Manning the Expanded Fleet

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1. Summary

Our results in brief

We investigated the personnel inventory that would be necessary to meet the Navy's manpower requirements under the 2008 shipbuilding plan. We find that at any time over the 30-year plan, the Service's *immediate* manpower requirements could be satisfied with an endstrength of only 322,000.[1] However, we estimated that the Service's *minimum viable long-term personnel inventory* will be substantially above this figure.

Over the next decade, the minimum viable personnel inventory will be between 332,000 and 334,000

One reason for the higher long-term requirements is that, by 2013, the Navy will have to add about 3,500 enlisted shore billets (above those currently planned) to maintain reasonable sea/shore flows for all ratings. Another reason is that the Service will need to add about 2,000 additional enlisted billets to support a viable "agricultural tail"—the base of the personnel pyramid that is necessary to grow the Service's more senior enlisted ranks. In addition, we believe that the Navy's current manpower requirement plans are based on an overly optimistic assessment of the Service's ability to cut billets from the shore establishment; we expect that a more realistic assessment adds at least 2,000 Sailors to the minimum viable personnel inventory. Finally, several changes in the fleet plan that are being considered (e.g., lengthening the service life of some amphibious assault ships and replacing DDG-1000s with DDG-51s) will increase manpower requirements by a few thousand. We estimate that, over the next decade, the minimum viable long term personnel inventory will be between 332,000 and 334,000.

Several ratings will have to expanded to supplement their "agricultural tails" or to relieve excessively long sea duty

This study yields several other findings that will be useful to Navy planners. Among these is a list of potentially problematic ratings—ratings that are either facing inadequate agricultural tails or that have too few shore billets. We indicate the number of personnel that would have to be added to the inventory of each rating to eliminate these problems (see table 1). We also indicate how these ratings could be affected by some of the more likely changes in future 30-year fleet plans (again, see table 1).

[1] The terms "billets authorized" (BAs) and requirements denote distinct but related concepts. However, for ease of exposition, we use these terms interchangeably. All manpower estimates discussed in this paper are BAs.

Table 1. Potentially problematic enlisted management categories (EMCs)

	Needed for Ag. Tail (1)	Needed for S/S Flow (2)	Shore cuts planned (3)	No. enlisted on each CG(X) (4)*	No. enlisted on each DDG(1000)*	No. enlisted on each DDG-51*	No. enlisted on each LHA*	No. enlisted on each LPD*
Aviation Boatswain's Mate-Aircraft Handling		566					105	5
Aviation Boatswain's Mate-Fuels		71					51	10
Aviation Boatswain's Mate-Launching and Recovery Equipment		412						
Aviation Ordnanceman		392	√				71	
Electricians Mate Surface		161	√	7	5	5	31	18
Engineman Surface		419	√	13	7	10	13	43
Gas Turbine Electrical	220		√	6	2	6		
Gas Turbine Mechanical		80	√	25	2	18		
Interior Communications – Surface		128	√	5		4	13	7
Machinist Mate, Nuclear Surface		192						
Mass Communications Specialist	334						7	1
Operations Specialist	1277			28	16	22	34	18
Quartermaster	97			6	3	6	17	7
Special Warfare Boat Operator		125						
Special Warfare Operator		162						
Total across all ratings	2,010	3,445		302	100	247	981	337

(1) The number of billets that must be added to the EMC to support future requirements for more senior personnel

(2) The number of shore billets that must be added to the EMC to support sea/shore flow

(3) EMCs for which the Navy plans cuts in shore billets

(4) The CG(X) is one of the few future classes for which we were unable to acquire useful estimates of manning. We assumed that manning on the CG(X) would equal that on the Ticonderoga class cruiser.

* These figures do not include either the shore billets or the additional "agricultural tail" billets that might be necessary to support these sea-duty billets

Background

One of the recommendations of the 2006 Quadrennial Defense Review (QDR) was that the Navy should undertake a substantial expansion of the fleet. The Navy translated the general guidance of the QDR into a detailed 30-year shipbuilding plan that has become known as the 313-ship Navy. This plan calls for expanding the fleet from about 276 ships to approximately 320 ships in a little over a decade.[2] Although senior leaderships in the Navy, in the Office of the Secretary of Defense (OSD), and in Congress continue to debate the exact composition of the fleet, there is little question that the number of Navy ships will grow significantly over the next decade.

Will the Navy be able to man the expanded fleet with reduced endstrength?

Concurrent with the expansion of the fleet, the Navy is downsizing its active force. Active endstrength stood at about 345,000 in FY 2005. In 2007, VADM John Harvey indicated that the Navy planned to reduce endstrength to 322,000 by 2013 (see Chief of Naval Personnel Public Affairs (2007)). By May 2009, strength had fallen to 332,000, but this includes 6,100 temporary billets meant to support Overseas Contingency Operations.[3] The simultaneous expansion of the fleet and downsizing of the active force raises an obvious but critical question: will the Navy be able to man a fleet of 313 (to 320) ships with a significantly reduced active duty force? The Deputy Assistant Secretary of the Navy, Manpower Analysis and Assessment, asked CNA to consider that question. In this document we look at the Navy's manpower needs and assess whether the Service can undertake substantial cuts in endstrength while still meeting its manpower requirements.

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2 The initial "313-ship plan" was produced in early 2006. The history of the 313-ship plan and its relation to the recommendations of the 2006 QDR are described in Work (2006) and the Congressional Budget Office (2005). Revisions of the plan were published in early 2007 (the 2008 plan) and early 2008 (the 2009 plan).

3 We do not include these temporary billets in any of our calculations or projections. Subtracting these 6,100 billets from current strength would result in an inventory of 325,900.

The need to look at the long term

If one looks at only the Service's immediate manpower needs, an endstrength of 322,000 seems reasonable

The principal objective of this project is to examine the individual ratings and paygrades and to assess the Service's ability to fill fleet billets—particularly those on ships and submarines—over the long term.[4] We focus on the long term because the number of Sailors needed for a viable *steady-state* inventory is substantially greater than the Service's *immediate* requirements (the number required to man the fleet at any specific time across the 30-year plan). One factor that puts long-term requirements above immediate requirements is the need to maintain an adequate "agricultural tail:" because of its closed personnel system, the Navy must access, train, and promote junior personnel to fill the higher ranks—even if some of the Sailors at the bottom of the personnel pyramid are not necessary to meet the Service's immediate workload at any given time.

A second factor that raises long-term requirements over immediate requirements is the need to ensure that there are enough shore billets to support the Service's sea/shore rotation policy. For example, if the Navy wishes Sailors to spend 2 months on sea duty for every month on shore duty, there must be half as many shore billets as sea billets—even if military essential shore work does not justify this number of shore billets.

Adding up the requirement numbers

Our analysis suggests that, at any point over the 30 years of the 313-ship plan, the Service would have little difficulty in meeting its *immediate* workforce requirements with an endstrength (faces) of 322,000. Between 2013 (the year when endstrength is expected to reach 322,000) and 2037 (the end of our study period), we identify immediate workforce requirements (spaces) of between 318,000 and 324,000.[5] This suggests the sort of alignment

4 Our focus on ships and submarines is motivated by three factors: (1) requirements for ships and submarines are determined with far greater accuracy than those for the shore establishment; (2) these requirements are tied to critical warfighting capabilities; and (3) we are able to make useful estimates of requirements for the fleet over a 30-year horizon, whereas our estimates for other commands extend only through 2013.

5 In addition to requirements for ships, submarines, squadrons, and shore commands, these include BAs for students. However, billets for "trainees, patients, prisoners, and holdees" (TPPH) have been excluded (these are consistently between 3 and 4 percent of endstrength).

between endstrength and requirements that has prevailed in recent years. For example, when actual endstrength stood at 332,353 in 2007, total BAs were 334,252.

Supplementing shore billets

An endstrength of 322,000 does not support adequate sea/shore rotation

However, when we look beyond the year-by-year estimates of the Navy's immediate workforce needs, and consider the adequacy of enlisted shore billets and the enlisted agricultural tail, we find that the Navy would face substantial challenges in manning the fleet with significantly reduced endstrength. Perhaps the greatest challenge would be providing adequate shore billets. We have produced a range of estimates—under alternative assumptions—of the number of additional shore billets that will need to be created. We believe that the most likely case is that, by 2013, the Navy will have to add about 3,445 enlisted shore billets to the 321,337 BAs (officers and enlisted) that we have already identified as filling the Service's immediate work requirements. [6]

Building the bottom of the personnel profile

An endstrength of 322,000 does not support a sufficient "agricultural tail"

The Service will also be hard pressed to sustain an adequate agricultural tail (an adequate base for the personnel pyramid) with only the BAs we have identified as filling immediate workload requirements. Throughout the Navy, requirements are becoming significantly more senior, and this trend is particularly acute in a handful of specific ratings.[7] We estimate that, by 2019, the Service will need to add about 2,010 billets to bolster its agricultural tail (2,010 above the 322,939 we have identified as essential for immediate work requirements in that year).

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6 The prescribed limits on tour lengths are 60 months for the first and second sea tours and 48 months for any subsequent sea tours. There are also *de facto* constraints on tour lengths: if Sailors are assigned a first sea tour that is of maximum duration (60 months), they will, on average, serve only 52 months of this tour. See Koopman and Gregory (2007).

7 For the Navy as a whole, the proportion of BAs in the E6 to E9 paygrades is expected to increase from 23.5 percent to 26 percent over the next 9 years. In the Operations Specialist (OS) rating, this proportion is expected to rise from 17 percent to 31 percent. Several other ratings are also expected to see significant increases in the seniority of their billet structure.

Challenges in making planned cuts on shore

Some planned cuts in shore billets will be difficult to undertake

We also expect that the Service will face substantial challenges in making intended cuts in shore requirements. The Navy has planned to support much of the anticipated reduction in endstrength with reductions in the "shore establishment." Under the Navy's planned billet structure, requirements in commands *other* than ships and submarines will decline by 12,294 between 2007 and 2013. In contrast, we estimate a net reduction of only 731 BAs on ships and submarines over the same period.

We estimate a minimum necessary endstrength of 328,000 for most years through 2024

Many of the specific reductions that are planned for the next few years, however, will prove especially difficult. For example, the Navy intends to cut non-fleet Hospital Corpsmen by 1,428 billets by 2013 (a reduction of 9 percent). In mid-FY 2008, however, Congress legislated a halt to the military-to-civilian (MilCiv) conversion process that will be necessary to eliminate these billets. An additional problem arises from the fact that many of the ratings for which the Service has scheduled reductions in shore billets are expected to experience excessively long sea tours (these ratings are indicated with a check mark in table 1), and we expect that the need to maintain adequate sea/shore flow will preclude many of these cuts.

Summing across ratings to derive an aggregate manpower requirement

If the Service were unable to make substantial cuts in shore billets, the minimum viable long-term endstrength would exceed 330,000

Our analysis has involved detailed examinations of individual ratings and, from these, we have identified more than a dozen as "potentially problematic," either because (1) they will require larger agricultural tails than exist in the future BAs we have identified or (2) they will require additional shore billets (above the future BAs we have identified). Table 1 lists several of these ratings and indicates the number of personnel that we estimate will have to be added to each. (We provide detailed discussions of some of these ratings in appendix A.) Looking across the Navy's shipbuilding plan, and taking into account both the need to maintain adequate agricultural tails and the need to limit sea tours to reasonable lengths, we estimate that the endstrength needed to man the fleet will be *at least* 328,000 in most years through 2024 (our estimated minimum has a short-lived decline of about 3,000 towards the end of the next decade, rebounds in the early 2020s, and then declines slowly to 2037). Moreover, if the Navy is unable to make a substantial portion of the cuts it has planned for the shore establishment, the minimum viable endstrength could exceed 330,000.

Changes in the composition of the fleet may *raise* requirements

The estimates of future Navy manpower requirements presented in this analysis are based on the FY 2008 30-year shipbuilding plan. Since this plan was published in early 2007, the Service has produced a revised 30-year plan (the FY 2009 Shipbuilding plan which was published in the first quarter of 2008), and (in recent comments) the Secretary of Defense has proposed further changes in the future fleet plan.[8] By comparing (1) the 2008 shipbuilding plan, (2) the 2009 plan, and (3) Secretary Gates' recent comments, we have identified several ship types for which future inventories seem likely to diverge from those in the 2008 plan. Using these three sources, we have made judgments about how inventories for these ships might evolve, assessed how the various inventory scenarios differ from the 2008 plan which underlies our analysis, and identified how possible deviations from the 2008 plan might affect future manpower requirements.

Replacing the DDG-1000 with the DDG-51

Replacing the DDG-1000 with the DDG-51 will raise immediate manpower requirements by more than 540 over the next decade

Both the 2008 and 2009 plans called for the production of seven DDG-1000s. However, Secretary Gates has indicated his intension to stop production at three and to offset this cut with renewed production of Burke class (DDG-51) destroyers. This action is likely to increase the Service's future manpower requirements. While the crew on the DDG-1000 is about 135, that on the DDG-51 class is approximately twice this number. If the Service were to produce four DDG-51s to compensate for the four cancelled DDG-1000s, manpower requirements for the fleet would increase by approximately 540. (This does not include any related growth in shore billets or expansion of the agricultural tail that might be required to support this expansion in fleet requirements.)

8 An FY 2010 shipbuilding plan was scheduled for release in the first quarter of calendar year 2009, but this plan has apparently been scuttled. We were not able to attain full details of the FY 2009 plan, but Dr. Michael Gessner of CNA has combined (i) elements of the plan provided by N8 and (ii) publicly available documents (e.g., Congressional testimony) to construct detailed estimates of the commissioning and decommissioning dates for this plan. Secretary Gates comments on the future fleet were delivered before the Senate Armed Services committee and on visits with the Services in May 2009.

Increasing the number of amphibious ships

Planned additions in amphibious ships would raise <u>immediate</u> requirements by more than 2,300 over the next decade

Relative to the 2008 plan that we used to derive our predictions, we expect a substantial increase in the number of amphibious ships in the fleet and an associated large rise in fleet requirements.[9] These changes to the fleet include:

- Because of delayed decommissioning, there will b one extra LHA in 2014, and a second in 2015. These will remain in the fleet through 2021 or 2022 (each of these ships has a crew of about 980).
- Delayed decommissioning will also result in one extra LPD-4 between now and 2017 (with a crew of 320).
- There will be one to three LSDs in the 2020s (each with a crew of 275).

