aircraft carriers decline, how might that impact regional commitments in other parts of the globe when the U.S. is involved in one or possibly two near simultaneous Major Regional Conflicts? Assuming that each MRC would require one MRSC consisting of four aircraft carriers each, what type of overseas presence in other parts of the globe might the Navy be able to sustain? These are all questions that need to be evaluated.

Recent studies have focused on the long-term peacetime operating tempo of aircraft carriers and the Navy in general to determine an adequate size force to maintain. (O'Rourke, 1991, p. CRS-1) Of concern were things such as maintaining a 50 percent personnel tempo, as well as supporting and completing all scheduled maintenance periods.

However, during a crises, when one or nearly two simultaneous MRCs develop, peacetime operating concerns could be expected to be discarded. Long-term operating tempo is replaced by short-term station-keeping abilities. A station-keeping multiplier is the number of total carriers needed to maintain one on station somewhere in the world. Thus, how would the formation of one, or even two MRSCs, with four aircraft carriers each, affect U.S. commitments in other parts of the world?

To appreciate this dilemma, one only has to look as far back as the Persian Gulf War. During the five months of

Desert Shield, the U.S. maintained 3 to 5 out of an inventory of 14 aircraft carriers in the area. This was an implied short-term station-keeping multiplier of 2.8 to 4.7. (O'Rourke, 1992, p. CRS-19) During the five weeks of Desert Storm, the U.S. maintained 6 aircraft carriers in the area, which implied a short-term multiplier of 2.3.

Assuming the U.S. was to form one MRSC, and still maintain the inventory of 11 active and one training aircraft carriers, no more than 7 carriers would be available. (One aircraft carrier would be assumed to be in a complex overhaul and not available for at least 90 days). However, to numerically form a second MRSC, the short-term multiplier attained during Desert Storm would be exceeded. (7 divided by 4 = 1.75). In fact, if 8 carriers formed two MRSCs in different parts of the world (e.g., Western Pacific and Mediterranean Sea), the United States would only have three carriers to relieve or replace deployed carriers--a situation that could not be sustained for a prolonged period of time.

In conclusion, aircraft carrier opportunity cost would impact in two distinct ways: deferred maintenance, and peacetime overseas operating commitments which may go unfulfilled.

E. TOOTH-TO-TAIL

Mentioned earlier in this chapter was the concept of the "tooth-to-tail" ratio that relates in terms of costs the "precision strike power" (tooth) of the MRSC to the necessary support required to sustain the MRSC (tail). With limited resources available for future force planning, this is a useful concept that can be introduced here and considered by DOD planners for additional refinement and clarification.

The terminology "precision strike power" (tooth) refers to those platforms in the MRSC that are directly involved in providing for ordnance delivery to the target or objective. Another way to look at it would be to say to oneself.... "What assets or platforms do I consider most capable in initiating power projection from the sea and hence, consider most valuable?" This group of assets and platforms would be different than those required to maintain power projection from the sea. Naturally, there would be some overlap, as in the case of aircraft carriers that not only launch tactical aircraft but also recover and ready them for additional sorties, yet that could be interpreted as a secondary role). The aircraft carrier's most important role, its one primary mission, is initiating air strikes by getting a plane off the deck and over the objective with ordnance on target. Recovery is secondary. In this instance, the aircraft carrier platform would be considered "tooth", not "tail".

Utilizing this distinction, the following force elements are considered to be part of the "tooth": aircraft carriers, Navy tactical aircraft (A-6, F-14, F-117N, F-18), surface combatants (including minesweepers), submarines, amphibious ships, MEB(s) without USMC air, both USMC tactical (AV-8B, AH-1/UH-1, OH-58) and logistics (CH-53, CH-46, and V-22) air, and weapons and ordnance. Platforms considered to be part of the "tail" would be Navy support aircraft, support and auxiliary ships. (Due to the fact that space assets are not costed out in the same manner as other force elements of the MRSC, they are excluded from this analysis).

Once assets and platforms are segregated into a tooth or tail role, an examination of relevant O&S costs needs to be determined in order to realistically develop a useful cost relationship. Recall that O&S costs are separated into three categories: primary, related, and support AEs. Primary AE O&S costs are those associated with direct operation of a platform, such as operating a ship at sea. Related AE O&S costs are indirectly associated with the ship, such as maintaining and manning command and control facilities ashore. Lastly, support AE O&S costs are those least closely associated with the platform's operation, including such items as maintenance, housing and medical support.

Accordingly, only the primary AE O&S costs of those assets and platforms involved in initiating precision strike are included in the "tooth" category. All other O&S costs -- the related and support AE costs of the "tooth" platforms, as well as all other primary, related, and support AE costs of the remainder of the platforms and assets -- are considered part of the "tail."

It is appropriate to express this ratio in a useful relationship, incorporating both the capital services values and the O&S costs discussed above:

$$\frac{\textit{Tooth FE}(\textit{C Svcs Value}+\textit{Pri AE})}{\textit{Tooth FE}(\textit{Rel AEs}+\textit{Supp AEs})+\textit{Tail FE}(\textit{C Svcs Value}+\textit{All AEs})}$$

where FE stands for Force Element. Stated differently:

$$\frac{(\textit{Capital Svcs Val} + \textit{Pri O/S Cost})\ \textit{Init}}{(\textit{Capital Svcs Val} + \textit{All O/S})\ \textit{Maint} + \textit{Other O/S of Init}}$$

where the numerator represents the cost to initiate, and the denominator the cost to maintain, a precision striking capability.

Using the data from Chapters III and IV, Figure L-10 shows a comparison of the tooth-to-tail ratios between MRSC-DS and MRSC-2015. Comparing the two graphs, for MRSC-DS, it is obvious that tooth is $7.324 billion as compared to tail of $6.119 billion (roughly a 7:6 ratio). For MRSC-2015, tooth is $7.521 billion as compared to a tail of $4.585 billion (roughly a 7:4 ratio). The more favorable ratio of 7:4 for MRSC-2015 reflects an increasingly effective and efficient force, able to perform its assigned mission without requiring as significant a support structure. Recall that in considering distinctions between what was considered tooth and what was considered tail, the former included platforms and assets required to <u>initiate</u>, whereas the latter <u>maintained</u>, precision strike.

VI. CONCLUSIONS

A. DISCUSSION

Presently, several different issues are in the process of shaping the U.S. Navy and Marine Corps of the future. Among these are the MTR, new strategic concepts in warfighting, fiscal and resource constraints, and the unwillingness of the United States to sustain high numbers of casualties in future conflicts. This thesis has attempted incorporate these concerns and determine how the size and composition of the U.S. Navy, built around the concept of the MRSC, may change as it enters the 21st Century. An MRSC is not the only answer available to Navy force planners, programmers and budgeters, but it may provide a new framework whereby "reactive" planning may be replaced by "proactive" planning. It does not address all roles or missions of the Navy and Marine Corps, but rather concentrates on their ability to quickly respond to two near simultaneous Major Regional Conflicts as envisioned in the BUR. It is an attempt to determine resource requirements to fit the strategy, not the other way around.

Navy and Marine Corps forces developed around the concept of MRSC-2015 are similar in many ways to MRSC-DS. MRSC-2015 can be forward deployed and have the flexibility and staying power to respond as the first forces on the scene in any U.S. involvement in Major Regional Conflicts. Manned aircraft, such as stealth fighters and attack planes, continue to operate from aircraft carriers at sea in support of MRSC-2015's deep-strike role. In addition, surface combatants, submarines, and mobile amphibious forces engaging in "operational maneuver from the sea," provide MRSC-2015 with a littoral as well as deep-strike capability against enemy forces. What is fundamentally different between MRSC-DS and MRSC-2015 is the fusion of space system capabilities with afloat Navy and Marine Corps assets that gives MRSC-2015 "information dominance" of the battlespace against the enemy.

B. CONCLUSIONS

Future Navy and Marine Corps forces developed around the concept of MRSC-2015 are fewer in number by approximately one-third when compared to MRSC-DS. Composition of MRSC-2015 remains approximately the same as MRSC-DS, with some force elements decreasing by more than one-third (e.g., the number of MEBs from two to one), and some less (e.g., surface/ submarine force element due to the increase in minesweepers).

O&S costs are becoming more variable as layers of infrastructure are reduced in the current downsizing underway in DOD. In analyzing the top line of the entire DOD, an estimated 50 percent fixed-variable factor for all support AEs resulted in a close approximation of estimated model expenditures with actual budget expenditures from FY 1990-93. In the Quick Cost Model, this assumed 50 percent fixed-variable factor was used in calculation of support AEs for MRSC-2015.

However, if significant additional downsizing occurs, the long-run total O&S curve should continue to become increasingly variable, and approach a 100 percent fixed-variable factor as shown in Figure L-1.

Navy tactical air O&S costs actually increased from MRSC-1990 to MRSC-2015, despite the number of aircraft decreasing by more than one-third. Navy support air O&S costs remained about the same, while their numbers also decreased. The behavior in aircraft O&S costs is probably due to changes in the fixed-variable percent for support AEs, some of which had fixed-variable percent originally higher than the assumed 50 percent used in MRSC-2015. As a result, aircraft O&S costs for MRSC-2015 would be greater than anticipated for a given force level. In addition, the F-14 aggregate element was used for input into the model for the F-117N, since the Stealth fighter has not been introduced into the fleet. Finally, no distinc-tion was made between the current F-18 A/B & C/D with the follow-on E/F model. Thus, any O&S cost savings engineered into the later aircraft are discounted.

O&S costs for MRSC-2015 are approximately 25 percent less than for MRSC-DS. This is expected due to the reduced number of platforms in MRSC-2015. In particular, most force element O&S costs were reduced proportional to the change in the number of platforms (i.e., approximately one-third). As discussed, Navy tactical air O&S cost actually increased, while Navy support air remained constant. This resulted in an overall decrease in O&S cost between MRSCs closer to 28 percent.

Capital services value increases by approximately 29 percent from MRSC-DS to MRSC-2015. This shows a shift in funding on a long-term yearly basis from O&S to capital stock development and acquisition. As a result, the need to recapitalize the fleet, through investment in the procurement and R&D accounts, becomes an increasingly dominant part of the overall budget. This conclusion was supported by using broad estimates for procurement and R&D ratios into the 21st century, which may require additional refinement and scrutiny.

Weapons and ordnance capital services value increased by approximately a factor of three from MRSC-DS to MRSC-2015. MRSC-2015 relies significantly on a new family of stand-off precision strike weapons, which allow many of the "traditional" platforms of MRSC-DS to maintain useful roles for MRSC-2015. Recall that weapons are assumed to have a service life of 15 years, and as a result, are all procured after the year 2000 for MRSC-2015. Accordingly, a 1:1 ratio for procurement to R&D was utilized, adding to a significant cost increase in acquiring new weapons.

Space occupies a larger share of capital services value in MRSC-2015, escalating by more than a factor of four. This is primarily due to space assets having an assumed 10 year service life, and as a result, a 1:1 procurement to R&D

ratio. Space O&S cost mirrors the increase in capital services value, showing a dramatic rise between MRSC-DS and MRSC-2015. Recall that all space costs are only a broad approximation, yet underline the increase in investment (procurement and R&D) and O&S costs that are likely to be needed to field and maintain the required space-based capability to support MRSC-2015.

The concept of tooth-to-tail illustrates the improvement in the precision striking power in MRSC-2015 for a given level of support. With a reduction in the number of support and auxiliary, as well as amphibious ship force elements, along with the increases in stand-off weaponry, the tooth-to-tail ratio improves for MRSC-2015. As a result, MRSC-2015 appears to be configured to better support power projection from the sea onto land.

Given the size and composition of one MRSC-2015, how affordable would it be to be able to provide the capability to support two near simultaneous Major Regional Conflicts, each with its own MRSC-2015? Recall that in Figure L-9, assuming a 80 percent availability of Navy and Marine Corps forces over the short-term, approximately $50 billion (FY 1990 dollars) is needed in investment and O&S costs (in Navy, Marine Corps and Air Force accounts) on a yearly basis.

C. RESEARCH QUESTIONS

The capital services value of a Navy configured around the concept of one MRSC-2015 is $5.43 billion (FY 1990 dollars), and $10.86 billion (FY 1990) for two MRSC-2015s. To allow for a 80 percent availability of forces, capital services value rises to $13.575 billion (FY 1990 dollars). O&S costs for one MRSC-2015 is $6.676 billion (FY 1990 dollars), and $13.352 billion for two MRSC-2015s. Allowing for a 80 percent availability of forces, O&S costs rise to $16.690 billion (FY 1990 dollars). Combining capital services values with O&S costs, and adding the estimated $20 billion (FY 1990) of space asset capital service value and O&S cost, the total is $50.265 billion (FY 1990 dollars) necessary to engage in two near simultaneous Major Regional Conflicts.

The size of a Navy configured around the concept of an MRSC is reduced by approximately one-third when comparing MRSC-DS with MRSC-2015. The Navy configured around MRSC-2015 maintains many of the same platforms and assets as in MRSC-DS. However, additional emphasis is placed on stand-off precision weaponry and stealth technologies. Increased emphasis on joint operations is the result of the total integration and fusion of space systems with Navy and Marine Corps assets, resulting in a synergistic effect in improving mission capability.

The O&S cost to capital services value ratio changes from approximately 2.2 for MRSC-DS to approximately 1.3 for MRSC-2015. This represents the increased emphasis needed for recapitalization, and the reduced costs of maintaining a smaller and more efficient force of MRSC-2015.

Several challenges were encountered when attempting to estimate the cost of MRSC-2015, both for capital services values and O&S costs. For capital services values, assumptions had to be made with regard to an R&D to procurement cost ratio for investing in the force of the future. This ratio was a broad approximation, and most likely contributed to some distortion of the capital services value for MRSC-2015. Space capital services value was a rough estimate of costs associated with developing and acquiring systems for MRSC-2015, and did not contain the accuracy of other data. As a result, separate analyses of MRSC-2015 (without space) and MRSC-2015 (with space) were conducted in an effort to compare force elements. In addition, assumptions had to be made as to what types of platforms and weapons the Navy and Marine Corps would acquire for MRSC-2015 such as the MX, the 21st Century Strike destroyer, and HELLWEPS.

For O&S costs, several platforms such as the DDG-51 destroyer, minesweepers, and V-22, were not in the Quick Cost Model database. As a result, substitutions had to be made that closely approximated the desired platforms. When entering platform types as inputs into the Quick Cost Model, older DDG-2/37 class destroyers were used for the DDG-51, patrol combatants for minesweepers, and CG-47 cruisers for the 21st century Strike destroyer. In addition, the CH-46 was used for the V-22, and the F-14 for the F-117N. Another difficulty was that the Quick Cost Model did not differentiate between classes of amphibious ships. For instance, in the model, the huge LHA or LHD-class amphibious assault ships had the same O&S cost as the smaller LST tank landing ships. These two classes of ships are very different in size and mission, and would not be expected to incur the same O&S costs. For MEB(s), a fractional estimate of the cost of a Marine division was used to approximate O&S costs. One-third was used for 1 MEB, and two-thirds for two MEBs.