Postponing or cancelling the CG-X program

Cancelling the CG-X would have only small effects on manpower requirements over the next decade, but could produce substantial reductions in the 2020s

Both the 2008 and 2009 shipbuilding plans call for the first of this class to be commissioned in 2017, for there to be two of this class by 2019, and for there to be an additional 17 of these ships by 2029. However, in his Defense Budget Recommendation Statement (6 April 2009), Secretary Gates indicated that he has delayed his decision on continuation of the CG-X until after the review of strategic requirements currently being undertaken by the QDR. The effect of this change on fleet manpower requirements depends on what ships, if any, replace these Cruisers. If there is no replacement, each of the cancelled CG-Xs would reduce our estimated

9 Commenting on changes in the FY 2009 shipbuilding plan, the Congressional Budget Office (2008) wrote that “the Navy’s 313-ship requirement in its 2009 shipbuilding plan calls for a force of 31 amphibious ships organized around nine expeditionary strike groups. Each group would include one large amphibious assault ship (LHA or LHD class), one amphibious transport dock (LPD), and one dock landing ship (LSD). A footnote in the 2009 plan states, however, that because the Marine Corps requires 33 amphibious ships to transport the assault echelons of two Marine expeditionary brigades, the Navy is reviewing options to increase the number of amphibious ships to 33. To meet the Marine Corps’s requirement for 33 ships over the 30-year period, the 2009 plan would not substantially increase the purchase of amphibious ships compared with the 2007 and 2008 plans, but it would increase the service life of two LPD-4s, two LHAs, and all 12 LSDs.”

fleet manpower requirements by about 330 Sailors.[10] This would correspond to a reduction of only 660 fleet billets in 2019, but this number would grow sharply through the 2020s. If the Service were to replace these cruisers with modified versions of the DDG-51, each of the cancelled cruisers would lower our estimates of fleet manpower requirements by about 60 (or 120 billets in 2019).

Delays in the LCS program

Over the last few years, there have been substantial changes in the procurement *schedule* for the littoral combat ship (LCS), but no changes in the *number* of ships that the Service plans to acquire. The 2008 30-year plan called for the first 27 LCSs to be commissioned by 2013 and the remaining 38 (of 55) to be commissioned by 2018. The 2009 plan called for slowing the acquisition schedule by about 5 years: under this plan, the 55th LCS would not enter the fleet until 2023. Recently, however, Secretary Gates has indicated his intention to accelerate the procurement of the LCS,[11] and the acquisition schedule that is ultimately realized may lie between that of the 2008 plan and that of the 2009 plan.

The LCS is likely to be produced on a slower schedule, but this would have little effect on our estimates of manpower requirements

The only effect on manpower requirements of delaying the acquisition of the LCS would be on the speed (urgency) with which the Service must build the agricultural tails for those ratings that serve on this class—and even this effect would be small. The LCS's manpower requirements include a large proportion of senior enlisted. For example, 68 percent of the ship's enlisted requirements are E6 and above. Because it takes almost a decade to advance a person from the initial stages of recruiting to the E6 paygrade, even under the slower acquisition schedule of the 2009 shipbuilding plan, the Service is already pushing up on timing constraints for developing the senior enlisted personnel it will need for the LCS.

Other changes with small effects over the next decade

The 2008 plan called for three MPF (F) T-AKE ships, the first of which was to be commissioned in 2012. The 2009 plan reduced this

10 Because this class was still under design, no reliable data were available on its likely manpower requirements. In our estimates, we assumed that the CG-X would have the same crew as the Ticonderoga class cruiser.

11 See the Secretary's address to the Naval War College on 17 April 2009.

to a single ship to be commissioned in 2013. This change will have little effect on manpower requirements because the ship is part of the Military Sealift Command (MSC) and is manned with only 13 Navy personnel (these serve alongside 124 civil-service mariners). In addition, Secretary Gates has indicated that the Mobile Landing Platform (MLP) ship is being delayed and may be cancelled. These three ships are assigned to the MSC, but each is scheduled to have an LCAC detachment of 11 Navy personnel.

Exploring alternative solutions

The final phase of this analysis looks for methods of mitigating future shortages in the fleet other than expanding the personnel inventory. One relatively easy "fix" might exist for ratings that are expected to grow, or to become more top heavy, but are *not* likely to have excessively long sea duty. For these ratings, it might be possible to meet expanding requirements by lengthening sea tours. The advisability of this policy, however, depends on whether Sailors in these critical ratings could be relieved of some of their shore work (in order to increase their time at sea) without adversely affecting the shore establishment.

To make this determination, we develop algorithms that make an approximate mapping of ratings to the type of shore work performed by Sailors in the ratings. We then use three criteria to assess if Sailors' work is essential to the shore establishment: (1) whether Sailors are required to have their particular rating and paygrade in their shore work,[12] (2) the A76 criteria codes,[13] and (3) the Military Criticality Assessment Process (MCAP).[14]

12 If Sailors in a rating generally do shore work that could be performed by others (and if their sea duty is not already close to the maximum tour length), it might be possible to make greater use of this rating at sea.

13 Even if Sailors' shore duty requires their ratings and experience, it might be the case that the work associated with these shore billets could be done by civilians or contractors—or that the work might be eliminated altogether. One way to assess this is with the A76 criteria codes established by the Department of Defense (DoD), which identify whether military work consists of "inherently governmental or commercial activities" (IGCA).

14 This metric evaluates functional areas at commands for how closely they support the Navy's essential warfighting capabilities, including the projection of military power, providing defense of the homeland, enhancing operational independence and support for

Among more sea intensive ratings, we find little potential for shifting personnel from shore to fleet

The first criterion suggests that there may be few opportunities for the easiest type of fix—freeing up personnel in problematic ratings for additional sea duty (by substituting into their shore billets Sailors from other ratings). When we look among the potentially problematic ratings that are expected to have relatively short sea tours, we find that the great majority of these Sailors are in shore billets that require their rating. For example, it might appear that the various Cryptologic Technician (CT) ratings would be good candidates for shifting personnel from shore to fleet: these ratings are expected to see significant increases in fleet requirements, and they are not expected to have especially long sea tours. However, when we look at the type of work these personnel are performing on shore, we see that less than a third of Sailors in these ratings are performing shore duty for which their rating is not required. (Moreover, a high percentage are in functions that are inherently governmental or exempt from commercial activities.)

Among shore intensive ratings, some opportunities for MilCiv conversion are already being exploited

We do find instances in which more involved fixes might be possible. In some shore-based ratings that are expected to grow or to become more senior, there are Sailors working in shore functions that might be subject to MilCiv conversion or outsourcing. For example, in the Information Systems Technician rating (IT), which is expected to become more senior over the next 30 years, almost 40 percent are in shore functions that are not inherently governmental or exempt, and the shore functions for Sailors in this rating have a low average MCAP score (1.6 out of 4.0), indicating that their work is not immediately related to the Navy's essential warfighting capabilities. However, the Navy has already slated some of these billets to be eliminated (by 2013, the Service plans to cut 462 IT billets or about 7.5 percent of the current IT force).

Building a capacity for rapid analysis

One other dimension of this project is worth noting: in bringing together the various models used in this study, we have created the capability to rapidly assess the effects on manpower requirements of changes in the composition of the fleet or changes in the

joint forces. MCAP helps us identify ratings, such as Legalman and Musician, that almost always have shore duty that is "inherently governmental or exempt" under the IGCA criteria codes but that do not have an immediate relationship to the Service's essential warfighting capabilities.

manning structure for the various ship classes. The models permit one to quickly identify whether existing personnel profiles can support changes in requirements and, if they cannot, what modifications of personnel and manpower structures would be necessary to accommodate such changes. One can get a better sense of some of the capabilities of these models by looking at our discussions of future requirements for individual ratings in appendix A.

2. Methodology

Estimating future manpower requirements

Our analysis involves the stages shown in figure 1. The first stage involves predicting immediate fleet manpower requirements, by rating and paygrade, for each of the next 30 years. We do this by matching manpower requirements for individual ships with the ships in the Navy's 30-year ship plan (this plan shows the current inventory of ships, the ships that will be coming into the fleet over the next 30 years, and the ships that will be decommissioned over this time).[15]

In this analysis, we pay especially close attention to enlisted requirements on ships and submarines. We focus on enlisted manning because the enlisted community constitutes the great majority of the Service's endstrength (officers composed only about 16 percent of the active force in 2008) and because, as a result of the Defense Officer Personnel Management Act (DOPMA) of 1980, the Service is much more constrained in making cuts to its officer corps than in making cuts among its enlisted personnel. Our focus on ships and submarines is motivated by three factors: (1) requirements for ships and submarines are determined with far greater accuracy than those for the shore establishment;[16] (2) these requirements are tied to critical warfighting capabilities (certainly other capabilities, such as those of the Seabees and Special Operations, are essential to warfighting, but ships and submarines provide the critical capabilities that are unique to the Navy); and (3) we are able to make useful estimates of fleet manpower requirements over a 30-year horizon, whereas our estimates for other commands extend only through the end of the Future Years Defense Plan (FYDP) in 2013. See section 3 for important trends in the development of the future fleet and section 4 for detailed estimates of future manpower requirements (including lists of ratings that are expected to grow or to become substantially more senior).

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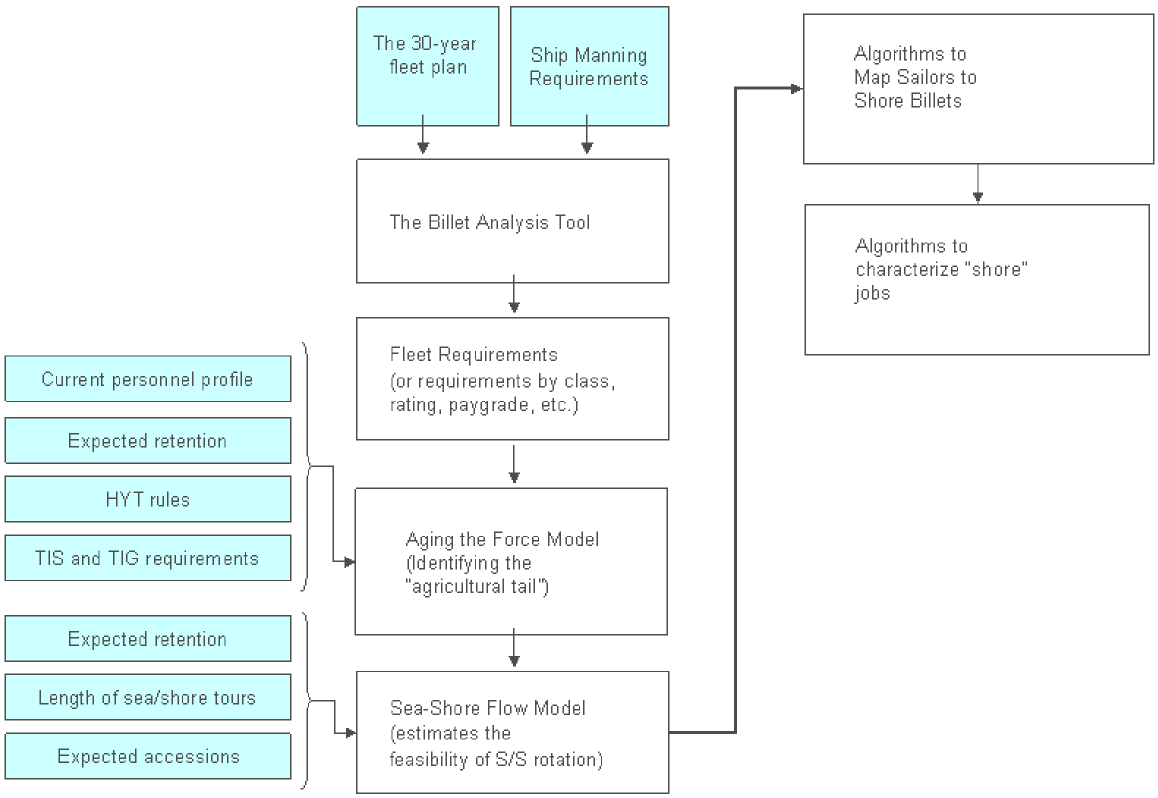
15 The "313-ship fleet plan," which was a supporting element of the 2008 Presidential Budget, provides our initial point of reference for the composition of the future fleet. Several modifications to this plan have already become evident, including the Navy's early termination of the DDG-1000 program and the delay of the CG-X program..

16 See Government Accountability Office (1997).

Figure 1. The stages of our analysis



Estimating immediate work requirements

In the first stage of our analysis, we consider only the Navy's *immediate* work requirements over the next 30 years. Our estimates fall into two broad categories: (1) those for ships and submarines and (2) those for all other commands. The best available data on requirements come directly from Total Force Manpower Management System (TFMMS): these data show billets authorized (BAs) by Unit Identification Code (UIC) through the FYDP (for the data used in the current study, this extends through 2013). For other commands, our estimates for later years (2014 and beyond) are simple "straight-line" projections of the requirements for 2013.

Our method of estimating requirements for ships and submarines is more complex. We again make use of TFMMS data for individual UICs, and here a UIC is usually a specific ship or submarine.[17] We then merge these data with the Navy's 30-year shipbuilding plan using the Billet Analysis Tool (BAT), a program developed by CNA that allows one to assess how changes in operating force units affect requirements for particular paygrades and ratings.[18] BAT allows us (1) to "roll up" requirements for individual UICs to derive total manning for the fleet, (2) to aggregate manning by ship type, or (3) to cut and aggregate these data in other dimensions (e.g., the number of BAs for NCOs in a particular rating by ship type).

Like the data for "other" commands, manpower requirements for *specific* hulls are available only through 2013, and past 2013 our projections *for specific ships* are straight-line estimates. BAT, however, allows us to capture changes in the composition of the fleet out to 2037; as a result, our estimates for requirements on ships and submarines show substantial variation over the entire 30-year ship plan (out to 2037).

Going beyond immediate work requirements

The number of people necessary to man the fleet at any single moment, however, can be significantly less than the number needed to maintain a viable personnel inventory over the long term. In any particular rating, the Navy must ensure that it has enough Sailors in shore billets to support the Service's sea/shore rotation policy. For example, if the Navy wishes Sailors to spend 3 years on shore for every 5 years at sea, there must be three shore billets for every five sea billets—even if the amount of shore work does not justify this number of billets. Moreover, the Service must ensure that it has enough junior personnel to fill its future (subsequent) requirements in higher ranks—and it may have to maintain this "agricultural tail" even if these junior personnel are not necessary to meet the Service's immediate workload.

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17 For legacy ships, we have used the data on manpower requirements that are taken from the ship-manning documents and that are maintained in TFMMS. For future ships, we have, where possible, used estimates of manpower requirements provided by the Navy or by contractors associated with the development of the ships. See appendix B for further details of our manpower estimates for future ships.

18 See appendix B of this report for further details of BAT.

Assessing the adequacy of ratings' agricultural tails

In the second phase of this study, we consider two questions: (1) whether there are currently enough junior personnel *in the inventory* to grow into the future senior requirements that we have identified; and (2) whether future *requirement structures* are sustainable (whether, across the shipbuilding plan, there are sufficient junior billets to support the Service's long-term requirements for senior personnel). Moreover, if it turns out that the answer to either of these questions is no, we need to estimate the number of additional billets that will be needed to build an adequate agricultural tail.

To make these determinations, we developed an "aging the force" model that takes as inputs the service histories of individual enlisted personnel, the Services' promotion requirements (time in service (TIS) and time in grade (TIG)), high-year-tenure rules, expected continuation behavior, and changes in future manpower requirements (by paygrade and rating). The model's outputs include data on future force profiles that show the number of enlisted personnel in future years by paygrade and occupation; the likelihood of promotion for specific cohorts; information on which occupations and paygrades will see gapped billets due to insufficient numbers of promotion-eligible personnel; and maximum and minimum values for average TIS at promotion to E5, E6, and E7.

Estimating future sea/shore rotation

In the third stage of our analysis, we consider whether the Service will be able to maintain its desired sea/shore rotation with its planned personnel inventory. To make this assessment, we use the Sea/Shore Flow model, which was recently developed by N122X (DCNO, MPT&E, Total Force Requirements Division, Manpower Analytics).[19] Details of the model are provided in appendix C, and the results that we derived from the model are discussed in section 5.

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[19] CDR Craig Schauppner of N122X and Mr. Pratik Joshi of Serco, Inc developed the model. We are grateful to them for making it available to us.

We take two important results from this model. First, we identify several ratings that are expected to have excessively long sea tours. The prescribed limits on tour lengths are 60 months for Sailors' first and second sea tours and 48 months for any subsequent sea tours. There are also purely practical factors that constrain tour lengths: if Sailors are assigned a first sea tour that is of maximum duration (60 months), they will, on average, serve only 52 months of this tour.[20] (Most of these truncated tours end in attrition from the Navy.) The model allows us to estimate the number of shore billets that the Service would have to create to accommodate the constraints on sea-tour length.

The second result that we take from the model is identifying ratings that currently have relatively short sea tours, but for which it may be possible to increase sea duty to eliminate emerging gaps in fleet billets. Among these, we are particularly interested in ratings for which fleet requirements are expected to grow substantially or to become significantly more senior.

Mapping ratings to shore work

We can expect the Navy to lengthen the sea tours for Sailors in order to mitigate fleet manpower shortages, but *only* if the shore duty performed by these Sailors can be performed by others, or eliminated altogether. So, in the fourth stage of this analysis we determine the type of work that Sailors in the various ratings perform in their shore duty, and we make various characterizations about this work. We begin this analysis by making an *approximate* mapping of enlisted personnel to the rating and paygrade requirements of the shore billets to which they are assigned.[21] Our mapping is only approximate because

20 See Koopman and Gregory (2007).

21 In the Navy, both billets and personnel are assigned ratings and paygrades. On one hand, Sailors' ratings are their occupational specialties, while their paygrades are their rate (naval officers are said to have a rank—such as Ensign—but naval enlisted personnel are said to have a rate—such as Petty Officer First Class). On the other hand, the rating and paygrade assigned to a *billet* indicate the rating and paygrade required of a Sailor if he or she is to fill that billet. However, one frequently finds imperfect matches between Sailors and the requirements of the billets which generated their assignments.

the Navy accounting system indicates the UIC[22] to which a Sailor has been assigned but not the particular billet the Sailor fills within that command. As a result, it is not possible to identify *precisely* the rating and paygrade requirements of the work that a Sailor is performing.[23]

In section 6, we explain (1) the algorithms we use to map Sailors to the work they perform on shore, (2) the biases that are implicit in these estimates, and (3) the direction of these biases (we have designed our algorithms so that we know the direction of the biases and make use of this knowledge in our analysis). Section 5 also shows the results of our estimates.

Characterizing the nature of Sailors' shore work

After identifying the type of shore work being performed by Sailors in the various ratings, we characterize the importance of this shore duty to the Navy's essential mission areas. We take three approaches to this task:

1. The simplest method is determining whether Sailors are required to have their particular rating and paygrade in their shore work. If Sailors in a rating generally do shore duty that could be performed by others, it suggests that the Service may make greater use of this rating at sea (substituting other personnel into the shore work performed by this rating).
2. We also use classifications of the IGCA inventories compiled by OSD to identify functional areas at commands as either inherently governmental, exempt from private-sector performance, or subject to review for divestiture or private-sector performance (see Department of the Navy, 2006). If a Sailor is in a rating that performs shore duty that might be divested or "outsourced" to the

[22] A UIC is six-digit code that identifies each DoD entity. Typically, the first digit designates the Service and the last five identify a specific organization, command, or hull.

[23] For example, one might look at data for the different billets at a command and assume that a Sailor is filling the billet that most closely aligns with his or her rating and paygrade when, in fact, the Sailor was detailed to the command because it had an available FAC-G billet (a billet that carries no particular rating requirement).

private sector, the Navy may make greater use of this Service member in the fleet (either eliminating parts of the work performed by this rating, substituting civilians into the job, or arranging for the work to be done by contractors).

3. Finally, we apply classifications developed by the MCAP to rank the importance of shore work. The MCAP process evaluates functional areas at commands for how closely they support the Navy's essential warfighting capabilities, including the projection of military power, providing defense of the homeland, and enhancing operational independence and support for joint forces.

In chapter 6, we discuss the results of applying these three approaches to the classification of shore duty. Appendix F (available under separate cover) describes the IGCA and how they were used in this analysis. Appendix G (also available under separate cover) provides details of the MCAP process.

The assumptions underlying our estimates

We use the following assumptions when predicting our estimates of future manpower requirements:

- The Navy will conform to the 2007 fleet plan. As we have previously mentioned, the Navy's fleet plan continues to evolve.
- Our estimates of requirements for ships, submarines, and other commands are the best available. There is always contention about how requirements for a ship will change over the long term. Generally, projections of future requirements for a class of ships significantly underestimate the BAs that are eventually found on these ships.[24] There is particular uncertainty regarding (1) the LCS (our estimates are based on the current Blue/Gold manning scheme) and (2) the CG-X (our estimates assume that manning for the future cruiser

[24] Moore, Koopman, and Callison (2002) examined manning across a variety of Navy ships and found that, for each class, there is substantial growth in requirements over time. In the period between design and commissioning, average requirements grow 6 percent. Between commissioning and 5 years in service, average requirements grow 11 percent. Across all subsequent years, average requirements grow 7 percent.

will be the same as manning for the current class of cruisers).

- Navy retention over the 30-year shipbuilding program will resemble that of the last several years. To predict future retention, we used a 5-year weighted average of retention (by rating and years of service) over the period 2002 to 2007 (the most recent years received more weight). Navy retention was relatively stable over this 6-year period.
- In order to avoid gapped billets, the Navy is willing to advance personnel as soon as they meet the TIS and TIG requirements for promotion. This assumption is likely to result in our underestimating—to a modest degree—the number of personnel that is required in a rating's agricultural tail.
- Sailors who meet the Service's TIS and TIG requirements are fully eligible for promotion. It is not possible for us to identify the proportion of personnel who meet all requirements for advancement. For this reason, we assume that Sailors who have passed the basic TIS and TIG thresholds are eligible for promotion. This assumption is likely to result in our underestimating—to a small degree—the number of personnel that is required in a rating's agricultural tail.

3. Trends in fleet size and composition

The Navy's current 30-year ship plan calls for the fleet to expand from approximately 280 to 329 in FY 2018. This plan, which has become known as the 313-ship fleet, has been the subject of significant controversy in Congress because of both technical concerns and questions of whether the plan is affordable given the resources that have been designated for Navy ship construction.[25] Nevertheless, we will use the 313-ship plan as our initial point of reference in discussing the Service's future manpower requirements. (In our discussions of individual ratings in appendix A, we indicate how marginal changes in the composition of the fleet can affect requirements.)

Figure 2 shows the composition of the fleet, by major categories of ships and submarines, to the year 2037, and appendix D shows the numbers on which this figure is based. The figure shows several factors that are important determinants of future manpower requirements:

- The number of ships in the fleet will expand through FY 2018. Starting in 2020, this number will slowly decline.
- During the period of overall fleet expansion, there are 2 years when the number of carriers will fall from 11 to 10. This period lasts from the decommissioning of USS *Enterprise* (CVN-65) in 2013 to the commissioning of USS *Gerald R. Ford*, the first in the CVN-21 class, in 2015.
- The period of fleet expansion will also see a decline in the number of attack submarines—from 52 at present to 40 in FY 2028. This number then rises and returns to its current level of 52 by FY 2037.
- The period of fleet expansion will also see the elimination of frigates. The Service currently operates 30 Perry class (FFG-7 class) frigates. While eight of these are operated by the Naval Reserve Force (NRF), the remainder are wholly manned by active duty personnel. Overall, the number of surface combat ships (frigates,

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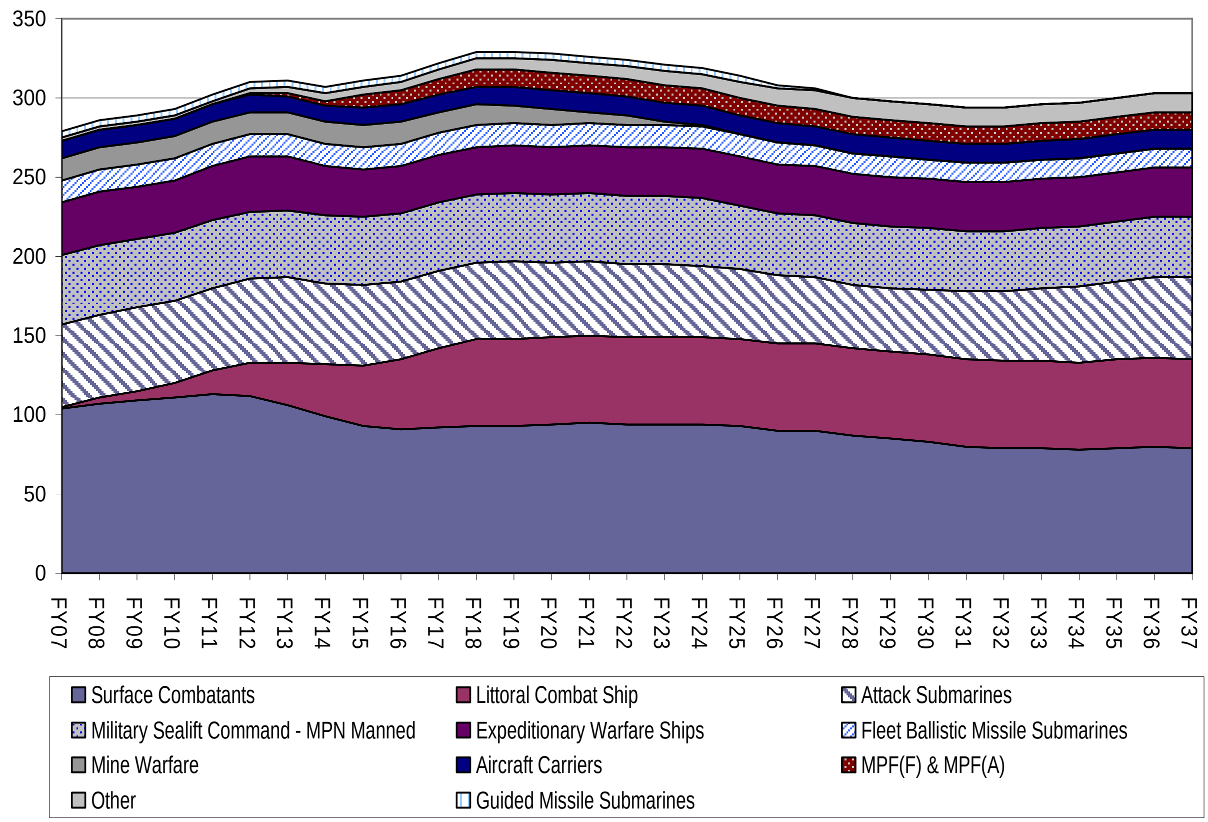
25 See Department of the Navy (2006) and The Congressional Research Service (2007) for congressional reports on the Navy's DDG-1000 Destroyer Program and options for the Navy's future fleet.

destroyers, and cruisers) *increases* from 107 at present to 113 in FY 2011, and then *declines* to 91 in FY 2016.

- Between FY 2017 and FY 2024, the Service will eliminate its 14 Avenger class large mine countermeasures ships. Five of these are currently operated by the NRF, but the other nine are wholly manned by active duty personnel.
- Among the additions to the fleet under the 313-ship plan are a 12th carrier (to be commissioned in FY 2019), 55 LCSs, and 11 maritime prepositioning force ships (MPF-F and MPF-A).
- While some of the ships that are being added to the fleet are relatively small (for example, the LCS), we will not see a diminution in the size of Navy ships: the *average* tonnage per ship is expected to rise by 13 percent over the 2008–2025 period, and the *total* tonnage of the fleet is forecast to grow by 28 percent in this period. (Both total tonnage and average tonnage would increase even if one were to exclude the MPF-F class from the fleet plan.)

Figure 2. Size and composition of the future fleet



4. Growth and seniority of manpower requirements

As the Navy expands the fleet, it will also be reducing its end-strength—from about 334,000 in 2007 to 324,000 in 2008 and to about 320,000 in 2013. The Service's plans for making these cuts involve substantially different rates of growth in the billets assigned to the fleet and shore activities. At present, about 31 percent of BAs are assigned to ships and submarines, 11 percent are assigned to air squadrons, and the remaining 58 percent are assigned to what is traditionally thought of as the "shore establishment."[26] Tables in appendix E indicate how the BAs of various ratings are distributed across these four categories.