D. AREAS FOR FURTHER RESEARCH

With some exceptions (e.g., SLEP for aircraft carriers), conversions and upgrades were not considered in the capital services value of platforms. The result is that a slight undervaluation of the capital services value may have occurred, especially in the ship area. Additional study and research in this area might be worthwhile to refine the capital services value estimates provided.

Various service life estimates of platforms and assets appeared in several references. The author limited selection to just one reference in determining the various force element service lives. This area may require further refinement and investigation, due to the impact of estimating service life on recapitalizing forces for the future.

A broad assumption was made with regard to R&D and procurement cost for future investment in forces. One potential area of study might be in determining how this ratio may change as the Navy and Marine Corps attempt to develop investment strategies for the force of the future.

A soon to be released (Spring 1994) version of the Quick Cost Model should incorporate an updated version of the fixed-variable percent factors affected by the reduced force infrastructure. Recomputing and analyzing O&S costs with updated fixed-variable percent factors for MRSC-2015 and comparing them to these results might be useful.

TYPE OF FORCE AEs	(a) PROXY USED TO DISTRIBUTE RESOURCES: Units	(a) Budget Authority (Dollars): Military Pay	(a) Budget Authority (Dollars): Total O&M	(a) Budget Authority (Dollars): Civilian Pay O&M Only	(a) Budget Authority (Dollars): BTL Procurement	(a) Officer End Strength in Aviation AEs	(a) Military End Strength	(b) SOURCE OF & DATA USED TO APPLY PROXY: Primary	(b) Related	(b) Auxiliary	(b) MSF Force Training	(b) Mgt. HQ-Combat	(b) BOS-Combat	(b) CSF Flight Training	(b) Logistics	(b) Training	(b) BOS-Support	(b) Mgt. HQ-Support	(b) Medical/Personnel Support	(c) APPROPRIATIONS ADJUSTED: Military Personnel - Service	(c) O&M - Service	(c) Procurement - BTL	(c) Military Family Housing	(c) Military Construction, Other	(c) Military Construction, Family Housing
Primary	✓																			✓	✓	✓			
Related		✓						✓												✓	✓	✓			
Auxiliary		✓						✓												✓	✓	✓			
MSF Force Training		✓						✓	✓											✓	✓	✓		✓	
MNGT HQ COMBAT		✓		✓				✓	✓	✓	✓									✓	✓	✓		✓	
BOS COMBAT		✓	✓					✓	✓	✓	✓	✓								✓	✓	✓		✓	
CSF Flight Training						✓		✓	✓	✓	✓	✓	✓							✓	✓	✓		✓	
Central Logistics			✓		✓			✓	✓	✓	✓	✓	✓	✓						✓	✓	✓		✓	
Individual Training		✓						✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓		✓	
BOS-Support		✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓
Central Spt. Act. and Mgt. HQ.-Support		✓		✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓			
Medical and Personnel Support		✓						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			
Miscellaneous							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					

(a) Relationship of AECs and Allocation Variables

(b) Inter-AEC Relationships

(c) Resources Adjust

AEs in Each AEC

APPENDIX B

INTERNAL FACTORS

F#	Factor Name	RI	RI Title	Coefficient
1	ES, Officers	00020	Active Service-Officer-Navy	1.0
		00030	Active Service-Officer-MC	1.0
2	ES, Enlisted	01020	Active Service-Enlisted-Navy	1.0
		01030	Active Service-Enlisted-MC	1.0
3	ES, Civilian	01600	Civilian	1.0
4	ES, Resrv.Off.	00060	Paid Drill-Officer Resrv.	1.0
		00110	Active Res Ofc	1.0
5	ES, NG. Off.	None		
6	ES, Resrv.Enl.	00130	Active Reserve Enlisted	1.0
		01060	Paid Drill-Enlisted	1.0
7	ES,NG. Enl.	None		
8	BTL Procure.	04100	Procurement-Aircraft-Navy	1.0
		04110	Procurement-Weapons-Navy	1.0
		04330	Other Procurement-Navy	1.0
		04340	Procurement-MC	1.0
9	O&M-Civ.Pay	01600	Civilian	-34.334
		05020	O & M Reserve-Navy	1.0
		05110	O & M-Navy	1.0
		05120	O & M-MC	1.0
		05310	Stock Funds-Navy	1.0
		05870	Industrial Funds-Navy	1.0
		05980	Operations Gain/Loss	1.0
10	Mil.Const.	04410	Military Const.-Navy	1.0
		04450	Mil.Con. Resrv.-Navy	1.0
11	Fam. Housing	None		
12	Fam.Hous.Con	04530	Family-Housing-Defense	1.0
13	Milpers	05610	Military Personnel-Navy	1.0
		05620	Military Personnel-MC	1.0
		05650	Reserve Personnel-Navy	1.0
		05660	Reserve Personnel-MC	1.0

APPENDIX C

Capital Stock Value-Ships
MRSC-DS

Class	Ship Name	Unit Cost
Aircraft Carriers		
CV	Saratoga	2,150,509
	Midway	1,164,328
	Ranger	1,711,331
	America	2,053,040
	Kennedy	2,065,390
CVN	Roosevelt	3,651,229
		12,795,827
Submarines		
SSN	Pittsburgh	597,759
	Chicago	748,963
	Louisville	669,335
	Key West	678,764
	Newport News	728,890
	Philadelphia	696,247
		4,119,958
Battleships		
	Missouri	1,556,251
	Wisconsin	1,273,556
		2,829,807
Cruisers		
CG		
	Worden	506,160
	Turner	513,107
	Biddle	417,646
	Horne	545,097
	Jouett	627,701
		2,609,711

Class	Ship Name	Unit Cost
CG-47	Antietam	1,037,080
	Princeton	1,169,088
	Bunker Hill	1,260,734
	Gates	1,310,011
	Leyte Gulf	976,610
	Mobile Bay	1,179,453
	Normandy	1,150,000
	San Jacinto	1,142,210
	Valley Forge	1,110,630
		10,335,816
CGN	Mississippi	668,769
	Virginia	1,092,956
		1,761,725
Destroyers DD	Caron	309,064
	Hill	278,692
	Fife	251,480
	Leftwich	289,526
	Oldendorf	393,106
	Foster	406,489
	Spruance	510,996
	Moosebrugger	336,011
		2,775,364
DDG	Kidd	723,411
	Tattnal	300,889
	Preble	389,152
	MacDonough	384,146
	Pratt	447,407
		2,245,005

Class	Ship Name	Unit Cost
Frigates FF		
	Hammond	154,943
	Vreeland	141,341
	Barbey	114,833
	Brewton	123,190
	Hart	114,833
		649,140
FFG		
	Jarrett	222,798
	Bradley	226,376
	Curts	295,019
	Ford	323,998
	Hawes	272,408
	McInery	210,229
	Nicholas	223,092
	Roberts	301,585
		2,027,505
Large Amphibs LHA		
	Tarawa	876,575
	Nassau	1,073,885
		1,950,460
LCC		
	Blue Ridge	678,943
		678,943
LPH		
	Iwo Jima	430,165
	Okinawa	415,364
	New Orleans	405,028
	Guam	424,032
	Tripoli	304,735
		1,979,342

Class	Ship Name	Unit Cost
Other Amphibs LSD		
	Fort McHenry	446,631
	Germantown	476,120
	Gunston Hall	389,122
	Mount Vernon	147,298
	Anchorage	173,056
	Pensacola	164,362
	Portland	189,300
		1,985,889
LPD		
	Raleigh	391,342
	Denver	307,783
	Dubuque	236,086
	Juneau	281,135
	Ogden	365,438
	Shreveport	231,338
	Trenton	241,890
	Vancouver	338,292
		2,393,304
LST		
	Barbor County	93,873
	Manitowoc	204,378
	Peoria	110,674
	Cayuga	109,456
	Fredrick	109,078
	Lamoure County	92,852
	Saginaw	118,562
	Spartensburg County	92,927
		822,344
LKA		
	Durham	157,710
	Mobile	144,288
	St. Louis	144,521
		446,519

Class	Ship Name	Unit Cost
		Minesweepers
MCM & MSO		
	Avenger	218,000
	Adroit	44,000
	Impurvious	44,000
	Leader	44,000
		350,000
Support/Replenishiment & Logistics Ships		
AOR/AOE		
	Detroit	536,737
	Kalmazoo	202,201
	Seattle	562,889
	Kansas City	202,057
	Sacramento	570,941
		2,074,825
AE		
	Haleakala	150,775
	Nitro	150,174
	Shasta	196,781
	Kiska	164,157
	Mount Hood	211,010
	Santa Barbara	232,360
		1,105,257
AO		
	Cimarron	238,024
	Monogahela	187,552
	Williamette	209,607
	Platte	189,276
		824,459

Class	Ship Name	Unit Cost
AFS		
	Concord	166,678
	Niagara Falls	163,020
	San Jose	155,253
	San Diego	156,509
		641,460
Support Ships		
AD		
	Yellowstone	437,292
	Acadia	355,381
	Cape Cod	386,279
	Puget Sound	378,082
AR		
	Jason	309,040
	Vulcan	257,376
AS		
	McKee	404,962
AGF		
	LaSalle	361,497
ARS		
	Opportune	39,917
ATS		
	Beaufort	58,565
		7,634,392
	Total:	65,037,052

Note: Costs estimated from the "Historical Costs of Ships Information System Database." Washington D.C., Department of the Navy, Naval Sea Systems Command (SEA 017), April 1992. All costs in thousands of FY 90 dollars.

APPENDIX D

CAPITAL STOCK VALUE-AIRCRAFT
MRSC-DS

Type	Req.	Training	Pipeline	Other	Inv.	UnitCost	Cost
F-14	104	.20	.13	4	154	72.0	11,088
F-18	134	.16	.10	5	183	36.9	6,753
A-6	50	.20	.13	2	74	44.9	3,323
AV-8B	26	.20	.12	5	42	25.2	1,059
S-3	41	.20	.13	2	61	28.8	1,757
E-2	30	.20	.13	1	45	64.5	2,903
EA-6B	27	.05	.14	0	33	39.6	1,307
AH-1	48	.16	.14	3	70	9.8	686
UH-1	48	.12	.11	11	65	9.8	637
CH-46	86	.11	.11	7	116	17.0	1,972
CH-53	50	.15	.14	8	77	22.6	1,740
SH-2/60	46	.20	.13	2	69	16.8	1,159
SH-3	36	.20	.13	2	54	9.8	529
OH-58	7	.14	.12	7	14	8.0	112
						Total	35,025

Note: Inventory numbers take into account aircraft needs for training, pipeline (maintenance), and other (e.g., R&D). To calculate inventory :

Ex: F-18 1.00/(1.00-.16) = 1.19, 1.19/(1.00-.10) = 1.32

1.32 x 134 = 177.1, 178 + 5 = 183

Costs estimated from The Revised Fiscal Requirements Model. (CRM 93-158). (Alexandria, VA,. Center for Naval Analyses, August 1993), Table 2. Factors obtained from "Naval Combat Aircraft: Issues and Options." Congress of the United States, Congressional Budget Office, November 1987, p. 38. All costs in thousands of FY 90 dollars.

APPENDIX E

CAPITAL STOCK VALUE-AMPHIBIOUS FORCES AFLOAT
MRSC-DS

Quantity	Description	Unit Cost	Total Cost
2	HQ Command Elements	20,775	41,550
2	Combat Service Support Elements	67,883	135,766
7	Infantry Battalion	8,693	60,851
4	Light Armored Infantry Company	5,318	21,272
2	Tank Company	23,458	46,916
2	Assault Amphibian Company	23,878	47,756
2	Recon Companies	1,011	2,022
1	Combat Engineer Company	2,907	2,907
1	Anti-Tank Platoon	1,634	1,634
1	Truck Company Det.	11,112	11,112
2	Air Control Group (Rotary Wing)	22,358	44,716
		subtotal	416,502
35	Tanks (M-60)	1,500	52,500
100	Amphibious Assault Vehicles (AAVs)	900	90,000
17	Landing Craft Air Cushion (LCACs)	25,000	425,000
150	Light Armored Vehicles (LAVs)	1,000	150,000
13	Landing Craft Utility	15,000	195,000
		Total	1,329,002

Note: Costs taken from Marine Corps Cost Factors Manual (MCO P7000.14K), Washington, D.C., HQMC, 14 June 1991, Table 6B2 for National Marine Expeditionary Brigade (MEB) Resource Costs. Assumes Two MEBs afloat. Does not include the cost of Marine fixed-wing aircraft, which is under APN. Assumes afloat fixed-wing aircraft control group integrated with carrier air wing. Order of battle taken from U.S. Marines in the Gulf, 1990-1991, Anthology and Annotated Bibliography. (Washington, D.C., HQ USMC. 1992), and author's estimate. Costs in thousands of FY90 dollars.

APPENDIX F

CAPITAL STOCK VALUE-SPACE ASSETS
MRSC-DS

Qty	Asset	GrndCon	UserCon	Booster	Sat	Total Cost
4	DSCS	150	150	120	180	2,400
5	FLTSATCOM	100	100	80	120	2,400
4	LEASAT	75	75	60	90	1,200
2	MACSAT	25	25	20	30	200
4	DSP	150	150	120	180	2,400
3	DMSP	50	50	40	60	600
16	GPS	75	75	60	90	4,800
*	Other Agency Assets					10,500
					Total:	24,100

Note: Information taken from Jane's Space Directory (JSD) (1993-1994) (Surrey, U.K. Jane's Information Group, Inc. 1993), pp. 185-206, New Technology for NATO-Implementing Follow-On Forces Attack. (Washington, D.C., Office of Technology Assessment, U.S. Congress. June 1987), Table 2-2, (Wolfert, 1994) and author's cost estimates for some assets. GPS was still not fully deployed at the time of the Persian Gulf War. LEASAT was leased for a period of time, then subsequently purchased. Assumes the following cost breakdown: 25% Ground Control, 25% User Control, 20% Booster and 30% Satellite. * Denotes several. All costs in millions of FY 90 dollars.