Fleet requirements will show a sustained decline only after 2024

Figure 3 shows the projected BAs for all classes of ships and submarines over the 30-year fleet plan. An important point illustrated in this figure is that BAs for ships and submarines will only show a sustained decline after 2024. The figure also shows the short-lived decline in BAs between 2014 and 2015 and the modest rise that begins in 2016 and crests in 2023. While it is easy to see from this figure how the variation in the number of carriers is expected to affects BAs, it is more difficult to distinguish other important effects, such as how changes in amphibious warfare ships, attack submarines, and surface combatants will affect requirements. To make these effects clearer, we have illustrated them separately in figures 4, 5, and 6.[27]

26 While our "other" category is composed largely of shore BAs, it also includes some BAs that are designated "sea duty" but are not assigned to ships, submarines, or squadrons. These include Sailors assigned to construction battalions (the Seabees), explosive ordnance disposal units, and Marine Corps Force Service and Support Groups.

27 To maintain transparency in our accounting of ships and ship requirements, we have used the designations of ship classification as they appear in the 30-year ship plan given to us by N81.

Figure 3. Enlisted requirements by ship type

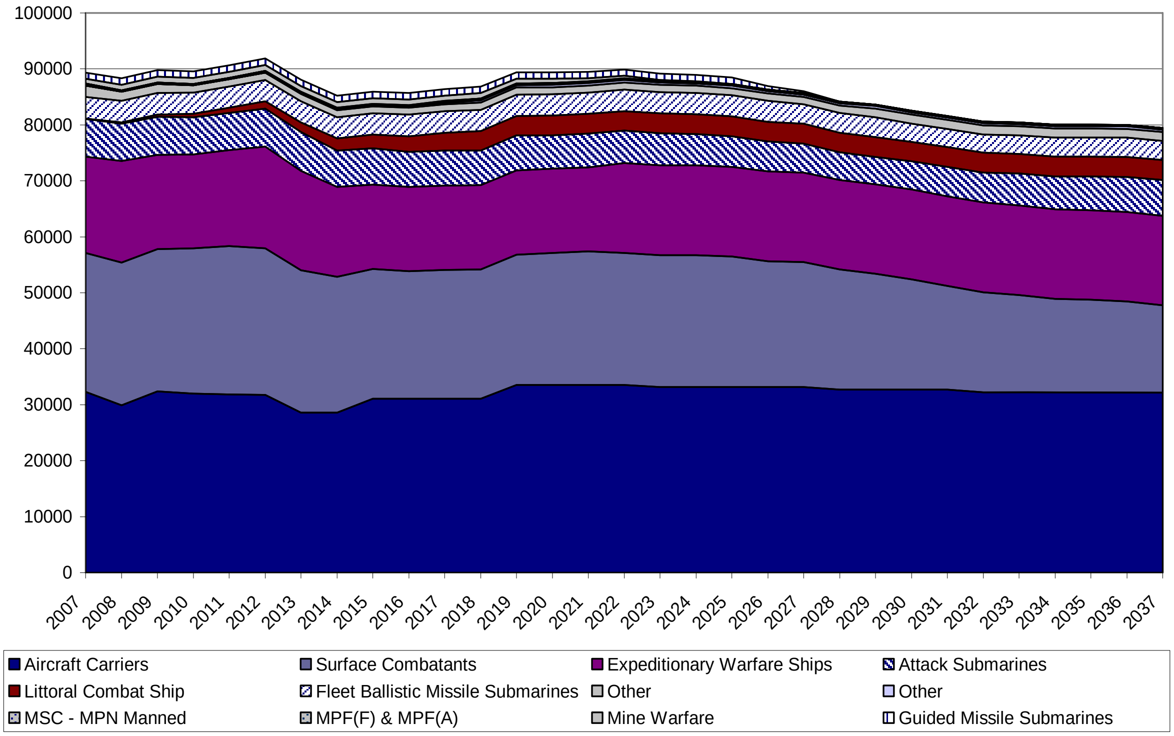


Figure 4. Enlisted BAs on amphibious warfare ships

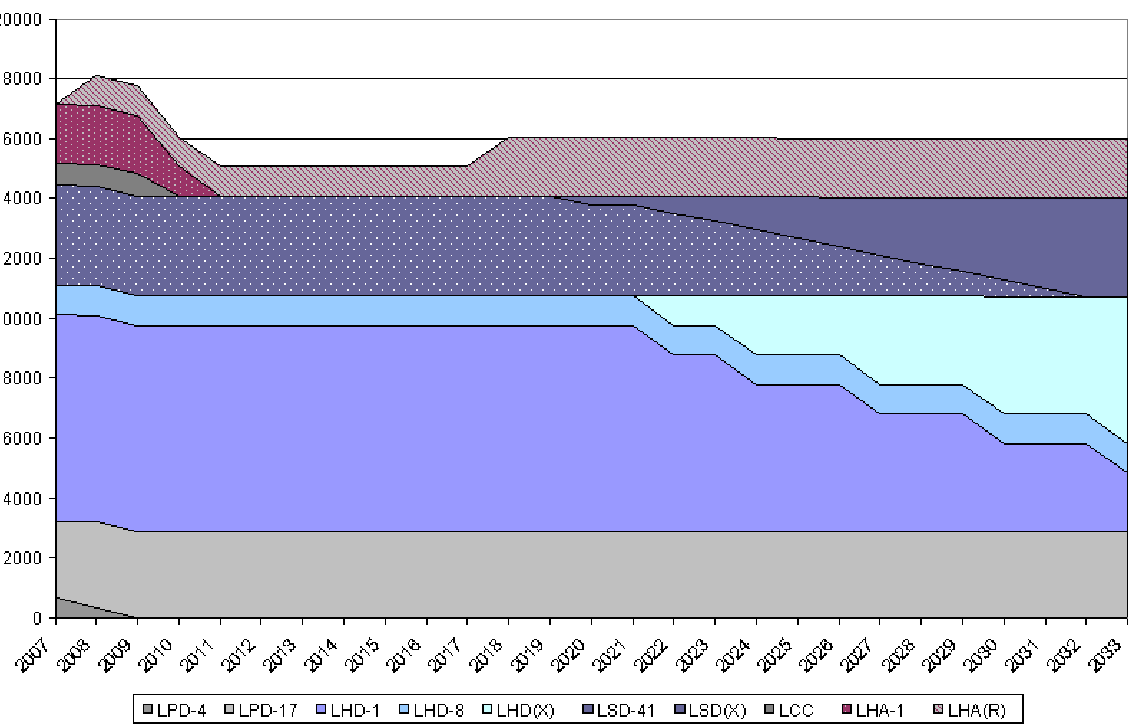


Figure 5. Enlisted BAs on attack submarines

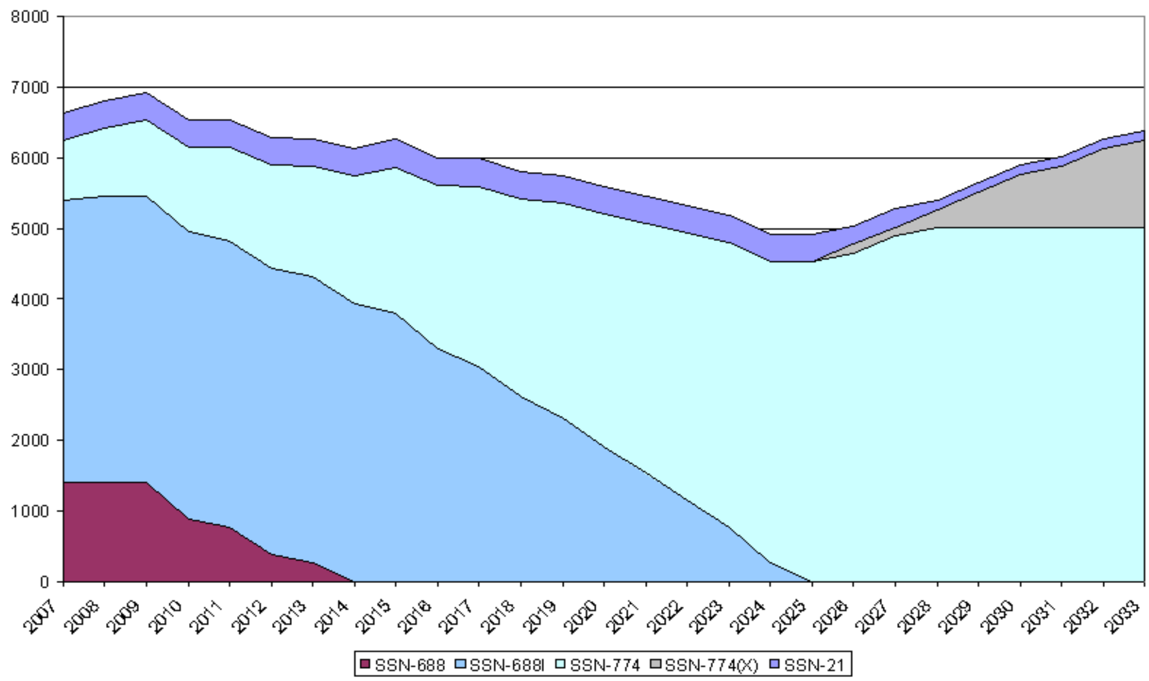
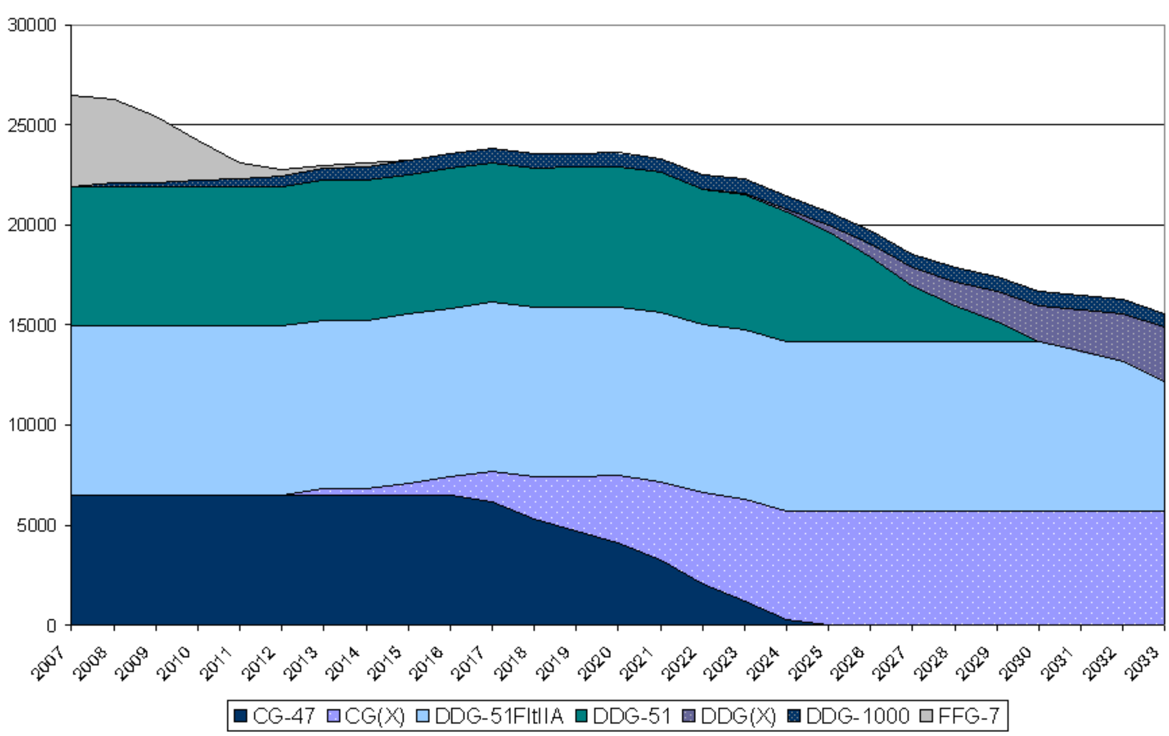


Figure 6. Enlisted BAs on surface combatants



Substantial growth in fleet requirements for many individual ratings

Many ratings are expected to experience growth in BAs on ships and submarines over at least part of the 30-year ship plan. Table 2 shows a large sample of these ratings.[28] Some care must be taken in interpreting this table. Because requirements among ratings can grow at different rates, for different lengths of time, and at different phases of the 30-year plan, no single table can compare ratings across all dimensions of growth. This table lists the number of BAs in the fleet in 2007 and the number expected *in the year in which BAs for this rating will be at their maximum*. It also indicates the year in which this maximum is expected to occur. Finally, it shows the average annual percentage rate of growth in BAs from 2007 to the year in which BAs for the rating are at a maximum.

In considering these data, one needs to recognize that a particular rate of growth may be easier to achieve for a small rating than for a large rating, or for a "low-tech" rating (a rating that requires few technical skills) than for a high-tech rating. Similarly, it may also be easier for a rating to maintain a high rate of expansion for a few years than over the long term.

One important point to take from this table is that, in general, it is higher tech ratings (ratings that require higher entrance qualifications from accessions) that are expected to show the most substantial growth in BAs. In these ratings, it is more expensive to recruit personnel, to train them, and to retain them. Also, these ratings are usually the most "top heavy"—that is, they have the most senior personnel profiles and relatively large proportions of personnel who are retained to retirement.

28 The table excludes those ratings that have less than 20 Sailors serving on ships and submarines (e.g., journalists).

Table 2. Ratings that will experience growth in *fleet* requirements

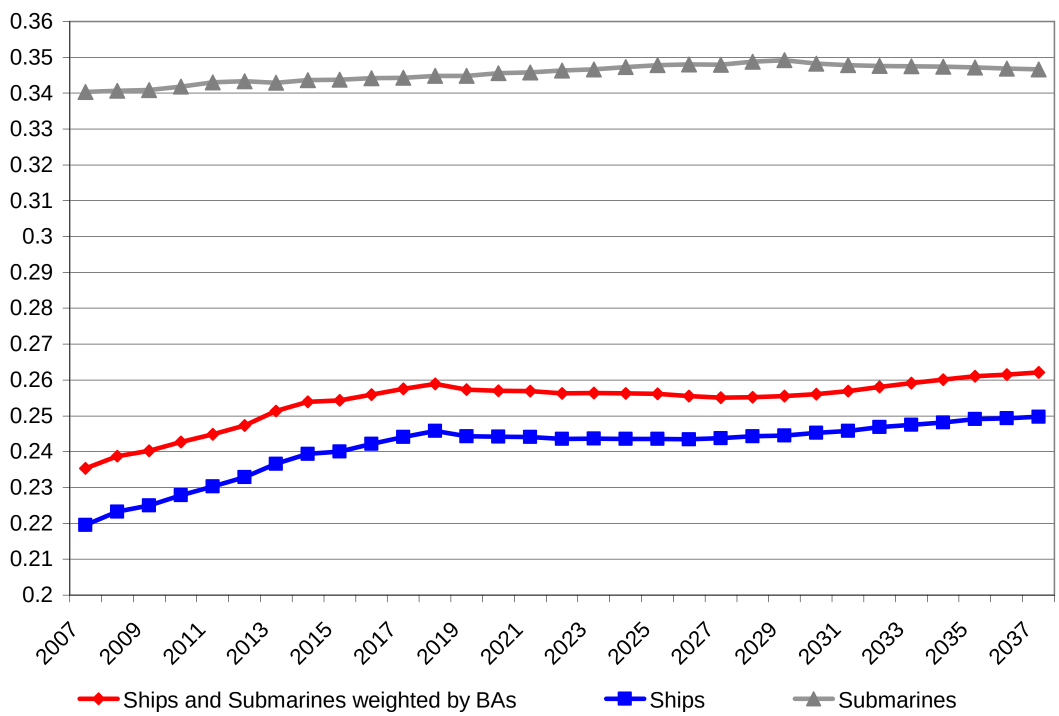
Rating	Rating Name	BAs in 2007	Maximum BAs 2008-2037	Year of Maximum BAs 2008-2037	Annual Percent Rate of Growth from Initial Year to Year of Maximum
AW	Aviation Antisubmarine Warfare Operator	20	66	2037	4.06
GSE	Gas Turbine Electrical	633	726	2013	2.31
CTR	Cryptologic Technician - Collection	458	612	2024	1.72
GS	Gas Turbine	79	102	2022	1.72
MA	Master at Arms	503	825	2037	1.66
CTM	Cryptologic Technician - Maintenance (Advanced Electronics Field)	160	206	2023	1.59
EN	Engineman	2514	3192	2023	1.50
MN	Mineman	368	410	2015	1.36
CTT	Cryptologic Technician - Technical	945	1023	2013	1.33
CMD	Construction Mechanic (Diesel Engine)	150	160	2012	1.30
STG	Sonar Technician (Surface)	1511	1610	2012	1.28
FC	Fire Controlman	3893	4687	2022	1.25
GM	Gunner's Mate	1398	1737	2025	1.21
CTA	Cryptologic Technician - Administration	75	91	2024	1.14
OS	Operations Specialist	3989	4256	2013	1.09
GSM	Gas Turbine Mechanical	1748	1862	2013	1.06
IT	Information Systems Technician	3464	3678	2013	1.00
EM	Electrician's Mate	3238	3435	2013	0.99
MC	Mass Communications Specialist	349	368	2013	0.89
DC	Damage Controlman	2031	2140	2013	0.88
IC	Interior Communications Electrician	1403	1477	2013	0.86
HM	Hospital Corpsman	901	1029	2023	0.83
NC	Navy Counselor	196	204	2012	0.80
AE	Aviation Electrician's Mate	275	348	2037	0.79
AM	Aviation Structural Mechanic	382	479	2037	0.76
AT	Aviation Electronics Technician	1100	1378	2037	0.75
AB	Aviation Boatswain's Mate	30	34	2024	0.74
CS	Culinary Specialist	3572	3732	2013	0.73
ND	Navy Diver	52	60	2030	0.62
ET	Electronics Technician	3540	3892	2023	0.59
AZ	Aviation Maintenance Administrationman	426	441	2013	0.58
BM	Boatswain's Mate	2036	2185	2023	0.44
PS	Personnel Specialist	858	878	2013	0.38
HT	Hull Maintenance Technician	1419	1451	2013	0.37
YN	Yeoman	756	773	2013	0.37
ABF	Aviation Boatswain's Mate (Fuels)	1853	1894	2013	0.37
QM	Quartermaster	1223	1249	2013	0.35
RP	Religious Programs Specialist	83	92	2037	0.34
SK	Storekeeper	3176	3237	2013	0.32
AD	Aviation Machinist's Mate	352	382	2037	0.27
AC	Air Controlman	517	529	2023	0.14
LN	Legalman	71	73	2037	0.09
ABH	Aviation Boatswain's Mate (Aircraft Handling)	4309	4318	2013	0.03
PC	Postal Clerk	169	169	2013	0.00
SN	Seaman	4658	4657	2008	LT 0
MR	Machinery Repairman	384	383	2008	LT 0
TM	Torpedoman's Mate	303	302	2008	LT 0
HN	Hospitalman	378	375	2008	LT 0
SH	Ship's Serviceman	1523	1509	2008	LT 0
ABE	Aviation Boatswain's Mate (Launching and Recovery)	2397	2339	2008	LT 0
AO	Aviation Ordnanceman	3959	3844	2008	LT 0
PR	Aircrew Survival Equipmentman	118	113	2008	LT 0
MM	Machinist's Mate	6202	5665	2008	LT 0
AG	Aerographer's Mate	67	120	2007	LT 0
AS	Aviation Support Equipment Technician	802	875	2007	LT 0
CT	Communications Technician	0	243	2007	LT 0
CTO	Cryptologic Technician - Communications	0	60	2037	LT 0
DN	Dentalman	0	24	2037	LT 0
DT	Dental Technician	0	36	2037	LT 0
IS	Intelligence Specialist	561	782	2007	LT 0
JO	Journalist	0	24	2037	LT 0
LI	Lithographer	0	36	2037	LT 0
PH	Photographer's Mate	0	114	2037	LT 0
PO	Petty Officer	0	180	2037	LT 0

Many ratings will experience sharply increasing seniority

When we consider the challenge of manning an expanded fleet with a reduced endstrength, we must recognize that increases in the number of BAs is only one of the factors that can necessitate growth in the personnel inventory. Even if the requirements for a rating are expected to remain constant over time, an increase in the *seniority* of these requirements may require growing the number of personnel in the rating. This is because the Navy has a closed personnel system, which means that it must access, train, and promote enough junior personnel to fill its higher ranks—even if some of these junior personnel are not necessary to meet the Service's immediate workload. As a result, if the requirements in a rating become increasingly skewed toward senior paygrades, the Service may eventually have to expand the number of *junior* personnel in this rating in order to fill the additional senior billets that will exist in the future.

Figure 7 shows how seniority is expected to change across all ship and submarine billets over the 30-year plan. The blue line

Figure 7. BAs in paygrades E6 and higher as a proportion of all BAs



on the graph represents the proportion of enlisted BAs on ships that are in paygrades E6 and above. Over the 30-year plan, this measure of seniority is expected to rise from 22 to 25 percent. Historically, enlisted requirements on submarines (indicated by the gray line) have been substantially more senior than those on ships, and figure 7 indicates that they will become slightly more senior through 2029. The red line in this figure shows this seniority measure when we combine BAs for ships and submarines.

Table 3 shows changes in seniority by rating over the 30-year plan. (Again, we use the metric of the proportion of enlisted BAs in a rating that are E6 or above.) Some ratings are expected to show large increases in both the proportion of enlisted personnel in senior paygrades and the *number* in senior paygrades:

- Among Operations Specialists (OSs), the proportion of senior enlisted almost doubles, from 17 to 32 percent. This results from the addition of 460 OS personnel in the E6 to E9 paygrades.
- For Gas Turbine Electrical (GSE), the proportion increases from 28 to 50 percent, resulting from an additional 104 GSEs in paygrades E6 and higher.

In some instances, however, the increase in seniority in a rating will be associated with only small rises in the number of senior personnel because there will be a decline in the overall population in the rating. One example is Aviation Boatswain's Mate (Aircraft Handling), in which our seniority measure is expected to rise from 10 to 14 percent, but this results from adding only an additional 32 Sailors in paygrades E6 and above.

Table 3. Ratings that will become more senior (proportion of ship and submarine BA that are in paygrades E6 and above)

Rating Name	2007 Percent in E6 or Above	Maximum Percent in E6 or Above	Year with Maximum Percent in E6 or Above	Total Number in Rating in 2007
Operations Specialist	16.80	31.49	2037	3,989
Gas Turbine Electrical	27.65	49.73	2037	633
Quartermaster	22.65	34.23	2037	1,223
Aviation Boatswain's Mate (Aircraft Handling)	9.93	13.82	2036	4,309
Aviation Boatswain's Mate (Launching and Recovery)	13.18	17.92	2036	2,397
Aviation Boatswain's Mate (Fuels)	10.58	13.44	2036	1,853
Mass Communications Specialist	24.07	30.56	2037	349
Boatswain's Mate	21.95	27.63	2037	2,036
Storekeeper	29.35	36.44	2037	3,414
Engineman	22.47	27.12	2021	2,514
Information Systems Technician	29.24	34.85	2036	3,464
Yeoman	34.28	40.61	2037	1,018
Air Controlman	17.79	20.90	2037	517
Machinery Repairman	24.74	28.71	2037	384
Fire Control Technician	33.63	38.23	2037	791
Fire Controlman	28.90	32.79	2037	3,893
Aviation Electrician's Mate	28.00	31.70	2012	275
Intelligence Specialist	34.94	38.76	2018	561
Sonar Technician (Surface)	21.38	23.38	2037	1,511
Aviation Electronics Technician	31.64	34.53	2008	1,100
Electrician's Mate	28.02	30.14	2018	4,311
Aviation Structural Mechanic	37.96	40.62	2010	382
Cryptologic Technician - Technical	29.11	31.04	2018	948
Torpedoman's Mate	31.02	32.99	2009	303
Culinary Specialist	25.28	26.84	2028	4,177
Ship's Serviceman	16.68	17.68	2013	1,523
Sonar Technician (Submarine)	22.51	23.76	2030	1,333
Personnel Specialist	43.59	45.94	2018	858
Hull Maintenance Technician	27.13	27.84	2013	1,419
Aerographer's Mate	44.78	45.71	2008	67
Aviation Machinist's Mate	33.52	34.19	2014	352
Electronics Technician	29.85	30.14	2015	6,483
Interior Communications Electrician	19.89	19.89	2007	1,403
Mineman	26.63	26.63	2007	368

Growth in agricultural tails

We have identified several ratings for which the Navy will need to expand agricultural tails (beyond the tails implicit in the Service's immediate workload requirements). The number of billets that will need to be added to each of these ratings is shown in table 4. The process of expanding lower paygrades should be relatively straightforward for all these ratings with the exception of GSEs. At present, there are too few E5 GSEs to support the planned expansion of E6 GSEs, and we expect that there will be several years in the next decade when the Service experiences gapped billets among E6 GSEs.

Table 4. Additional billets required to expand ratings' agricultural tails

Operations Specialist	1277
Mass Communications Specialist	334
Gas Turbine Electrical	220
Quartermaster	97
Other	82
Total to build agricultural tails	2010

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5. Requirements are becoming more sea-centric

Most cuts will come from the shore establishment

In the previous section, we saw that manpower requirements on ships and submarines only show a sustained decline after 2024. Much of the reduction in endstrength that the Navy is undertaking will be supported by cutting billets from the short establishment. Figure 8 indicates the projected change in BAs for the fleet (ships and submarines) and all other commands. Between 2007 and 2013, a net reduction of 8,970 BAs from the “shore establishment” (our “other” category) is scheduled, with the largest reductions slated in the ratings shown in table 5.

Figure 8. Change in BAs from 2007, by category

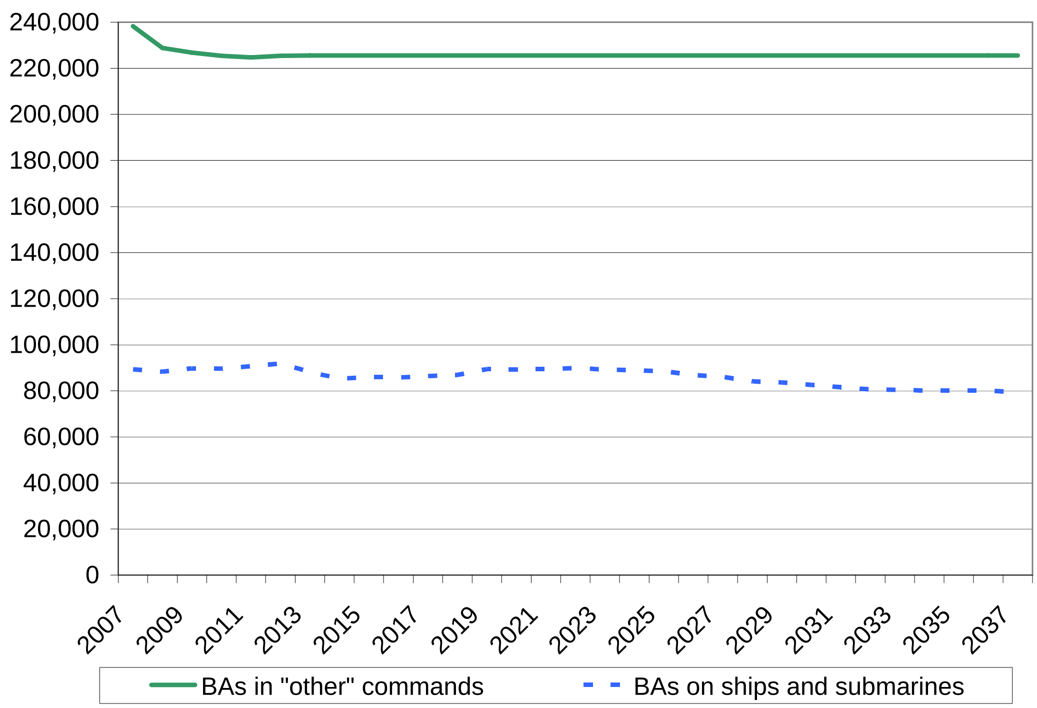


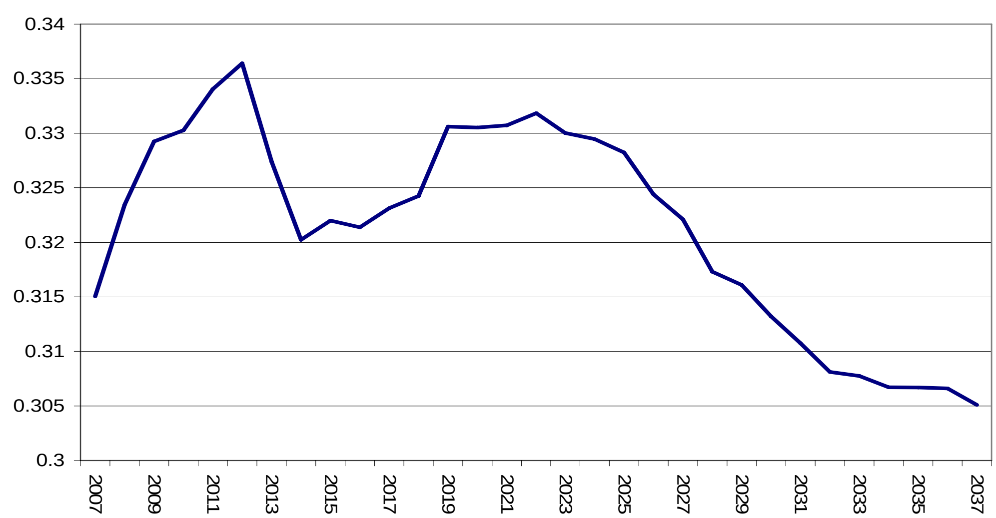
Table 5. Ratings that will experience large declines in "shore" BAs