APPENDIX G

CAPITAL STOCK VALUE - WEAPONS
MRSC-DS

Type	Quantity	Unit Cost	Cost
TMHK	465	1,590	739,350
HARP	652	1,000	652,000
SLAM	100	910	91,000
HARM	1,500	240	360,000
MAV	300	110	33,000
HELF	2,000	45	90,000
TOW	2,000	12	24,000
HAWK	100	300	30,000
STGR	500	40	20,000
PHNX	300	810	243,000
SWDR	1,800	274	493,200
SPRW	2,124	173	367,452
MK82	9,600	3	28,800
MK83	9,600	5	48,000
GBUs	1,500	65	97,500
STDM	1,364	730	995,720
16"	2,800	5	14,000
5"	28,000	1	28,000
76mm	2,400	1	2,400
MN48	120	1,510	181,200
MK46	264	500	132,000
ASROC	234	491	114,894

Type	Quantity	Unit Cost	Cost
TALD	300	18	5,400
UAV	50	1,000	50,000
AMMO			334,000
		Total:	5,204,916

Note: Costs estimated from The Revised Fiscal Requirements Model. (CRM 93-158). (Alexandria, VA. Center for Naval Analyses, August 1993), Table 4, FY 1995 Budget and Revised FY 1994 Budget Plan Submission to the Secretary of Defense (Blue Book) and P-1 Annex. Department of the Navy, Washington, D.C., 15 October 1993, "Unit Costs for all Up Round G.P. Bombs and GBU-24B," Department of the Navy, Naval Air Systems Command Memorandum dated 17 Feb 1994, Marine Corps Cost Factor Manual (MCO P7000.14K), Table 6B2, Washington, D.C., HQMC, 14 June 1991, and author's estimate. Costs in thousands of constant FY90 dollars.

APPENDIX H

CAPITAL STOCK VALUE-SHIPS
MRSC-2015

Class	Ship Name	UnitCost FY 90X1000
Aircraft Carriers CVN	Enterprise	3,972,625
	Nimitz	3,763,550
	Vinson	3,278,731
	Roosevelt	3,651,229
		14,666,135
Submarines SSN	Providence	677,897
	Pittsburgh	597,759
	Key West	678,764
	Oklahoma City	508,808
	Louisville	669,335
	Helena	523,929
		3,656,492
SSN-21* (1.5:1)	SSN-23	1,498,165
	SSN-24	1,498,165
		2,996,330
SSBN	Alabama	1,311,383
	Tennessee	1,726,388
		3,037,771

Class	Ship Name	UnitCost FY 90X1000
Cruisers		
CG-47		1,037,080
	Antietam	1,260,734
	Bunker Hill	970,716
	Lake Champlain	976,610
	Leyte Gulf	1,179,453
	Mobile Bay	1,193,903
	Philippine Sea	1,169,088
	Princeton	1,142,210
	San Jacinto	1,310,011
	T.S. Gates	1,482,524
	Ticonderoga	
		11,722,529
Destroyers		
DDG-51		801,680
	DDG-65	801,680
	DDG-66	801,680
	DDG-67	801,680
	DDG-68	801,680
	DDG-69	801,680
	DDG-70	801,680
	DDG-71	801,680
	DDG-72	
		6,413,440
DDGX* (1:1)		980,000
	DDGX-1	775,000
	DDGX-2	775,000
	DDGX-3	775,000
	DDGX-4	
		3,305,000
Large Amphibs		
LHD		1,091,243
	Wasp	1,091,243
	Kearsage	
		2,182,486
LCC		678,943
	Blue Ridge	
		678,943

Class	Ship Name	UnitCost FY 90X1000
LHA		
	Saipan	907,318
	Tarawa	876,575
		1,783,893
Other Amphibs LSD-41/49		
	Fort McHenry	446,631
	Germantown	476,120
	Gunston Hall	389,122
		1,311,873
LX* (1.5:1)		
		702,983
	LX-1	507,680
	LX-2	507,680
	LX-3	502,742
	LX-4	502,742
	LX-5	502,742
	LX-6	502,742
	LX-7	
		3,729,311
Minesweepers MCS		
	ex-LPH	537,513
		537,513
MCM		
	Avenger	218,000
	Defender	115,000
	Sentry	115,000
	Champion	115,000
	Guardian	115,000
		678,000

Class	Ship Name	UnitCost FY 90X1000
MCS		
	MHC-56	99,625
	MHC-57	99,625
	MHC-58	99,625
	MHC-59	99,625
	MHC-60	99,625
		498,125
Combat Support/Replenishment & Logistics Ships AOR/AOE		
	Detroit	536,737
	Kalamazoo	202,201
	Seattle	562,889
	Kansas City	202,057
		1,503,884
ADCX* (1:1)		
	ADCX-1	300,000
	ADCX-2	300,000
	ADCX-3	300,000
	ADCX-4	300,000
		1,200,000
AO		
	Cimarron	238,024
	Monogahela	187,552
	Williamette	209,607
		635,183
MX* (1:1)		
	MX-1	250,000
	MX-2	250,000
	MX-3	250,000
		750,000
Support Ships AD		
	Yellowstone	437,292
	Acadia	355,381
	Cape Cod	386,279

Class	Ship Name	UnitCost FY 90X1000
AS	McKee	404,962
AGF	LaSalle	361,497
ATS	Beaufort	58,565 2,003,976
	Subtotal:	63,290,884
	(*) New Platform R&D:	8,738,760
	Total:	72,029,644

Note: Costs estimated from Review of the FY 1994/1995 Budget. Department of the Navy, Office of the Comptroller. Washington, D.C., 14 Oct 93, p. 1, "Historical Costs of Ships Information System Database. Washington, D.C., Department of the Navy, Naval Sea Systems Command (SEA 017), April 1992. "A Capable, Affordable 21st Century Destroyer," Naval Engineers Journal. May 1993, pp. 213-221, The Revised Fiscal Requirements Model (CRM 93-158), Alexandria, VA, Center for Naval Analyses, August 1993, Table 4., and "Selected Options for Enhancing Naval Options in Regional Conflicts." Washington D.C., Congress of the United States, Congressional Budget Office, June 1993. Costs in thousands of FY90 dollars.

APPENDIX I

CAPITAL STOCK VALUE-AIRCRAFT
MRSC 2015

Type	Req.	Training	Pipline	Other	Inv.	Unit Cost	Cost
F-117N*	56	.20	.13	3	84	87.1	7,316
F-18E/F*	144	.16	.10	5	196	50.0	9,800
AV-8B	28	.20	.12	5	45	25.2	1,134
S-3	28	.20	.13	2	43	28.8	1,238
E-2	20	.20	.13	1	30	64.5	1,935
EA-6B	22	.05	.14	0	27	39.6	1,069
AH-1	26	.16	.14	3	39	9.8	382
UH-1	8	.12	.11	11	22	9.8	216
V-22*	45	.11	.11	14	71	40.0	2,840
CH-53	52	.15	.14	3	86	22.6	1,943
SH-2/60	24	.20	.13	1	36	16.8	605
SH-3	24	.20	.13	1	36	9.8	353
OH-58	7	.14	.13	7	14	8.0	112
					Subtotal:		28,943
				(*) New Aircraft R&D:			13,303
							42,246

Note: Inventory numbers take into account aircraft needs for training, pipeline (maintenance), and other (e.g., R & D). To calculate inventory:

Ex: F-18 1.00/(1.00-.16) = 1.19, 1.19/(1.00-.10) = 1.32

1.32 x 144 = 190.1, 191 + 5 = 196

All costs in millions of FY 1990 dollars. All procurement to R&D ratios for new aircraft (*) assumed to be 1.5:1.

Costs estimated from The Revised Fiscal Requirements Model (CRM 93-158). (Alexandria, VA. Center for Naval Analyses, August 1993), Table 2, "Lockheed Pushes F-117N for Navy Deep-Strike Role," Aviation Week & Space Technology, 13 September 1993, pp. 96-97, "Options for Fighter and Attack Aircraft: Costs and Capabilities," Washington D.C., CBO Staff Memorandum, May 1993, and author's estimate.

APPENDIX J

CAPITAL STOCK VALUE-AMPHIBIOUS FORCES AFLOAT
MRSC 2015

Quantity	Description	Unit Cost	Total Cost
1	HQ Command Element	20,227	20,227
1	Combat Service Support Element	67,883	67,883
2	Infantry Battalions	8,693	17,386
2	Light Armored Infantry Company	5,318	10,636
1	Tank Company	23,458	23,458
1	Assault Amphibian Company	23,878	23,878
1	Recon Company	1,011	1,011
1	Combat Engineer Company	2,907	2,907
1	Anti-Tank Platoon	1,634	1,634
1	Truck Company Det.	11,112	11,112
1	Air Control Group (Rot.)	22,358	22,358
		subtotal	202,490
17	Tanks (M1A1)	3,000	51,000
50	Adv. Amphibious Assault Veh. (AAAVs)	2,200	110,000
24	Landing Craft Air Cushion (LCACs)	25,000	600,000
75	Light Armored Vehicles (LAVs)	1,000	75,000
		Total	1,038,490

Note: Costs estimated from Marine Corps Cost Factors Manual MCO P7000.14K, June 1991, Table 6B-2, Cost and Capability Evaluation of the Marine Corps Combined Arms Regiment (CAR). (Monterey, California. Naval Postgraduate School Thesis, December 1993), pp. 7-10 and author's estimate. All costs in thousands of FY90 dollars.

APPENDIX K

CAPITAL STOCK VALUE-WEAPONS
MRSC-2015

Type	Quantity	Unit Cost	Cost
TRDT	12	30,000	585,000
TBIP	266	1,590	423,940
SLAM	200	810	162,000
ATCM	494	630	311,230
TSSM	150	2,740	411,000
HELF	2,000	45	90,000
TOW	2,000	40	80,000
HARM	1,000	440	440,000
JSOW	240	1,500	360,000
STDM	758	730	553,340
TBMD	488	1,050	512,400
AMRM	800	1,200	960,000
JDAM	10,000	60	60,000
RAM	1,446	250	361,500
HELW	500	10	5,000
AVGN	3,000	197	591,000
ASRC	288	491	141,408
MK50	132	1,000	132,000
MK48	200	1,510	302,000
TALD	240	18	4,320
SRUV	32	6,000	192,000

Type	Quantity	Unit Cost	Cost
CRUV	48	8,500	425,000
VTOL	16	11,000	176,000
AMMO			166,000
		subtotal:	7,445,138
		(1:1) New Weapon R&D:	7,445,138
		Total:	14,890,276

Note: Costs estimated from The Revised Fiscal Requirements Model. (CRM 93-158). Alexandria, VA, Center for Naval Analyses, August 1993, Table 4, "Selected Options for Enhancing Naval Capability in Regional Conflicts", (Washington, D.C., CBO Staff Memorandum, June 1993), "Naval Anti-Missile Laser is Readied for Sea," Defense Electronics, April 1993, p. 19, "Unmanned Aerial Vehicles-Still a Top DOD Priority." Defense Electronics, March 1993, pp. 36-44, "Annual Report to the President and Congress," Washington, D.C., Department of Defense, January 1994, and author's estimate. Costs in thousands of constant FY90 dollars.