Rating	Rating name	Decline in shore BAs from 2007 to 2013
HM	Hospital Corpsman	2793
PS	Personnel Specialist	2250
HN	Hospitalman	1747
MA	Master at Arms	1673
SN	Seaman	1040
YN	Yeoman	877
AM	Aviation Struct'l Mech'c	629
SK	Storekeeper	606
AT	Aviation Elect'cs Tech'n	541
MM	Machinist's Mate	501
AD	Aviation Machinist's Mate	491
ET	Electronics Technician	483
IT	Information Systems Tech'n	462
CS	Culinary Specialist	431
BM	Boatswain's Mate	406
HT	Hull Maintenance Tech'n	399
EM	Electrician's Mate	328
FN	Fireman	323
GM	Gunner's Mate	319
AE	Aviation Electrician's Mate	293
EN	Engineman	253
OS	Operations Specialist	196
DC	Damage Controlman	187
FC	Fire Control Technician	183
AO	Aviation Ordinanceman	175
IC	Interior Communic'ns Tech'n	161
CTT	Crypto'c Tech'n – Tech'l	149
AG	Aerographer's Mate	145
AZ	Aviation Maintenance Admin.	142
MR	Machinery Repairman	138
AME	Av. Struc. Mech. Safety	119
CTM	Crypto'c Tech'n – Maint.	118
GSM	Gas Turb. Systems Mech.	111
AW	Av. ASW Operator	99
STG	Sonar Technician Surface	94
AN	Airman	81
STS	Sonar Tech'n – Submarine	79
GSE	Gas Turb. Systems Elec.	60
PR	Parachute rigger	56

A rising sea/shore rotation ratio

The fact that (1) fleet billets are staying relatively constant through 2024 (they are actually above current levels for several of these years) and (2) shore billets are declining indicates that manpower requirements are becoming increasingly sea-centric. Figure 9 provides a highly aggregated perspective on future sea/shore rotation: it shows the ratio of enlisted BAs on ships and submarines to total BAs in the Service. This suggests that, over the 30-year plan, the proportion of time that Sailors spend at sea will reach its maximum in about 4 years. After this, the proportion of time on sea duty will enter a trough for several years but will remain *above its current level*. Sea duty will reach another "local maximum" around 2023 and only then will it begin a long-term decline.

Figure 9. The ratio of BAs on ships and submarines to total BAs



Sea-duty constraints: rating by rating

Table 6 shows predicted sea-tour lengths in 2013 for those ratings in which we expect *fleet* requirements to either grow substantially or become significantly more senior. These predictions are taken from the Sea/Shore Flow model developed in N122X (see appendix C for technical details). We ran the model on data for 2013 because, for many ratings, this is when sea-tour lengths will be at (or near) their highest values over the 30-year ship plan. The model searches for the best combination of sea-tour lengths to fill sea billets while

Table 6. Minimum sea tour lengths for select ratings

Increased Seniority	Growth	Rating		Sea Tour 1	Sea Tour 2	Sea Tour 3	Sea Tour 4	Sea	Shore	Students	TPPH	RHA	Total
Yes		ABE	Aviation Boatswain's Mate-Launching & Recovery Equip't	80	63	48	48	2429	446	26	62	3	2966
Yes		ABF	Aviation Boatswain's Mate-Fuels	56	59	47	42	1975	409	17	55	2	2458
Yes		ABH	Aviation Boatswain's Mate-Aircraft Handling	70	60	37	48	4604	838	46	78	4	5570
Yes		AC	Air Traffic Controller	18	18	9	11	725	1610	54	59	2	2450
Yes		AE	Aviation Electrician's Mate	38	59	40	47	2759	1322	144	124	4	4353
Yes		BM	Boatswain's Mate	47	40	48	48	3353	1337	21	149	3	4863
	Yes	CTA	Cryptologic Technician-Administration	19	26	12	11	125	548	25	26	1	725
	Yes	CTM	Cryptologic Technician-Maintenance	21	45	35	11	359	330	80	30	1	800
	Yes	CTR	Cryptologic Technician-Collection	27	24	10	12	1087	1758	253	82	11	3191
	Yes	CTT	Cryptologic Technician-Technical	32	42	34	19	1400	913	226	92	3	2634
Yes		DC	Damage Controlman	47	59	44	51	2180	724	82	91	0	3077
	Yes	EMSW	Electricians Mate Surface	55	64	61	48	2667	817	156	154	1	3795
Yes	Yes	ENSW	Enginman Surface	65	65	48	67	4061	1033	157	190	4	5445
Yes	Yes	FC	Fire Controlman	42	63	51	44	2844	1074	290	159	5	4372
Yes		FT	Fire Control Technician	55	49	33	47	846	338	86	81	0	1351
	Yes	GM	Gunner's Mate	37	55	42	41	2301	920	197	144	1	3563
Yes	Yes	GSE	Gas Turbine Systems Technician-Electrical	50	58	50	12	851	255	55	49	0	1210
	Yes	GSM	Gas Turbine Systems Technician-Mechanical	52	60	64	22	2122	533	97	100	3	2855
Yes	Yes	IT	Information System Technician	28	50	19	12	5304	4868	468	406	33	11079
	Yes	MA	Master-at-Arms	14	13	20	11	2631	6865	91	221	10	9818
Yes		MC	Mass Communication Specialist	26	53	38	12	650	596	35	42	16	1339
	Yes	MN	Mineman	34	58	33	43	1431	529	61	94	1	2116
Yes		MR	Machinery Repairman	56	27	43	42	397	170	45	38	0	650
Yes	Yes	OS	Operations Specialist	43	58	33	60	4808	2071	259	324	9	7471
Yes		QMSW	Quartermaster	52	58	39	48	1488	618	46	110	0	2262
Yes		SK	Storekeeper	47	44	42	36	5007	3069	160	239	1	8476
	Yes	STG	Sonar Technician-Surface	48	44	37	36	1919	718	193	109	2	2941
Yes		YN	Yeoman	32	25	36	12	1833	2464	56	139	13	4505

keeping sea duty under some user-specified maximum. The maximum values we specified were 52 months for Sailors' first sea tour, 60 months for their second sea tour, and 48 months for any subsequent sea tours. (We assume that Sailors spend 36 months on shore tours between each sea tour.)[29]

The cells that are shaded dark gray indicate cases in which it is not possible to fill all fleet billets given a personnel inventory equal to the total number of requirements. In other words, if the Service were to set the personnel inventory in a rating equal to the total number of billets (both sea and shore), the dark gray cells indicate that Sailors' sea tours would have to exceed the prescribed maximum. (To shorten sea duty to the prescribed maximum, the Service would have to add shore billets and increase the number of personnel in the rating.) The cells with light gray shading indicate cases in which sea duty is approaching the prescribed maximum within 5 months.

The table indicates that in several ratings it will not be possible to fill all sea billets without exceeding the maximum sea-tour lengths. Most notable among these ratings are the Aviation Boatswain's Mates (ABE and ABH—the first of which exceeds the maximum sea-tour length for both the first and second sea tours), Electrician's Mate Surface (EMSW), Engineman Surface (ENSW), Fire Controlman (FC), Gas Turbine Technician Mechanical (GSM), and (OS).

The table also suggests several ratings for which the Navy *might* be able to lengthen sea tours to offset growth in fleet requirements (or to offset fleet requirements that are becoming more senior). These include the Cryptologic Technician ratings (CTI, CTA, CTM, CTR, and CTT), Information System Technicians (IT), Masters at Arms (MA), Mass Communication Specialists (MC), Storekeepers (SK), Sonar Technicians Surface (STG), and Yeo-

29 In June 2007, Chief of Naval Personnel Vice Admiral John Harvey told the Navy's career counselors that the Service was moving to a "fleet standard" under which Sailors should spend no more than 5 years at sea followed by a minimum of 3 years on shore. Since then, there have been discussions of plans based on 60/60/48/48 and 60/54/48/48. See the *Navy Times,* 1 April 2008. As we discussed above, we selected a maximum first sea-tour length of 52 months based on the analysis of Koopman and Gregory (2007) who found that, even when Sailors are assigned to sea tours of 60 months,

men (YN). Whether the Service would wish to increase sea duty for those in these ratings, however, would depend on the nature of the work that these Sailors are performing on their shore duty. We explore this in a later section.

Sea/shore rotation—looking behind the numbers

In considering the predictions in table 5, one should note that they provide only a mathematical definition of when sea/shore ratios are expected to become untenable: these are ratings for which we expect more sea billets than can be sustained given (1) the number of shore billets in the rating, (2) the Service's policy cap on the sea/shore rotation ratio, and (3) the de facto constraint on the length of first sea tours. However, the Service may find that, for still other reasons, the sea-tour length in a particular rating may become problematic long before it approaches our definition of "untenable." Several factors can affect a rating's capacity to maintain long sea tours, including the following:

- Sailors are less able to bear high sea/shore rotation ratios if they serve on ships and submarines with low turnaround ratios (shorter dwell times). A typical 2-year deployment cycle for a ship or submarine might consist of 6 months of deployment overseas, a 1-month postdeployment leave and upkeep period, 6 months of intensive maintenance, 10 months of training, and 1 month of "leave, upkeep, and stores load-outs prior to deployment." The turnaround ratio is (1) the number of days it spends in homeport over (2) the number of days a unit spends on deployment (this ratio is 3 in our example). As the turnaround ratio declines, sea duty becomes more onerous. For most communities, a *minimum* turnaround ratio of 2 is maintained for peacetime operations.[30]

[30] There are exceptions to the dwell time minimum. For example, Navy Seabees deploy for 7 months and return to their home base for 7 months of training before their next deployment.

- Sailors who serve in ratings with more arduous in-port sea duty are less able to maintain higher sea/shore rotation ratios.[31] Gas Turbine Systems Technician- Electrical (GSE) are an example: in general, have strenuous work schedules when they are in home port and are less able to bear high sea/shore rotation ratios. In contrast, the aviation support ratings, such as ABEs, have strenuous duty when the air squadrons are on the carriers, but have relatively light sea duty in home port, and this mitigates the effects of high sea/shore rotation ratios.

- Ratings that are filled largely by junior personnel have less difficulty in maintaining higher sea/shore rotation ratios. Again, the aviation support ratings and GSEs offer contrasting examples. Much of the work of Aviation Boatswain's Mate Fuels (ABFs) can be performed by Sailors on their first enlistment. Once these Sailors complete their initial training, they remain on sea duty much of the time until their first reenlistment point. At this juncture, the great majority leave the Service and are replaced by others who serve only one sea tour. In contrast, much of the work performed by GSEs must be undertaken by more senior, experienced Sailors. The high sea/shore rotation ratio for this rating implies that the Service must keep a substantial number of GSEs on sea duty for much of their extended naval careers.

How much will ratings have to grow to limit sea-tour length?

We have identified several ratings for which we expect excessively long sea tours (those that exceed the 52/60/48/48 standards). Table 7 indicates the number of shore billets (and the number of personnel) that the Navy would have to add to ensure that sea tours conform to these constraints. We expect that, to limit sea-tour lengths, the Navy will have to add about 3,445 enlisted shore billets to the 321,337 BAs (for officers and enlisted) that we have already identified as filling the immediate work requirements for FY 2013.

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31 See the testimony of John Hagan, U.S. Navy, Master Chief Petty Officer of the Navy, before the House Appropriations Committee, National Security Subcommittee on Quality of Life, 18 Mar 1998.

Table 7. Additions needed to limit length of sea duty

	Additional sailors needed	
Aviation Boatswain's Mate – Aircraft Handling	566	
Engineman Surface	419	
Aviation Boatswain's Mate – Launching and Recovery Equip't	412	
Aviation Ordnanceman	392	
Machinist's Mate, Nuclear Surface	192	
Special Warfare Operator	162	
Electrician's Mate Surface	161	
Special Warfare Boat Operator	125	
Interior Communications – Surface	128	
Gas Turbine Mechanical	80	
Aviation Boatswain's Mate – Fuels	71	
Other	737	
Total to lower length of sea duty		3445

The difficulty of making marginal cuts in requirements

Historically, the Navy has had difficulty making cuts in its shore establishment

The Navy's success in reducing its endstrength will depend on its ability to make cuts across a wide range of commands—particularly those in the shore establishment. However, the Navy has historically had difficulty in cutting billets and, surprisingly, it has had particular trouble making small, marginal reductions in manpower. While the Service has undertaken a substantial downsizing of its personnel inventory over the last 20 years, much of this resulted from decommissioning entire ships. When it comes to cutting small numbers of billets off existing ships, Bost, Mellis, and Dent (1999) point out that the Service has often had great difficulty. They observe that

> the U.S. Navy has diligently introduced technology to reduce manning in certain areas only to find that these hard-earned savings are somehow not translated into reduced shipboard manning. They have been watered down or actually washed out by manning increases in other areas scattered throughout the ship. These increases never appear on any initial appraisal documents or operating requirement, but show up unidentified and unexplained at different times and in places anywhere on the ship.

Manpower planners we consulted for this study suggested that the Navy is likely to have an even more difficult time cutting billets from shore commands than from ships. One reason is that the processes for setting manpower requirements for the shore establishment have often been less precise than those used for ships. Shore commanders (like their sea-borne counterparts) have an incentive to retain as many billets as possible under their control and they have been known to use the poorly defined manpower requirements to argue for retaining nonessential, or even completely redundant personnel.

A 1997 report by the Government Accountability Office (GAO) stated that

> the Navy has had a long-standing problem quantifying the size of its shore infrastructure needed to support its operating forces. Despite concerns raised by Congress and various audit organizations for more than 20 years, many of the same problems continue with the current program. Problems continue primarily because of the low priority the Navy has traditionally given to managing the shore establishment and the ineffective oversight of the shore requirements program. Without an effective requirements program, the Navy has little assurance that resources directed at personnel requirements are being used in the most efficient way possible and that its shore establishment is appropriately sized.

A recent CNA report by Monroe (2008) suggests that these criticisms remain valid.

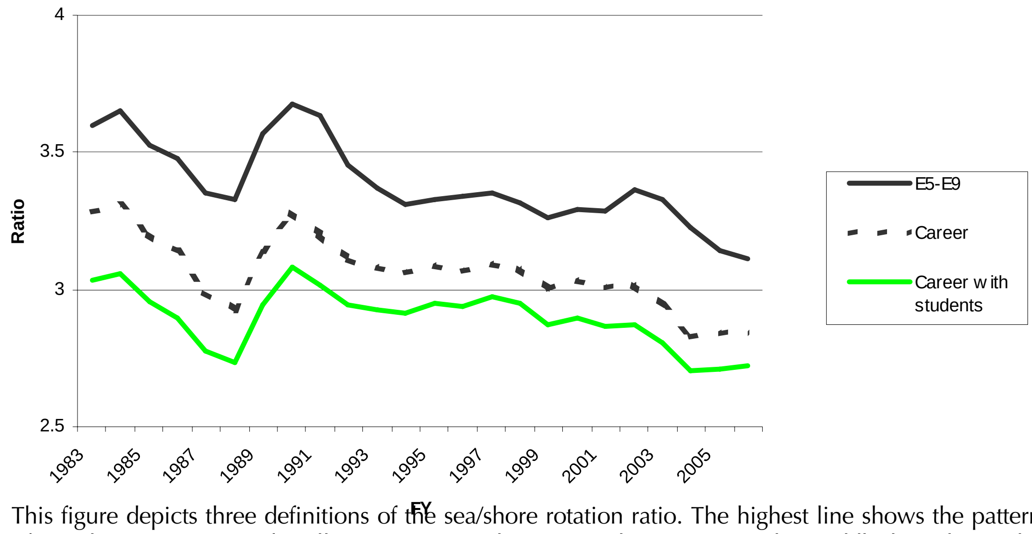
Reversing a long-term trend

The difficulty the Service has had in making cuts in the shore establishment is reflected in the historical trend of the sea/shore ratio shown in figure 10. Over the last quarter century, substantial reductions in sea billets, together with smaller reductions in the shore establishment, has resulted in an almost uninterrupted decline in the sea/shore ratio. (In fact, the actual trend in sea/shore rotation is even more dramatic than that shown in figure 10: the uptick in the sea/shore ratio shown between 1989 and 1990 is an artifact of a change in manpower accounting—without this change, the ratio would have declined over the entire interval.)

We expect that many of the specific reductions that the Navy has planned for the shore establishment over the next few years will prove especially difficult. For example, the Navy intends to cut non-fleet Hospital Corpsmen by 1,428 billets by 2013 (a reduction of 9 percent). In mid-FY 2008, however, Congress legislated a halt to the MilCiv conversion process that was necessary to eliminate these billets.[32] An additional problem arises because many of the ratings that are scheduled for reductions in shore billets are

[32] TFFMS data calls for the HM rating shedding 406 BAs between the end of FY 2007 and FY 2008. Over this period, however, the personnel serving in this rating declined by only 187.

Figure 10. Sea/shore ratio – E5-E9 and career distribution



This figure depicts three definitions of the sea/shore rotation ratio. The highest line shows the pattern of sea-duty assignments for all Navy personnel in paygrades E5 to E9. The middle line shows the sea/shore ratios just for those who have made a decision to reenlist. The bottom line is the same as the middle, except that all career personnel who are in school are counted as being on shore duty. These data are from a Scientific Analyst Memo prepared by Alan Marcus and Sam Kleinman at CNA.

Some of the planned cuts in shore billets are in ratings that are expected to have excessively long sea tours

expected to experience excessively long sea tours. These ratings include the following:

- Aviation Electronics Technician (AT) – the Service plans a reduction of 541 shore billets.
- Engineman (EN), Electrician's Mate (EM) – the Service plans a reduction of 253 shore billets.
- Fire Control Technician (FC) – the Service plans a reduction of 183 shore billets.
- Gas Turbine Systems Technician-Electrical (GSE) – the Service plans a reduction of 60 shore billets.
- Aviation Ordnanceman (AO) – the Service plans a reduction of 175 shore billets.
- Interior Communications (IC) – the Service plans a reduction of 161 shore billets.
- Gas Turbine Systems Technician-Mechanical (GSM) – the Service plans a reduction of 111 shore billets.

We expect that the need to shorten sea tours for these ratings will result in fewer shore billets being eliminated than the Navy is currently planning.

6. Mapping Sailors to their shore work

We have identified several ratings for which the Navy might wish to lengthen sea tours (shorten shore tours) to accommodate for growth in fleet requirements or for fleet requirements that are becoming more senior. Whether this would be desirable, however, depends on the type of shore duty being performed by Sailors in these ratings. To make this determination, we need to make an approximate mapping of Sailors and their assigned shore billets.

Problems in mapping bodies to billets

If one were to look at the various types of data available on Navy personnel and Navy jobs (billets), it might seem possible to develop an exact picture of the type of shore work done by Sailors in their shore duty. The Navy personnel and manpower accounting systems identify both (1) the ratings and paygrades of Sailors and (2) the rating and paygrade *requirements* of the billets to which Sailors are assigned (detailed). Other accounting systems assign *function codes* to the billets at each UIC (e.g., a billet at a specific UIC might be characterized as "Force Management and General Support" or "Command and Intelligence").

Several factors, however, preclude mapping directly from a particular Sailor, to the Sailor's shore billet, and to the type of work that the Sailor is performing in his or her billet. The most important obstacle is that the data do not link a Sailor to any particular billet. The Navy accounting system indicates the UIC to which a Sailor has been detailed (e.g., a particular ship or shore command), but not the billet vacancy that resulted in the Sailor being detailed to that UIC.[33]

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33 For example, suppose we observe a shore UIC that has two billets: one that requires a BM3 (Boatswain's Mate Third Class) and one that requires a YN3 (Yeoman Third Class). One might observe two Sailors at this UIC who have ratings and paygrades that do not align with the billets' requirements—perhaps a Hull Technician Second Class and a Storekeeper Third Class. From the data, we could not determine which Sailor had been detailed to which billet.

To an extent, one can *infer* matches between (1) Sailor's ratings and paygrades and (2) the billet requirements at the UICs where Sailors serve. However, these pair-wise matches of bodies to billets only go so far. While many Sailors' rating/paygrade combinations can be matched to billet requirements at a UIC, after exhausting the exact matches, there are invariably many loose ends—Sailors and billets that are unmatched and that have little in common.

There are still other complications in mapping Sailors to the type of shore work that they perform:

- Many UICs have FAC-G, or "wild card," billets that can be filled by Sailors in any rating. Our algorithm may fit a Sailor to the billet with the most closely aligned requirements when, in fact, this Sailor fills a FAC-G.
- Even if it were possible to determine a precise billet vacancy that resulted in a Sailor being detailed to a UIC, one could still not be certain about the type of work that a Sailor is performing because personnel do not necessarily work in the billet to which they have been detailed. Sailors may be detailed on the basis of having a particular rating, but once they arrive at their new UIC they may be placed in work that is unrelated to their rating but that has higher priority for their command.
- A shore billet requirement may be defined to ensure that Sailors in a particular rating have desirable assignments when they return from sea duty, and not because the billet actually requires the skills possessed by the person in that rating.

How our matching algorithm works

Our approach to mapping "faces to spaces" at a UIC is to assume that the closest possible matches have been made between the ratings/paygrades of Sailors' and the rating/paygrade requirements of billets. Our algorithm first makes whatever *exact* matches it can between (1) Sailors' paygrades and ratings at a UIC and (2) billet requirements (of paygrade and rating) at the UIC. The algorithm then notes the number of such matches that were made, removes the matched Sailors and billets from further consideration, and looks for matches that are close but not exact (e.g., allowing Sailors to fill a billet if they have the appropriate rating but are within one paygrade up or down of the billet requirement). Next, the program allows Sailors to be assigned to FAC-G billets. Finally, the program indicates the number of Sailors at a specific UIC who have a particular rating and paygrade, but who cannot be placed in exact matches, approximate matches, or FAC-G matches. The program then "rolls up" each of these types of matches across all shore UICs.

Our goodness-of-fit estimates

Table 8 shows the results of our matching algorithm (based on data for 2007). The first two columns on the left are similar to those in the previous table; they indicate the ratings for which requirements are expected to grow or to become more senior. The third column indicates ratings for which the sea/shore rotation is expected to be problematic (i.e., to have sea-tour lengths that push up against the policy constraint). (This column shows which of the four possible sea tours, over a hypothetical 30-year career, would exceed the maximum length.) The columns on the right-hand side of the table are our estimates of the *goodness of fit* between (1) Sailors' ratings and paygrades and (2) the requirements of the billets to which our algorithm has mapped these Sailors. They show the proportion of matches that are either exact or close approximations (matches that have the same rating but that allow some leeway in paygrade).

Interpreting a systematic bias in our estimates

Because we don't have the full set of information necessary to precisely match Sailors to shore billets, we have to make assumptions about the nature of these matches. Where assumptions are necessary, we err on the side of optimism: we assume that Sailors were detailed to a UIC to fill the closest possible requirements. We also assume that Sailors are doing the work indicated by the requirements of the billet to which they have been matched.

Table 8. Goodness-of-fit measure for shore duty

Increased Seniority	Growth	Sea tours near or above policy limit	Rating		E1-E3 No. in Grade	E1-E3 Proportion in closely matched billets	E4 No. in Grade	E4 Proportion in closely matched billets	E5 No. in Grade	E5 Proportion in closely matched billets	E6 No. in Grade	E6 Proportion in closely matched billets	E7 No. in Grade	E7 Proportion in closely matched billets	E8 No. in Grade	E8 Proportion in closely matched billets	E9 No. in Grade	E9 Proportion in closely matched billets
Yes		1 2 3 4	ABE	Aviation Boatswain's Mate-Launching & Recovery Equip't	26	0.38	78	0.54	243	0.58	125	0.51	86	0.47	19	0.37		
Yes		1 2 3	ABF	Aviation Boatswain's Mate-Fuels	19	0.26	136	0.71	187	0.52	89	0.61	61	0.61	13	0.38		
Yes		1 2 4	ABH	Aviation Boatswain's Mate-Aircraft Handling	86	0.42	237	0.76	325	0.75	190	0.75	110	0.65	29	0.48		
Yes			AC	Air Traffic Controller	199	0.90	265	0.95	499	0.93	423	0.93	105	0.88	30	0.93	14	0.79
Yes		2 4	AE	Aviation Electrician's Mate	465	0.94	152	0.98	562	0.86	354	0.83	175	0.87	49	0.80		
Yes		3 4	BM	Boatswain's Mate	19	0.37	175	0.61	753	0.64	370	0.56	308	0.61	79	0.58	24	0.38
	Yes		CTA	Cryptologic Technician-Administration	27	0.85	80	0.96	260	0.90	157	0.87	87	0.86	18	0.83	11	0.82
	Yes		CTM	Cryptologic Technician-Maintenance	33	0.79	119	0.73	198	0.72	219	0.74	76	0.87	20	0.75	8	0.75
	Yes		CTR	Cryptologic Technician-Collection	136	0.90	186	0.94	396	0.93	483	0.86	199	0.87	45	0.76	20	0.85
	Yes		CTT	Cryptologic Technician-Technical	59	0.63	50	0.70	300	0.80	320	0.78	185	0.78	40	0.78	17	0.76
Yes		2 3 4	DC	Damage Controlman	49	0.20	57	0.54	290	0.42	237	0.51	209	0.63	53	0.62	16	0.44
	Yes	1 2 3 4	EMSW	Electricians Mate Surface	18	0.17	150	0.61	438	0.75	339	0.67	233	0.70	57	0.63	17	0.53
Yes	Yes	1 2 3 4	ENSW	Enginman Surface	82	0.26	130	0.61	482	0.80	397	0.73	255	0.75	69	0.62	30	0.57
Yes	Yes	2 3 4	FC	Fire Controlman	16	0.00	63	0.33	522	0.56	453	0.59	303	0.70	50	0.78	31	0.52
Yes		1 4	FT	Fire Control Technician	3	0.00	10	0.40	62	0.87	133	0.83	110	0.86	19	0.79	8	0.63
	Yes	2	GM	Gunner's Mate	71	0.61	64	0.63	273	0.78	411	0.75	249	0.78	30	0.87	7	0.71
Yes	Yes	2 3	GSE	Gas Turbine Systems Technician-Electrical	8	0.50	24	0.67	84	0.62	93	0.67	79	0.76				
	Yes	2 3	GSM	Gas Turbine Systems Technician-Mechanical	20	0.30	90	0.40	352	0.62	183	0.66	142	0.71				
Yes	Yes		IT	Information System Technician	299	0.81	564	0.86	1792	0.89	1425	0.84	644	0.86	177	0.82	55	0.75
	Yes		MA	Master-at-Arms	1450	0.94	2134	0.95	2225	0.95	1496	0.92	482	0.90	118	0.92	38	0.68
Yes			MC	Mass Communication Specialist	153	0.54	99	0.77	237	0.81	256	0.81	91	0.78	32	0.78	6	0.50
	Yes	2 4	MN	Mineman	42	0.88	44	0.84	76	0.68	105	0.74	59	0.81	23	0.65	3	1.00
Yes		1 3	MR	Machinery Repairman	22	0.50	10	0.60	135	0.87	102	0.87	40	0.70	5	0.20	2	0.50
Yes	Yes	2 4	OS	Operations Specialist	46	0.11	99	0.30	1183	0.60	570	0.68	318	0.81	88	0.81	24	0.58
Yes		2 4	QMSW	Quartermaster	28	0.36	55	0.18	207	0.40	233	0.40	159	0.54	27	0.59	15	0.33
Yes			SK	Storekeeper	164	0.70	380	0.76	1523	0.71	812	0.71	475	0.73	148	0.64	39	0.69
	Yes		STG	Sonar Technician-Surface	9	0.00	52	0.33	321	0.69	347	0.76	140	0.73	88	0.84	12	0.83
Yes			YN	Yeoman	291	0.76	386	0.89	900	0.88	706	0.92	514	0.90	107	0.85	13	0.69

In using optimistic assumptions, we have built into our matching algorithm a predictable bias. When our algorithm indicates that Sailors in a rating seldom do work that is related to their rating, we should have a high degree of confidence in this conclusion (the algorithm reached this conclusion *in spite of* the optimistic assumptions). However, when our algorithm suggests that Sailors in a rating *often* do shore work that requires their rating, we should be more skeptical (the algorithm may have produced this result *only because of* the optimistic assumptions).