Figure L-1

Long-Run Total O&S

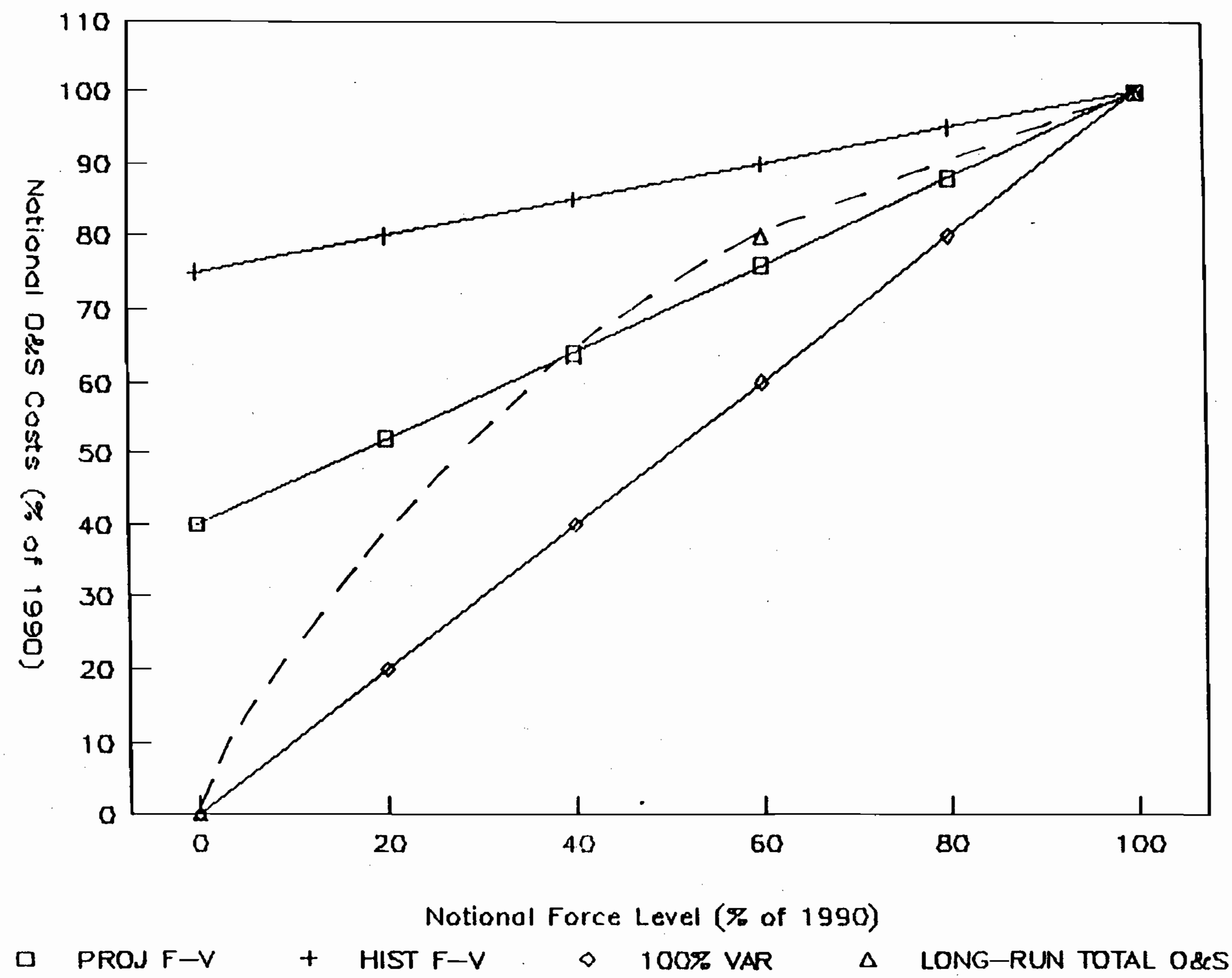


Figure L-2A

Capital Services Value—MRSC—DS

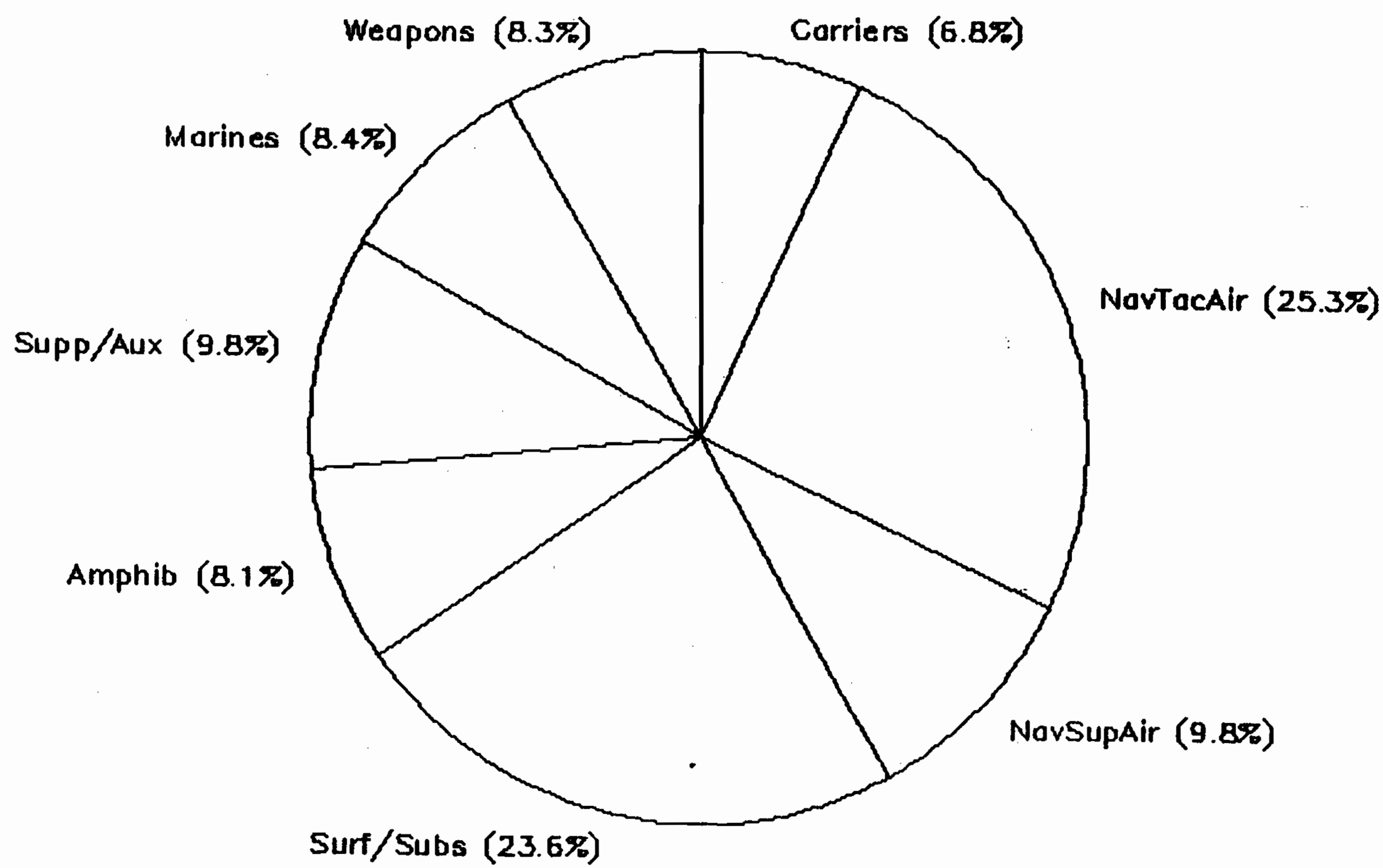


Figure L-2B

Capital Services Value—MRSC 2015

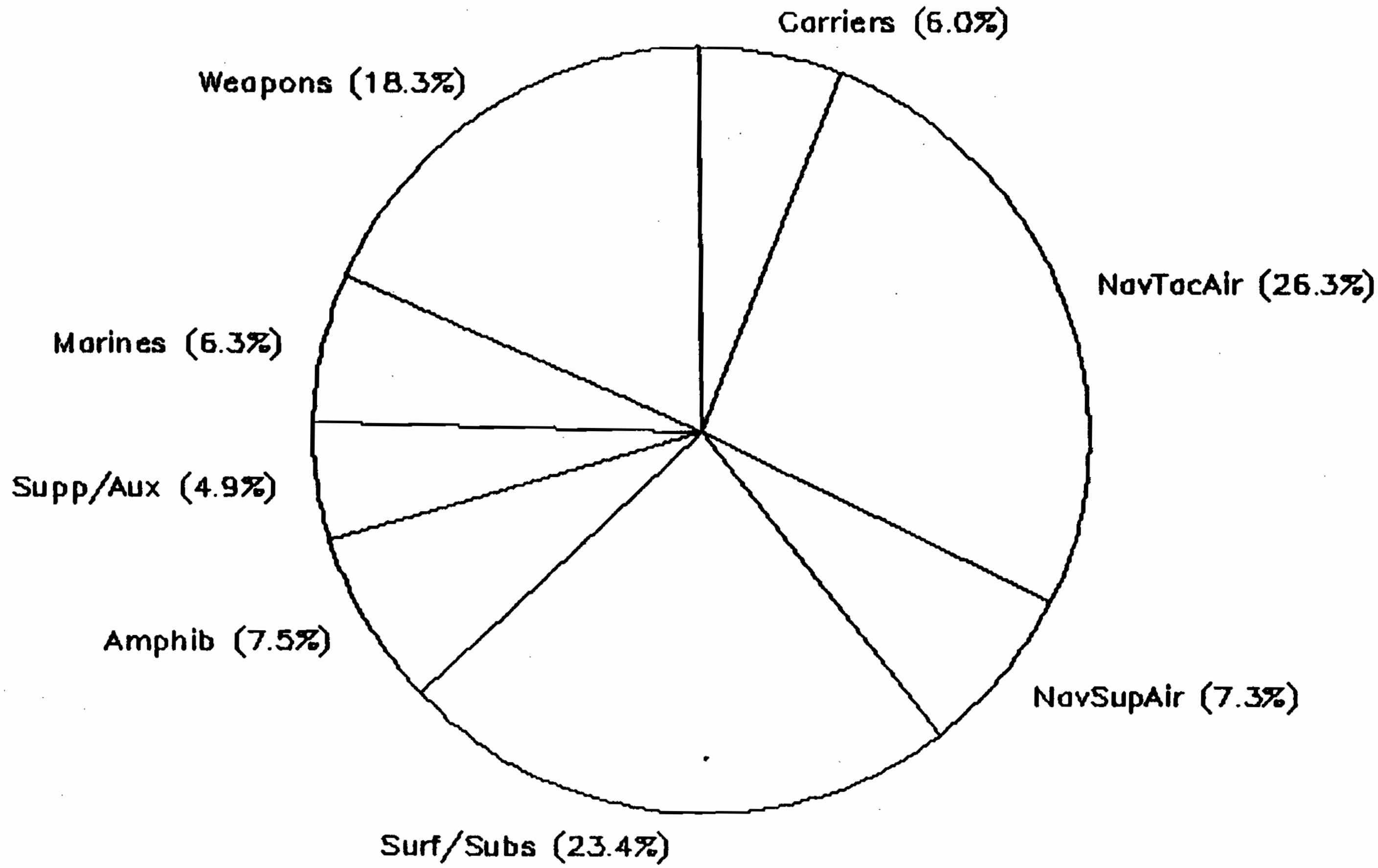


Figure L-3

Capital Stock vs. Capital Services

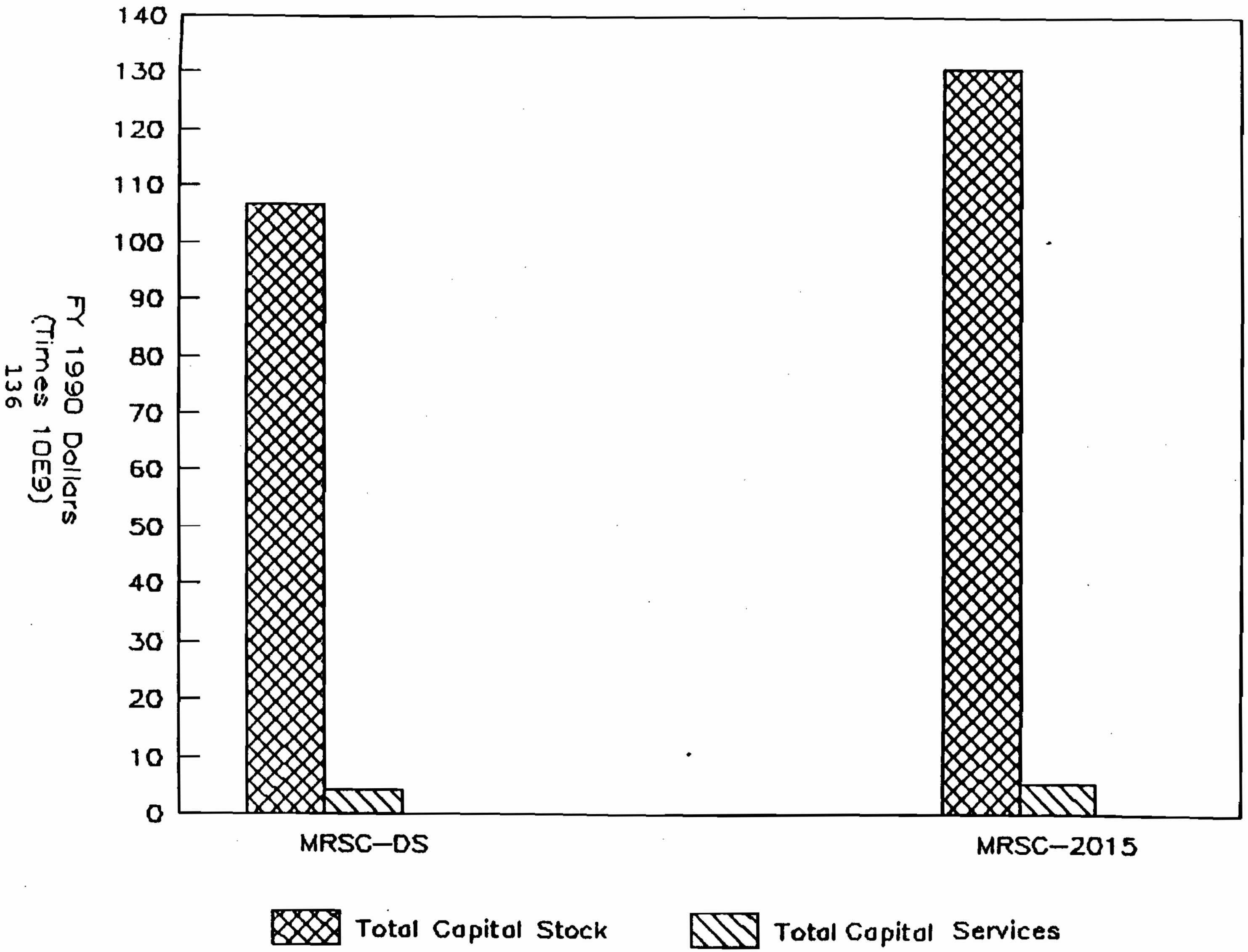


Figure L-4A

O&S-MRSC-DS

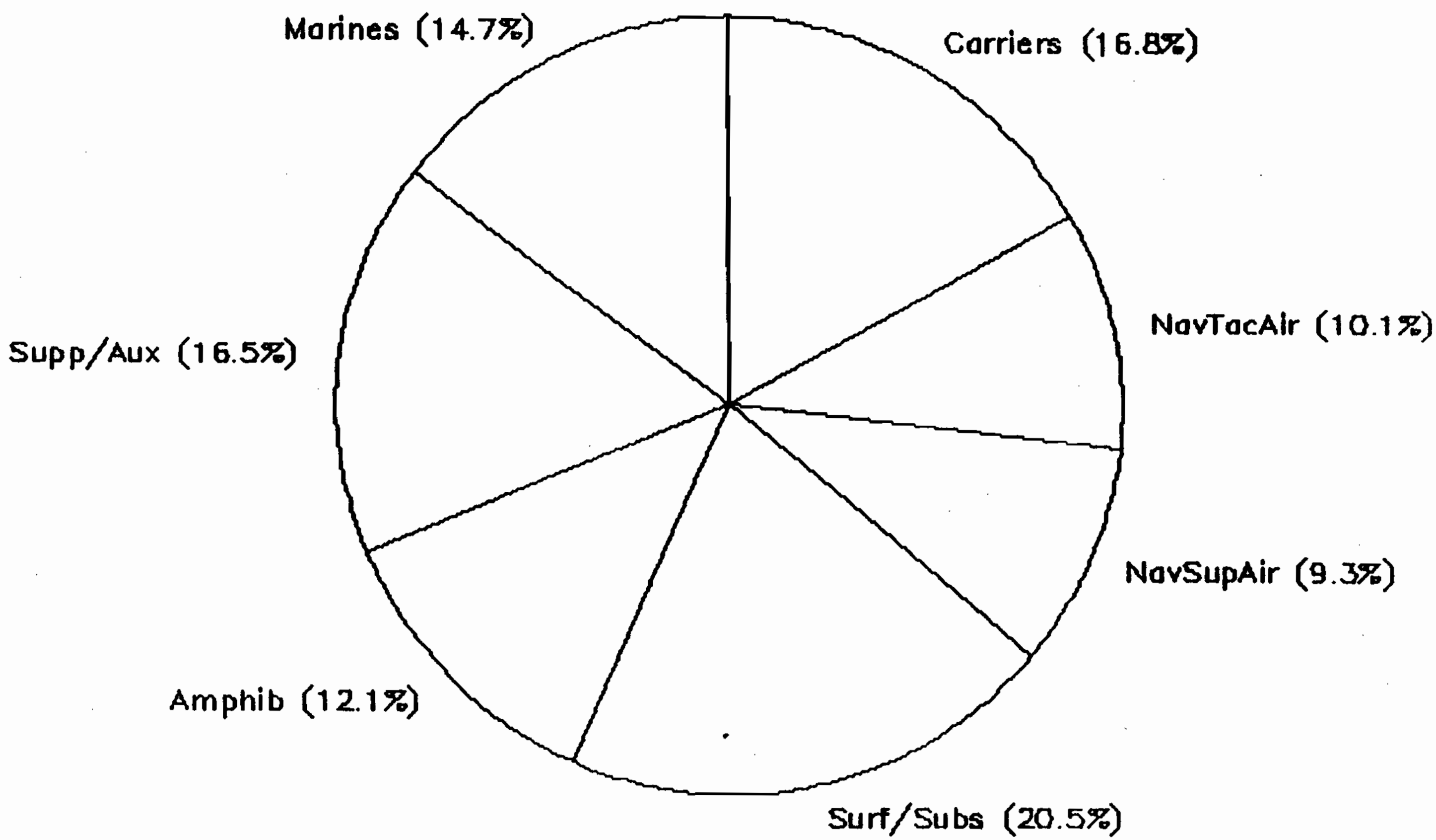


Figure L-4B

O&S-MRSC-2015

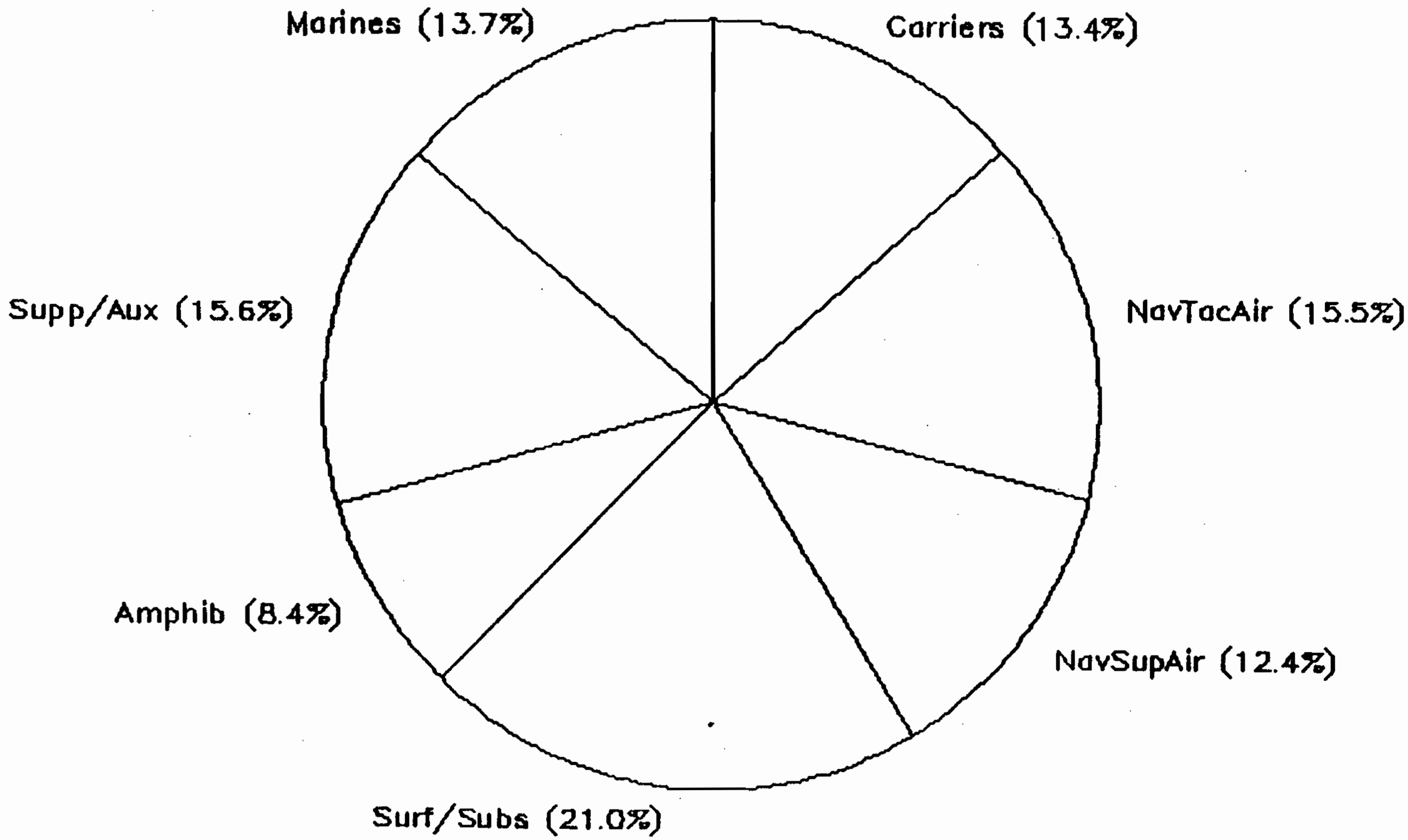


Figure L–5

MRSC O&S Costs

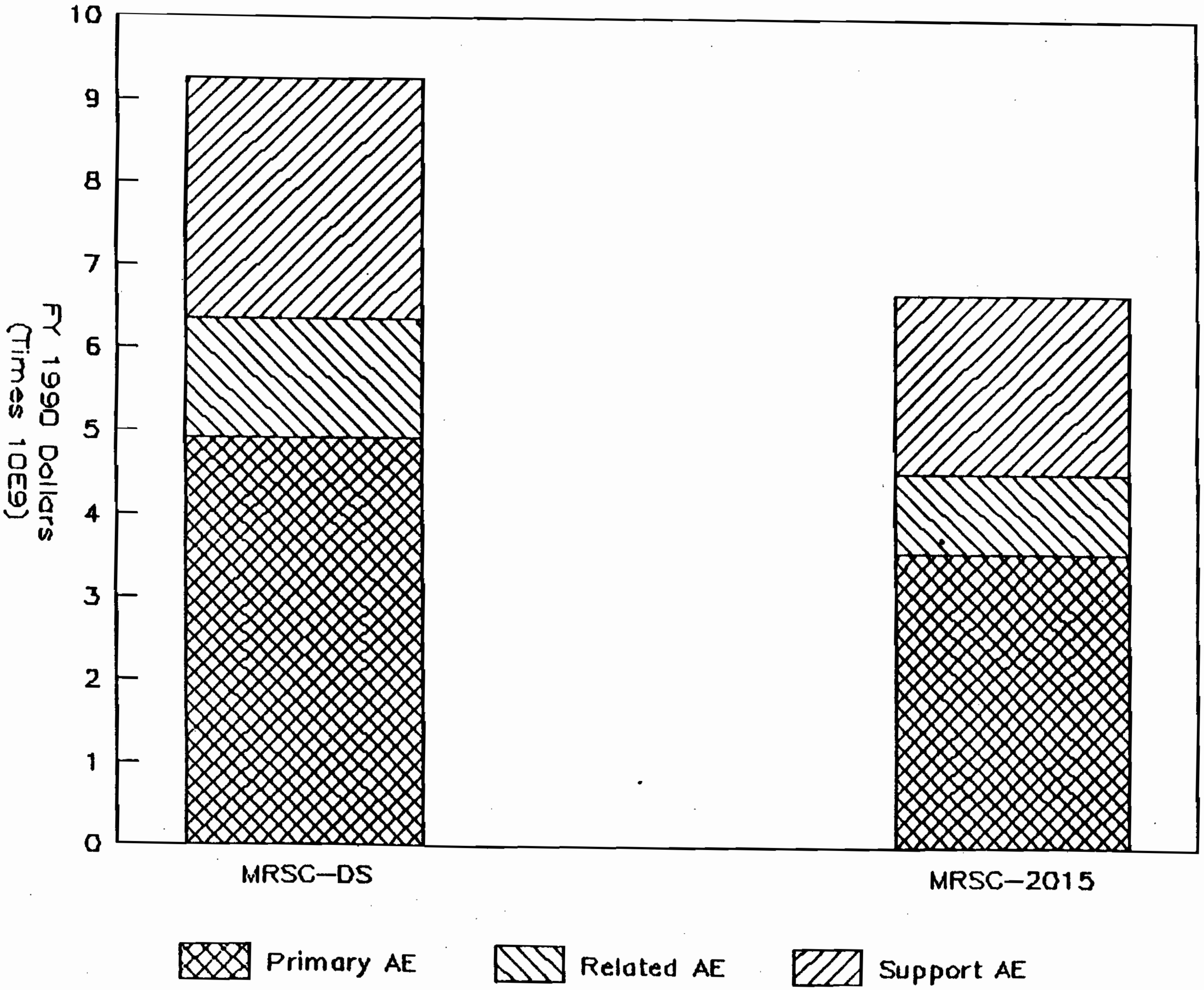


Figure L-6

MRSC-DS vs. MRSC-2015

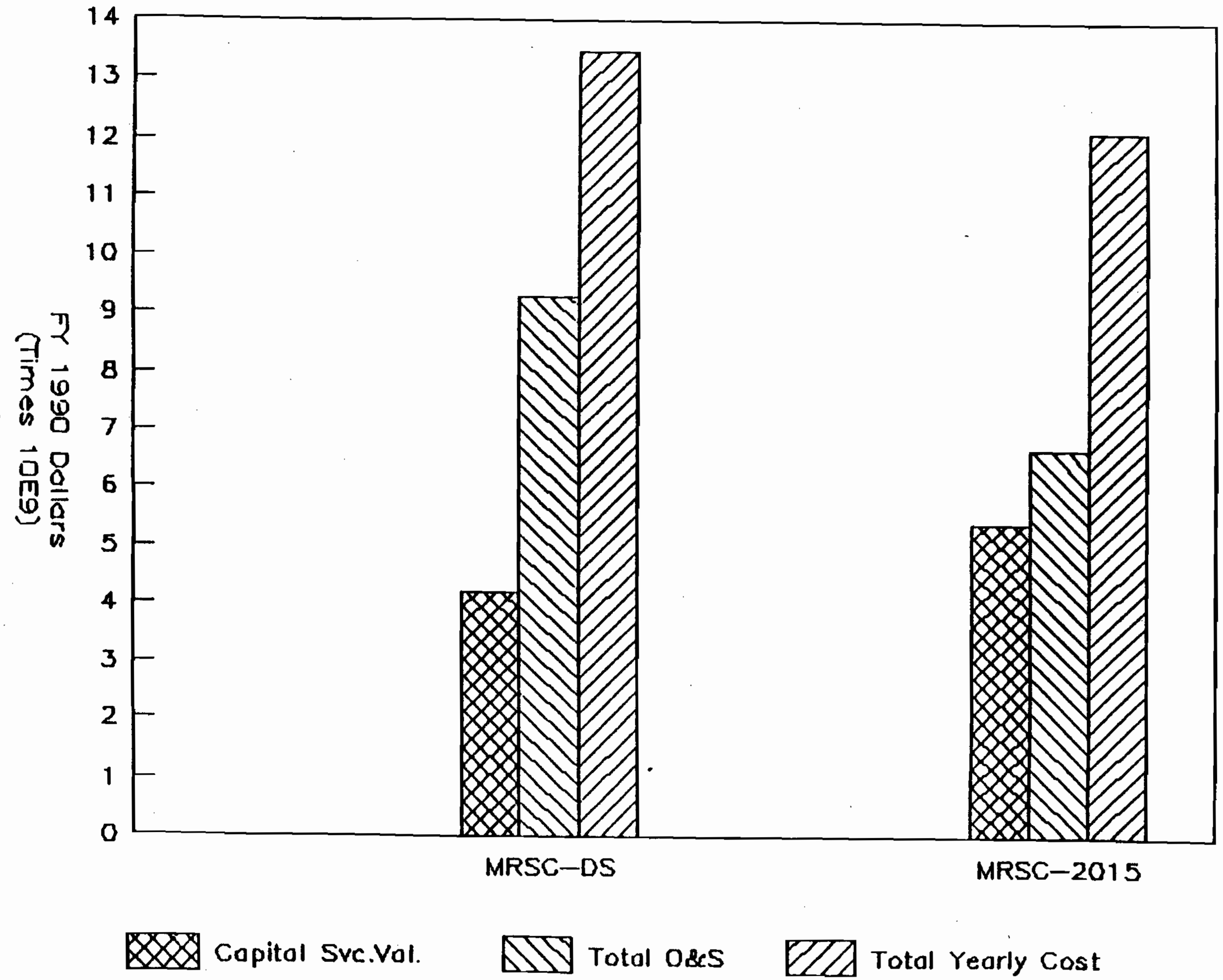


Figure L—7A

O&S to Capital Services Value

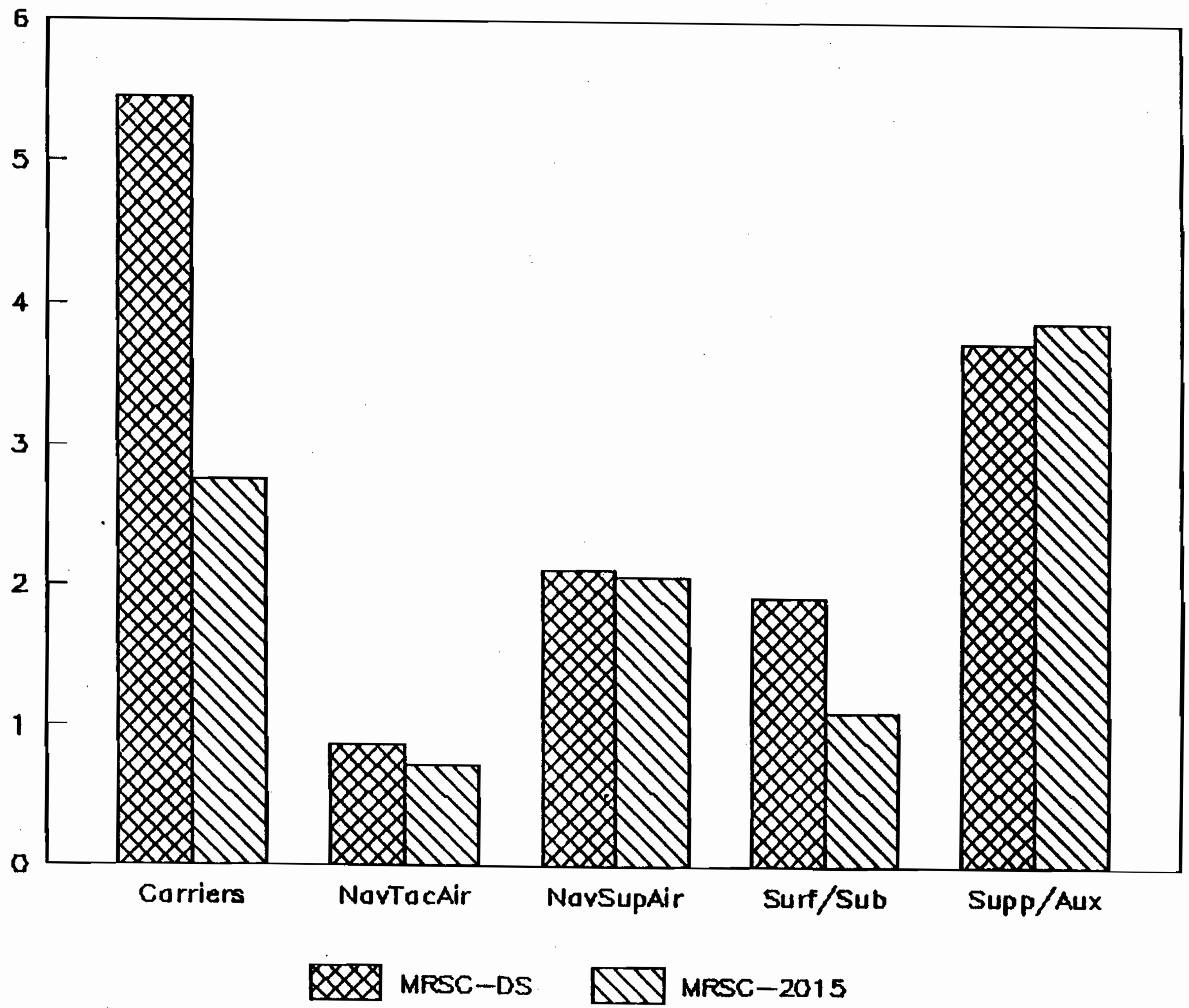


Figure L-7B

O&S to Capital Services Value

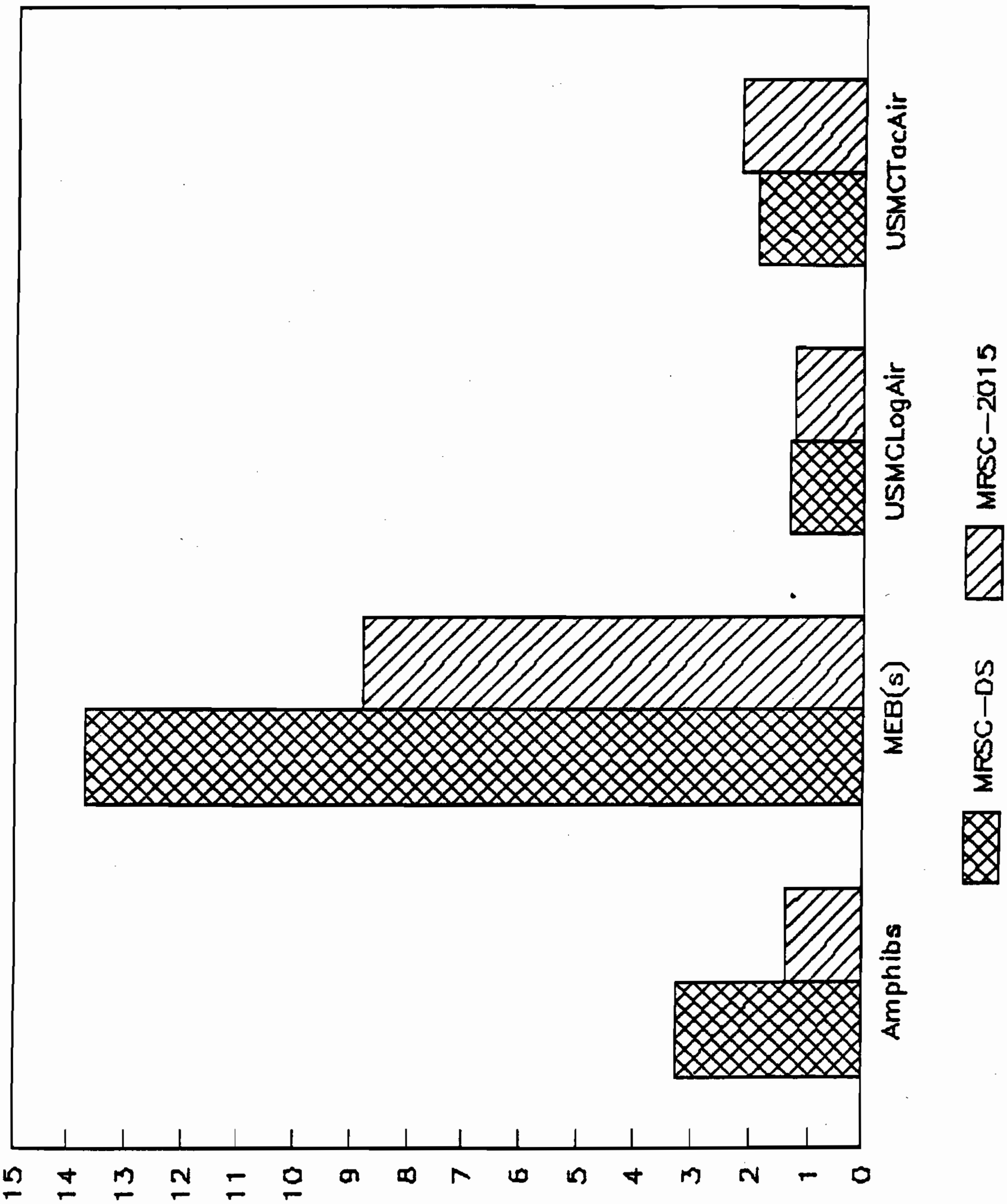


Figure L-7C

O&S to Total Capital Services Value

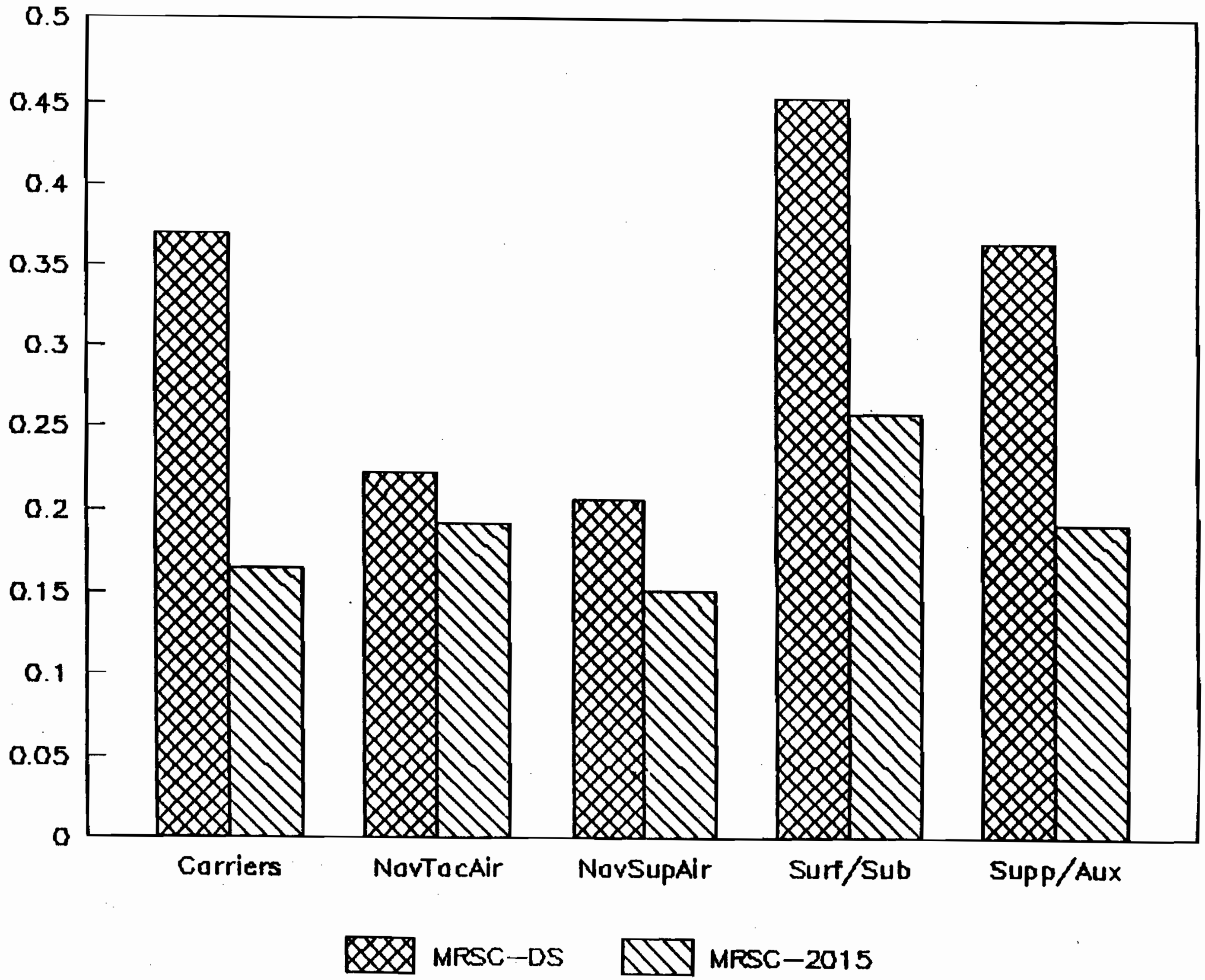


Figure L-7D

O&S to Total Capital Services Value

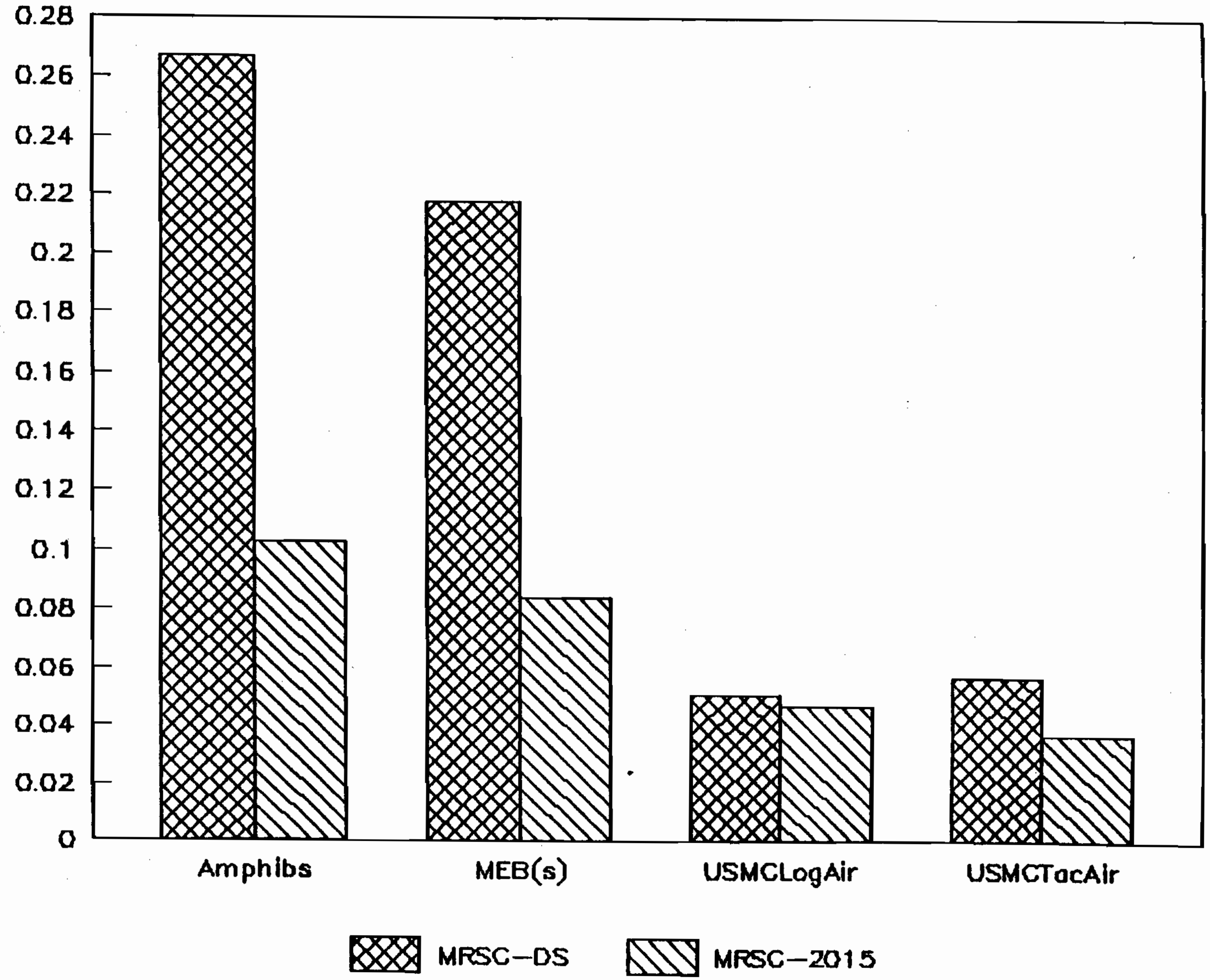


Figure L-7E

CapSvcVal. to Total CapSvcVal.

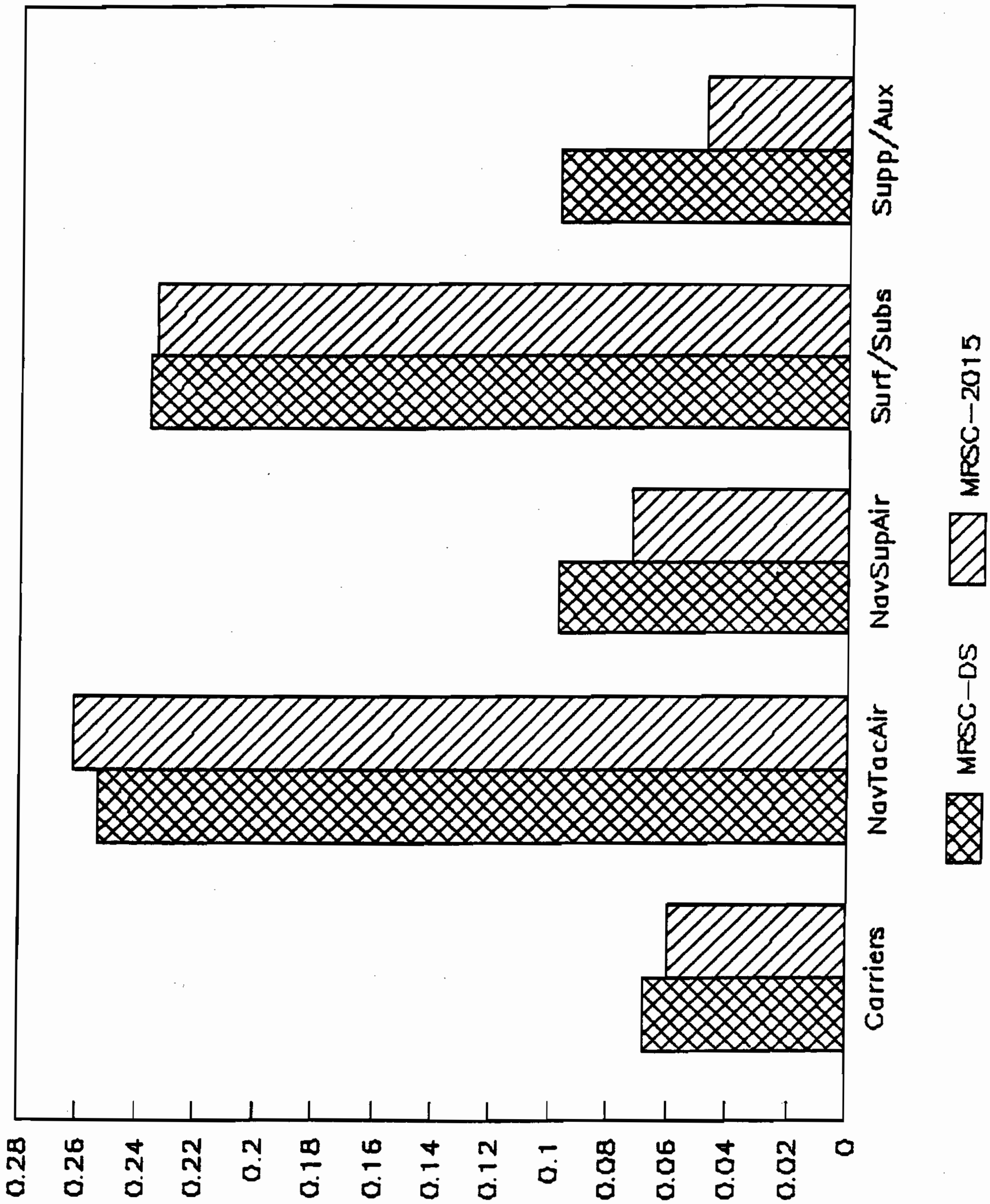


Figure L-7F

CapSvcVal. to Total CapSvcVal.

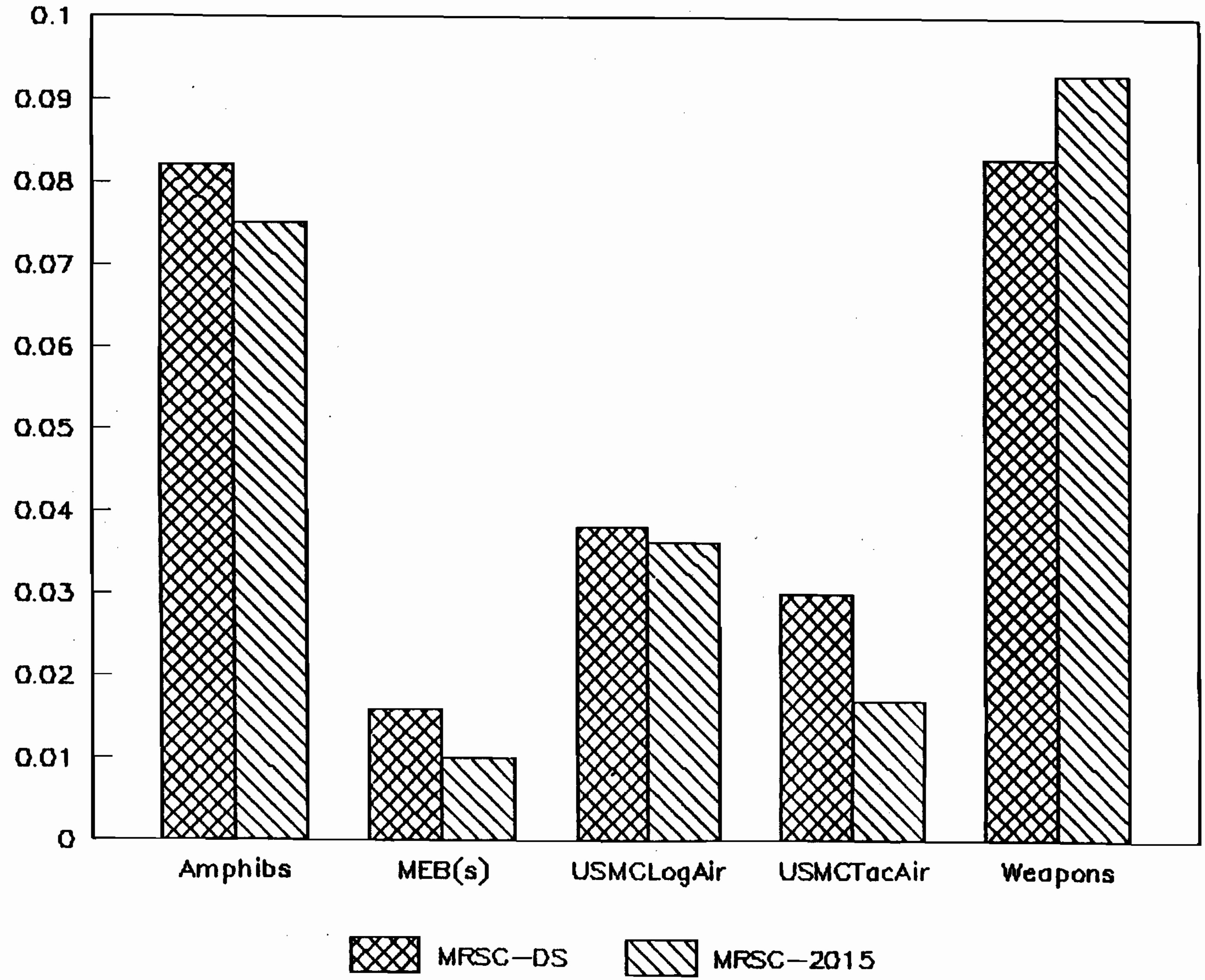


Figure L-8

MRSC–DS(Space) vs. MRSC 2015(Space)

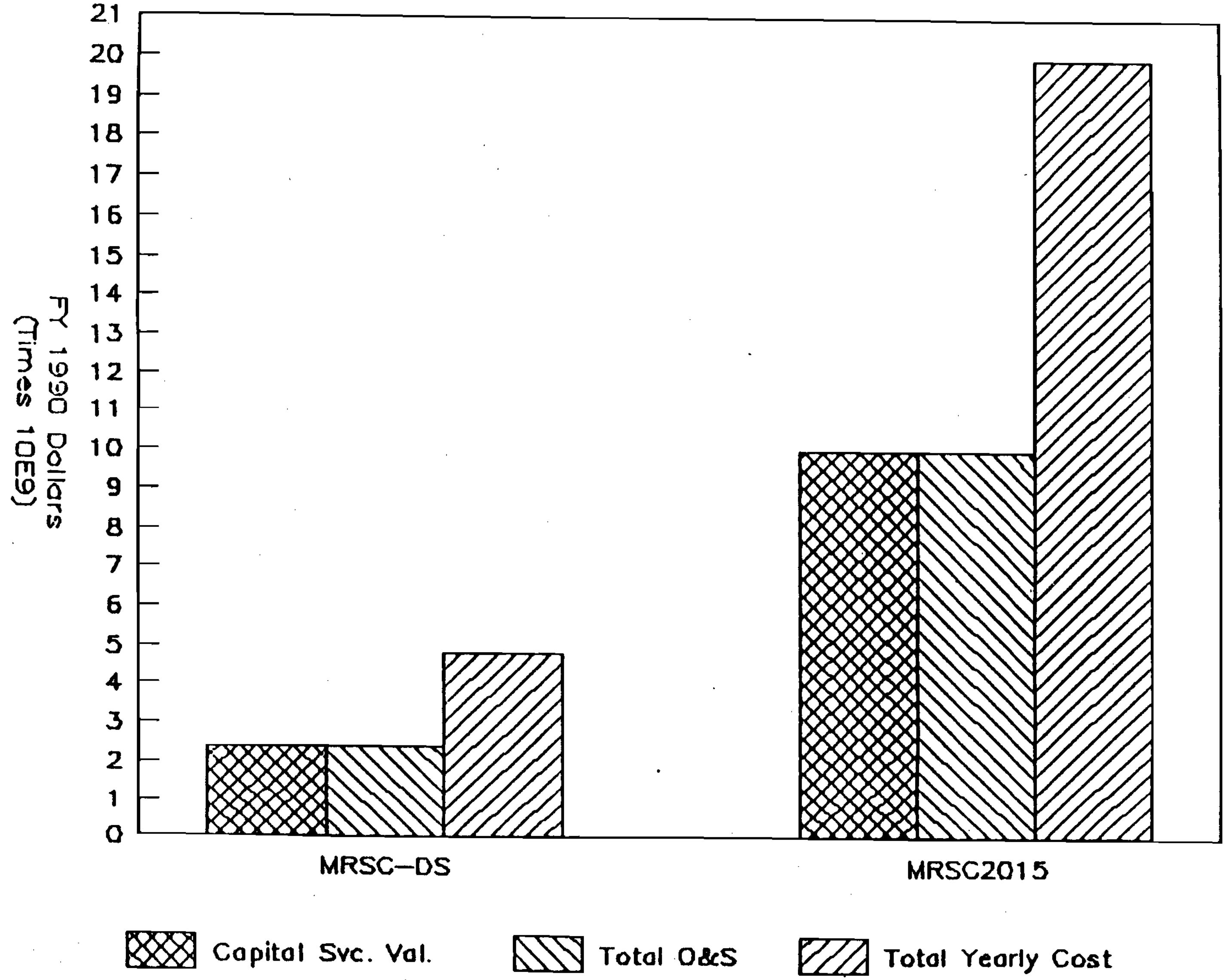


Figure L-9

MRSC-2015 Economies of Scale

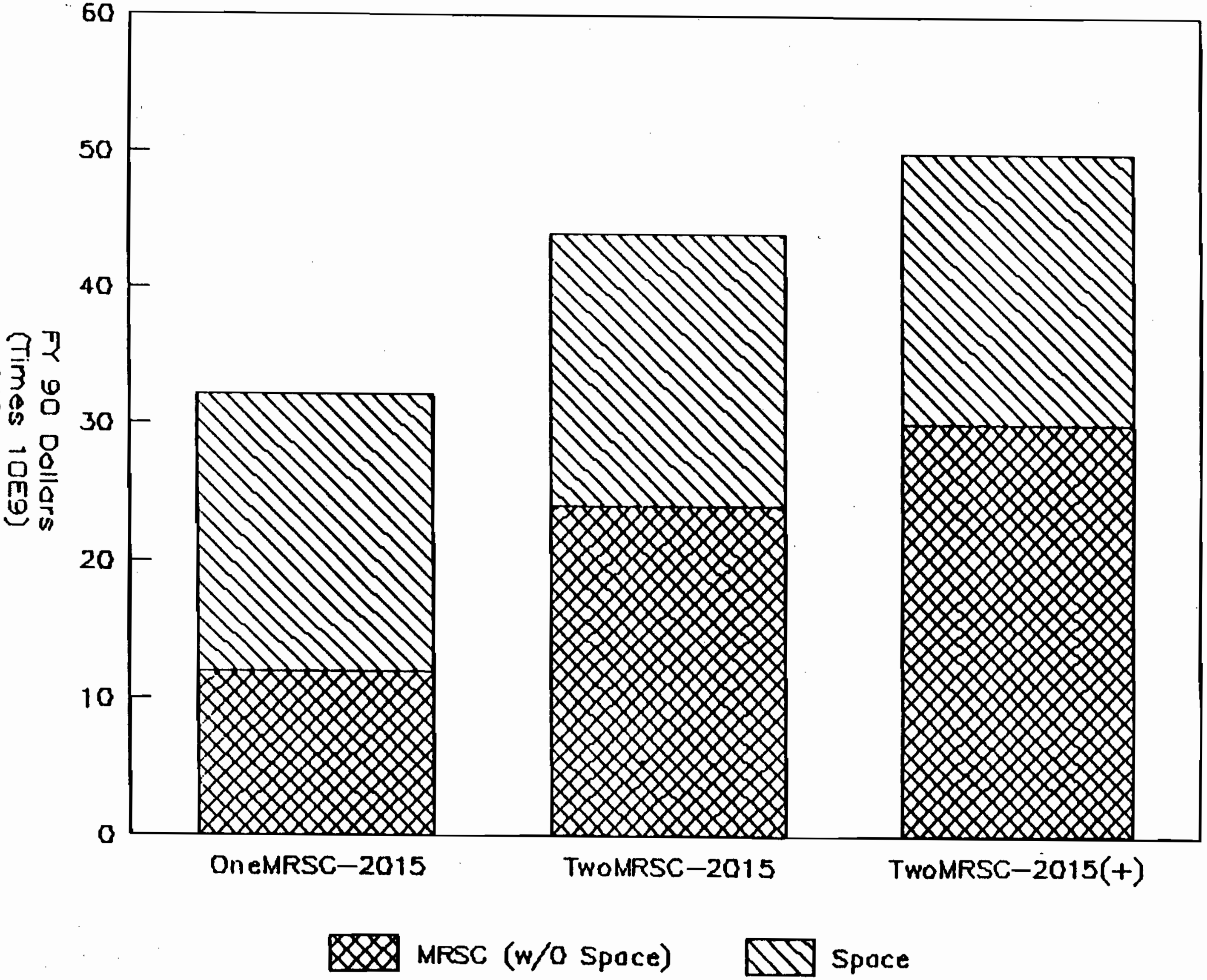
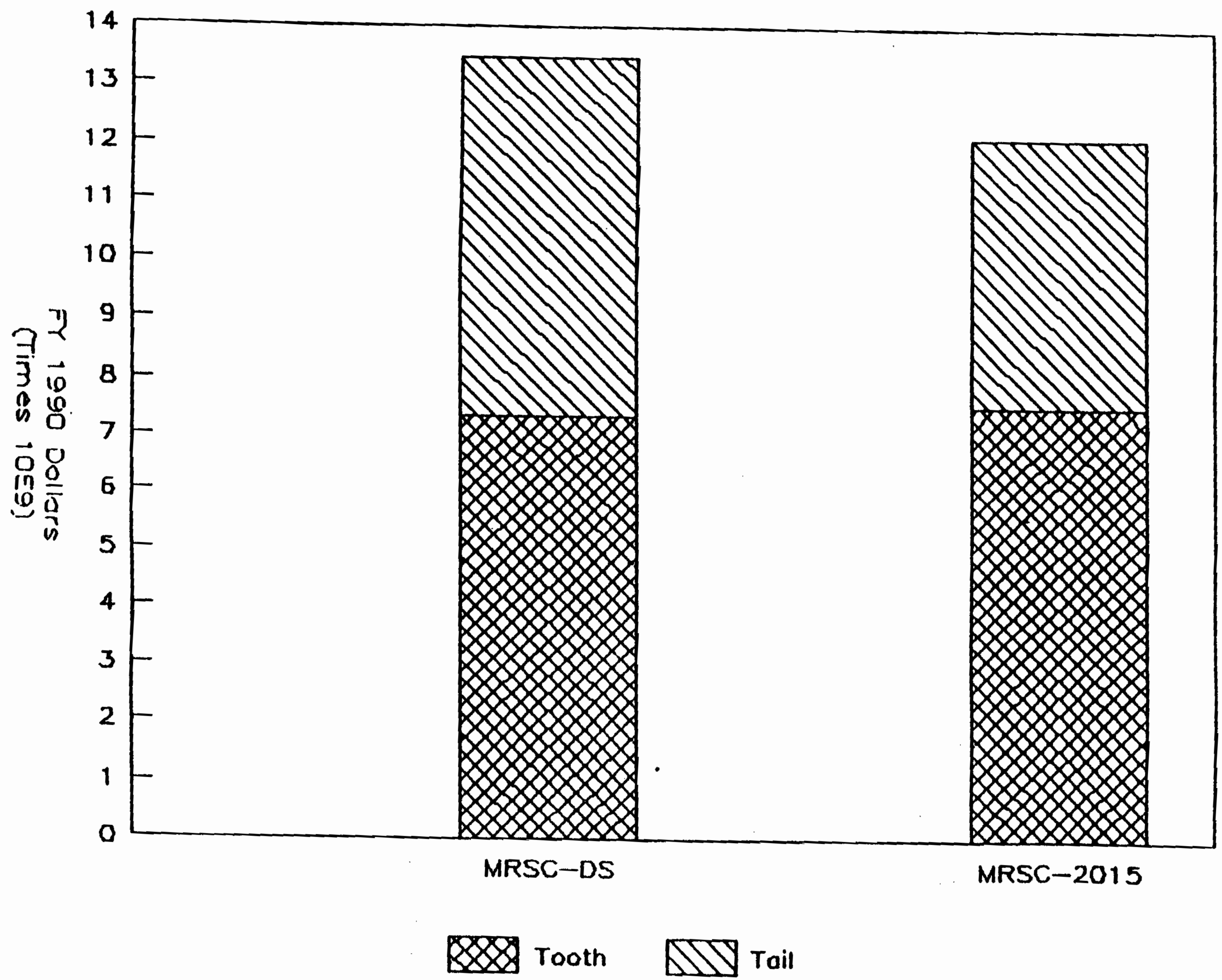


Figure L-10

Tooth-to-Tail MRSC-DS vs. MRSC-2015



C2	Command and Control
C3	Command, Control and Communications
CBO	Congressional Budget Office
CG-47	Ticonderoga-class Guided Missile Cruiser
CH-46	Navy and Marine Medium Lift Helicopter
CH-53	Marine Heavy Lift Helicopter
CPGW	Conduct of the Persian Gulf War-Report to Congress
CRUV	(CRUAV) Close Range Unmanned Aerial Vehicle
CV	Aircraft Carrier
CVBG	Aircraft Carrier Battle Group
CVN	Nuclear Powered Aircraft Carrier
DD	Destroyer
DDG	Guided Missile Destroyer
DDGX	21st Century Strike Destroyer
DMSP	Defense Meteorological Support Program Satellite
DOC	Department of Commerce
DOD	Department of Defense
DSCS	Defense Systems Communication Satellite
DSP	Defense Support Program Satellite
E-2	Navy Command and Control & Early Warning Aircraft
E-3	AWACs aircraft
E-8	JSTARs aircraft
EA-6B	Navy and Marine Electronic Warfare Aircraft
F-14	Navy Fighter aircraft
F-117N	Navalized version of Air Force "Stealth Fight
-18	Navy and Marine Fighter and Attack aircraft

FF	Frigate
FFG	Guided Missile Frigate
FH, N&MC	Family Housing, Navy and Marine Corps
5"	Surface Combatant Gun and Ammunition
FLTSATCOM	Fleet Satellite Communication System
FTS	"...From the Sea"-Navy document
FY	Fiscal Year
FYDP	Future Years (Six Years) Defense Program
GBU	Glide Bomb Unit (refers to a family of air-to-ground precision guided bombs)
GPS	Global Positioning System
HARM	High Speed Anti-Radiation Missile
HARP	(Harpoon)- Air, Surface and Submarine-Launched anti-ship missile
HAWK	Marine Surface-to-Air Missile
HELF	(Hellfire)-Air-to-Surface Missile
HELW	(HELLWEPS)-Surface-to-Air Laser Weapon
JDAM	Joint Direct Attack Munition-an air-launched bomb
JSOW	Joint Stand-Off Weapon-an air-launched glide weapon
JSTARS	Joint Surveillance and Target Attack Radar System
K	Thousands of Units
LAV	Marine Light Amphibious Vehicle
LCAC	Marine Landing Craft Air Cushion
LCC	Navy Amphibious Command Ship
LCU	Marine Landing Craft Utility Ship
LEASAT	Leased Communication Satellite
LHA	Tarawa-class Amphibious Assault Ship

LHD	Wasp-class Amphibious Assault Ship
LPH	Amphibious Assualt Ship
LSD	Landing Ship Dock
LX	New Amphibious Assualt Ship
M1A1	Marine Abrams Battle Tank
MK 46	Air or Surface-launched Torpedo
MK 48	Submarine-launched Advanced Capability (ADCAP) torpedo
MK 50	Advanced Lightweight Torpedo
M-60	Marine Main Battle Tank
MK 82	500 pound air-dropped bomb
MK 83	1000 pound air-dropped bomb
MACSAT	Mobile Area Communication Satellite
MAV	(Maverick) Air-to-Surface Missile
MCM	Mine Countermeasures Ship
MCN	Military Construction, Navy
MCNR	Military Construction, Naval Reserve
MCS	Mine Command Ship
MEB	Marine Expeditionary Brigade
MPMC	Military Personnel, Marine Corps
MPN	Military Personnel, Navy
MS	The "Maritime Strategy"-Navy document
MRC	Major Regional Conflict
MTR	Military Technological Revolution
MX	Minesweeper Transport
NATO	North Atlantic Treaty Organization
NETF	Naval Expeditionary Task Force

NTCS-A	Naval Tactical Communication System
OH-58	Army Light Helicopter
OMB	Office of Management and Budget
O&M, MC	Operations and Maintenance, Marine Corps
O&M, N	Operations and Maintenance, Navy
OPN	Other Procurement, Navy
O&S	Operating and Support Cost
PE	Program Element
PGM	Precision Guided Munition
PHXM	Phoenix Air-to-Air Missile
PMC	Procurement, Marine Corps
RI	Resource Identifier
RICs	Resource Identification Codes
RPMC	Reserve Personnel, Marine Corps
RPN	Reserve Personnel, Navy
RPV	Remotely Piloted Vehicle
RSC	Reconnaissance Strike Complex
RSTA	Reconnaissance, Surveillance and Target Acquisition
S-3	Navy Anti-Submarine Aircraft
SEW	Space and Electronic Warfare
SH-2	Navy Helicopter
SH-3	Navy Helicopter
SH-60	Navy Helicopter
76mm	Surface ship gun and ammunition
16"	Battleship gun and ammunition
SIS	"Space Investment Strategy"-DOD document

SLAM	Standoff Land Attack Missile
SLEP	Service Life Extension Program
SOAD	Standoff Area Defense Weapon
SOPD	Standoff Point Defense Weapon
SPRW	(Sparrow)-Air-to-Air and Surface-to-Air Missile
SRUV	(SRUAV)-Short Range Unmanned Aerial Vehicle
SSBN	Nuclear Powered Ballistic Missile Submarine
SSN	Nuclear Powered Attack Submarine
SSN-21	Nuclear Powered Attack Submarine-Seawolf Class
STDM	Standard Surface-to-Air Missile-refers to a family of surface-to-air missiles
STGR	Stinger shoulder-launched anti-air missile
TALD	Tactical Air-Launched Decoy
TBIP	Tomahawk Baseline Improvement Program
TBMD	Theater Ballistic Missile Defense and associated weapons
TG	Task Group
TMHK	Tomahawk Cruise Missile
TOW	Tube-launched, Optically-tracked, Wire-guided anti-tank missile
TRDT	Trident Submarine Launched Ballistic Missile
TSSM	Tri-Service Standoff Attack Missile-air launched
UAV	Unmanned Aerial Vehicle
V-22	Medium Lift Replacement Aircraft
VLS	Vertical Launch System
VTOL	Vertical Take-Off and Landing UAV
WMD	Weapons of Mass Destruction
WPN	Weapons Procurement, Navy

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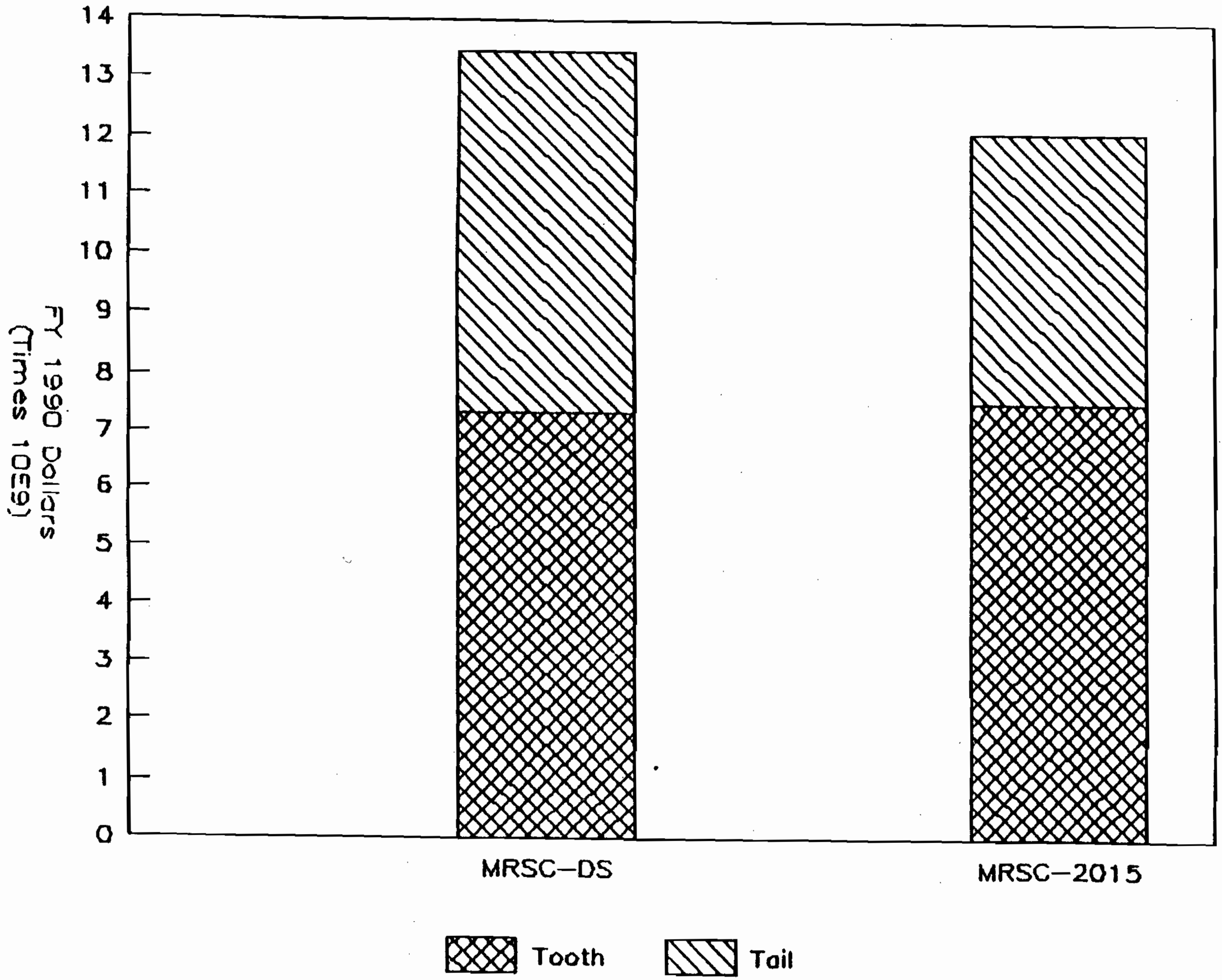
Figure L-10

Tooth-to-Tail MRSC-DS vs. MRSC-2015



APPENDIX M

ESCALATION INDICES

FY	RDT&E	SCN	WPN	APN	PMC
89	86.36	88.66	87.74	87.80	87.80
90	89.77	91.16	90.70	90.74	90.68
91	92.99	93.44	93.25	93.27	93.27
92	95.43	95.63	95.52	95.53	95.54
93	97.70	97.80	97.75	97.76	97.77
94	100.00	100.00	100.00	100.00	100.00

C2	Command and Control
C3	Command, Control and Communications
CBO	Congressional Budget Office
CG-47	Ticonderoga-class Guided Missile Cruiser
CH-46	Navy and Marine Medium Lift Helicopter
CH-53	Marine Heavy Lift Helicopter
CPGW	Conduct of the Persian Gulf War-Report to Congress
CRUV	(CRUAV) Close Range Unmanned Aerial Vehicle
CV	Aircraft Carrier
CVBG	Aircraft Carrier Battle Group
CVN	Nuclear Powered Aircraft Carrier
DD	Destroyer
DDG	Guided Missile Destroyer
DDGX	21st Century Strike Destroyer
DMSP	Defense Meteorological Support Program Satellite
DOC	Department of Commerce
DOD	Department of Defense
DSCS	Defense Systems Communication Satellite
DSP	Defense Support Program Satellite
E-2	Navy Command and Control & Early Warning Aircraft
E-3	AWACs aircraft
E-8	JSTARs aircraft
EA-6B	Navy and Marine Electronic Warfare Aircraft
F-14	Navy Fighter aircraft
F-117N	Navalized version of Air Force "Stealth Fighter"
F/A-18	Navy and Marine Fighter and Attack aircraft

APPENDIX N

GLOSSARY

A-6	Navy Attack Jet
AAAV	Marine Advanced Amphibious Assault Vehicle
AD	Destroyer Tender
ADCX	New Dry Cargo Ship
AE	Ammunition Ship
AEGIS	Navy surface ship anti-air warfare system
AGF	Miscellaneous command ship
AH-1	Marine Attack Helicopter
AMRM	(AMRAAM) Advanced Medium Range Air-to-Air Missile
AO	Fleet Oiler
AOE/AOR	Fast Combat Support Ship/Replenishment Oiler
APN	Aircraft Procurement,Navy
AS	Submarine Tender
ASRC	(ASROC) Anti-Submarine Rocket
ATCMs	(ATACMs) Army Tactical Missile System
ATS	Salvage and Rescue Ship
AVGN	Advanced Major Caliber Light Gun with Precision Guided Munitions
AWACs	Airborne Warning and Control System
BA	Budget Authority
BB	Battleships
BUR	The "Bottom Up Review"-DOD document
C-17	Military Transport Aircraft

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