Estimates from the matching algorithm

In table 6, the dark blue cells indicate that Sailors' ratings and paygrades are usually required in their shore billets. Of these Sailors, more than 65 percent (0.65) work in shore billets that are close matches with the Sailors' rating and paygrade (again, recall that, because of our optimistic assumptions, these high-end estimates should be taken with a "grain of salt"). The light blue color indicates that between 0.33 and 0.65 are in billets that are close matches to the Sailors' rating/paygrade combinations. Finally, the white cells indicate Sailors who seldom work in shore billets for which their background is required (less than 0.32 of their shore billets are close matches to their rating/paygrade). Because of our optimistic assumptions, we can have a high degree of confidence that Sailors in these ratings/paygrades seldom do shore work that is related to their rating.

The potential for shifting Sailors to the fleet—a first look

Our preliminary analysis shows that shortening shore duty and lengthening tours with the fleet is going to be difficult (see table 6). As an example, consider the case of the Cryptologic Technician ratings. While fleet requirements for these ratings are expected to grow, and these Sailors have relatively short sea duty, our matching algorithm suggests that a very high proportion of their shore billets require a Cryptologic Technician rating.

Classifying shore duty with IGCA criteria codes

Even if Sailors' shore duty requires the ratings and experience of these personnel, it may be possible that the work associated with these shore billets could be done by civilians or contractors—or the work might be eliminated altogether. One way to assess this is to use the DoD-established "A76 criteria codes," which classify the work at UICs as being inherently governmental or commercial activities (IGCA). The IGCA codes indicate if particular activities must be exempt from commercial competition—that is, whether they must be performed by DoD military or civilian personnel. These judgments are based on the following:

- Military operations
- Military support elements in operating forces
- Civilian support elements in operating forces
- Exemptions for military and civilian wartime designations
- Civilian authority direction and control
- Military-unique knowledge and skills
- Exemptions for esprit de corps and military support
- Continuity of infrastructure operations
- Military augmentation of the infrastructure during war
- Civilian and military rotation
- Civilian and military career progression
- Restricted by law, executive order, treaty, or international agreement
- Restricted by DoD management decision

Explanations of these classifications are provided in appendix F (in an annex to this report).

Table 9 shows the proportion of shore billets by rating that are in inherently governmental or exempt functions. There are several ratings that we have identified as potentially problematic, that are expected to have relatively modest sea tours, and that have a substantial portion of personnel working in shore billets that might be eligible for commercial competition. These include Storekeeper (only 52.8 percent work in shore billets that are inherently governmental or exempt), Sonar Technician-Surface (54.9 percent), Yeoman (55.8 percent), Mass Communications Specialist (58.4 percent), Information System Technician (61.5 percent), and Cryptologic Technician-Maintenance (62.9 percent).

Table 9. Proportion of shore billets that are inherently governmental or exempt from commercial competition

Increased Seniority	Growth	Sea tours near or above policy limit	Rating		No CA	All IG	All Exempt	All CA	No CA	All IG	All Exempt	All CA	Sum of All IG and Exempt
Yes		1 2 3 4	ABE	Aviation Boatswain's Mate-Launching & Recovery Equip't	100	141	252	84	17.3	24.4	43.7	14.6	68.1
Yes		1 2 3	ABF	Aviation Boatswain's Mate-Fuels	111	68	198	128	22.0	13.5	39.2	25.3	52.7
Yes		1 2 4	ABH	Aviation Boatswain's Mate-Aircraft Handling	134	93	553	197	13.7	9.5	56.6	20.2	66.1
Yes			AC	Air Traffic Controller	87	1341	30	77	5.7	87.4	2.0	5.0	89.3
Yes		2 4	AE	Aviation Electrician's Mate	66	216	808	667	3.8	12.3	46.0	38.0	58.3
Yes		3 4	BM	Boatswain's Mate	293	350	612	473	17.0	20.3	35.4	27.4	55.7
	Yes		CTA	Cryptologic Technician-Administration	41	435	90	74	6.4	68.0	14.1	11.6	82.0
	Yes		CTM	Cryptologic Technician-Maintenance	128	361	62	122	19.0	53.6	9.2	18.1	62.9
	Yes		CTR	Cryptologic Technician-Collection	86	1191	98	90	5.9	81.3	6.7	6.1	88.0
	Yes		CTT	Cryptologic Technician-Technical	120	540	123	188	12.4	55.6	12.7	19.4	68.3
Yes		2 3 4	DC	Damage Controlman	154	225	227	305	16.9	24.7	24.9	33.5	49.6
	Yes	1 2 3 4	EMSW	Electricians Mate Surface	183	150	536	383	14.6	12.0	42.8	30.6	54.8
Yes	Yes	1 2 3 4	ENSW	Enginman Surface	257	253	671	264	17.8	17.5	46.4	18.3	63.9
Yes	Yes	2 3 4	FC	Fire Controlman	186	309	549	394	12.9	21.5	38.2	27.4	59.7
Yes		1 4	FT	Fire Control Technician	31	52	173	89	9.0	15.1	50.1	25.8	65.2
	Yes	2	GM	Gunner's Mate	166	283	479	177	15.0	25.6	43.3	16.0	69.0
Yes	Yes	2 3	GSE	Gas Turbine Systems Technician-Electrical	31	64	117	76	10.8	22.2	40.6	26.4	62.8
	Yes	2 3	GSM	Gas Turbine Systems Technician-Mechanical	102	158	372	155	13.0	20.1	47.3	19.7	67.3
Yes	Yes		IT	Information System Technician	545	1417	1631	1363	11.0	28.6	32.9	27.5	61.5
	Yes		MA	Master-at-Arms	365	4844	1491	1243	4.6	61.0	18.8	15.6	79.8
Yes			MC	Mass Communication Specialist	172	142	368	192	19.7	16.2	42.1	22.0	58.4
	Yes	2 4	MN	Mineman	50	27	178	97	14.2	7.7	50.6	27.6	58.2
Yes		1 3	MR	Machinery Repairman	28	22	109	157	8.9	7.0	34.5	49.7	41.5
Yes	Yes	2 4	OS	Operations Specialist	427	525	861	515	18.3	22.6	37.0	22.1	59.5
Yes		2 4	QMSW	Quartermaster	168	197	233	126	23.2	27.2	32.2	17.4	59.4
Yes			SK	Storekeeper	818	404	1467	852	23.1	11.4	41.4	24.1	52.8
	Yes		STG	Sonar Technician-Surface	151	144	388	286	15.6	14.9	40.0	29.5	54.9
Yes			YN	Yeoman	237	474	1154	1052	8.1	16.2	39.6	36.1	55.8

Classifying shore duty with MCAP scores

Many of the reasons why a particular function might be designated as inherently governmental or exempt relate to the conditions under which work is done (e.g., whether the work is conducted in a "high threat environment") or to the skills necessary to do the work (whether the work requires knowledge that is not available in the private sector). In contrast, the Military Criticality Assessment Process (MCAP) evaluates functional areas for how closely they support "Sea Power 21," the Navy's essential warfighting capabilities. These capabilities include projecting military power, providing defense of the homeland, and enhancing operational independence and support for joint forces. MCAP helps us identify ratings that have shore duty that is "inherently governmental or exempt" under the ICGA criteria codes, but that do not have an immediate relationship to the Service's essential warfighting capabilities.

This MCAP metric was developed in 2005 and reflects the judgment of four retired Navy Flag Officers, a retired Master Chief Petty Officer of the Navy, and a retired Assistant Deputy Commandant for the U.S. Marine Corps (Installation and Logistics). Functions are graded on a continuum from 0 to 4 as follows:

4 The function executes the Sea Power 21 core capability

3 The function delivers or produces the essential people and technologies necessary to execute the Sea Power 21 core capability

2 The function directly impacts the delivery or production of the essential people, processes, and technologies necessary to execute the Sea Power 21 core capability

1 The function has a greater than limited indirect impact on the delivery of the essential people, processes, and technologies necessary to execute the Sea Power 21 core capability.

0 The function has limited indirect to no impact on the Sea Power 21 core capability

Table 10 shows our list of potentially problematic ratings and their associated average MCAP score. Because we are not able to precisely assign Sailors to the billets they occupy at a command, there is some uncertainty about the average MCAP score that should be assigned to a particular rating. We have quantified this uncertainty by producing a high and low MCAP measure. The high MCAP score is produced by assuming that all the Sailors at a UIC who have a particular combination of rating, paygrade, and "match type"[34] are working in the UIC's function with the highest MCAP value that we identified among all those at the UIC with

[34] As we discussed above, there are three match types: (1) where possible, we matched Sailors to billets by rating and approximate paygrade; (2) we then matched personnel to FAC-G billets; and, (3) finally, we indicated the number of other cases (cases that do not fit into the first two categories).

Table 10. MCAP scores associated with shore billets

					Lo MCAP		Hi MCAP
Increased Seniority	Growth	Sea tours near or above policy limit	Rating	`	Weighted Lo MCAP	Weighted MCAP	Weighted Hi MCAP
Yes		1 2 3 4	ABE	Aviation Boatswain's Mate-Launching & Recovery Equip't	1.5	1.7	1.8
Yes		1 2 3	ABF	Aviation Boatswain's Mate-Fuels	1.6	1.8	1.9
Yes		1 2 4	ABH	Aviation Boatswain's Mate-Aircraft Handling	1.2	1.3	1.5
Yes			AC	Air Traffic Controller	0.6	0.7	0.8
Yes		2 4	AE	Aviation Electrician's Mate	2.9	3.1	3.2
Yes		3 4	BM	Boatswain's Mate	1.9	1.9	2.0
	Yes		CTA	Cryptologic Technician-Administration	1.7	1.7	1.7
	Yes		CTM	Cryptologic Technician-Maintenance	1.6	1.8	1.8
	Yes		CTR	Cryptologic Technician-Collection	1.7	1.7	1.7
	Yes		CTT	Cryptologic Technician-Technical	1.9	1.9	1.9
Yes		2 3 4	DC	Damage Controlman	2.2	2.3	2.4
	Yes	1 2 3 4	EMSW	Electricians Mate Surface	2.2	2.4	2.5
Yes	Yes	1 2 3 4	ENSW	Enginman Surface	2.1	2.3	2.3
Yes	Yes	2 3 4	FC	Fire Controlman	2.1	2.2	2.3
Yes		1 4	FT	Fire Control Technician	2.5	2.7	2.7
	Yes	2	GM	Gunner's Mate	2.1	2.2	2.3
Yes	Yes	2 3	GSE	Gas Turbine Systems Technician-Electrical	2.3	2.6	2.7
	Yes	2 3	GSM	Gas Turbine Systems Technician-Mechanical	2.5	2.6	2.6
Yes	Yes		IT	Information System Technician	1.5	1.6	1.8
	Yes		MA	Master-at-Arms	1.1	1.2	1.2
Yes			MC	Mass Communication Specialist	1.4	1.6	1.7
	Yes	2 4	MN	Mineman	3.3	3.4	3.4
Yes		1 3	MR	Machinery Repairman	2.4	2.6	2.7
Yes	Yes	2 4	OS	Operations Specialist	2.1	2.3	2.4
Yes		2 4	QMSW	Quartermaster	1.7	1.7	1.8
Yes			SK	Storekeeper	2.0	2.2	2.3
	Yes		STG	Sonar Technician-Surface	2.0	2.3	2.6
Yes			YN	Yeoman	1.9	2.0	2.1

that rating, paygrade, and match type. For example, suppose we looked at a particular UIC and found several GSEs in the E5 paygrade who our algorithm had matched to billets by rating and approximate paygrade. Suppose further that among all these billets, the function with the highest MCAP had an MCAP score of 3.2. We would assign the MCAP score of 3.2 to all the Sailors at this billet with this rating, paygrade, and match type. We would then take a weighted average of these scores across all UICs and derive the high MCAP score for this rating, paygrade, and match type (these averages are weighted by the number of personnel at the UIC who fall into the rating, paygrade, match type combination). The low MCAP score is produced in an analogous way. (Note that the data in table 10 show these data at the rating level—the data have been aggregated across paygrades and "match types").

The data in table 10 suggest that several ratings, which have been identified as potentially problematic and are expected to have relatively modest sea tours, have personnel in shore billets that have low immediate relevance to the Service's essential warfighting capabilities. For example, the shore billets of those in the Information System Technician rating are often classified as inherently governmental because they involve military-unique knowledge. However, the weighted MCAP score for the shore work performed by this rating is only 1.6. This suggests that the Service might not suffer significant loss in warfighting-capabilities if it were to make greater use of these personnel in the fleet—at least on a temporary basis.

What is the potential for shifting personnel from shore duty?

We find that there may be few opportunities for freeing up personnel in problematic ratings for additional sea duty. When we look among the ratings that are expected to have reasonable sea tours but for which fleet requirements are expected to grow, we find that the great majority of these Sailors are in shore billets that require their rating. We do find instances in which more involved fixes might be possible. In some shore-based ratings that are expected to grow or to become more senior, there are Sailors working in shore functions that might be subject to MilCiv conversion or outsourcing. However, in some of these ratings, the Navy has already slated billets to be eliminated, and these reductions are already reflected in our estimates of future immediate manpower requirements.

Appendix A: Detailed analyses of select ratings

In this section, we present the detailed information that our models produced on a sample of our "potentially problematic" ratings. Integrating the results from these models allowed us to cross check the validity of our estimates and resulted in our identifying ratings for which the Service had set unrealistic manpower targets (e.g., those ratings that are expected to have excessively long sea tours and for which the Service had scheduled reductions in shore billets).

EN Engineman

In 2007, there were 5,123 BAs for this rating, of which 49 percent were on ships and submarines. Requirements for this rating are relatively junior: 22 percent of the BAs in the fleet and 32 percent of all BAs for this rating are E6 to E9 (E9 is the terminal paygrade for this rating).

We expect this rating to be characterized by

- **Strong growth in fleet requirements**. BAs on ships and submarines are expected to grow from 2,514 in 2007 to 3,110 in 2012.
- **Modest reductions in non-fleet requirements.** We expect that between 2007 and 2008, EN BAs in non-fleet commands will fall from 2,609 to 2,363. The Service may have difficulties in cutting shore billets for ENs, however, because this rating is expected to experience sea tours in excess of the Navy's policy limits (see below).
- **A modest increase in seniority among fleet billets.** The proportion of fleet requirements that are E6 or above is expected to grow from about 22 percent in 2007 to 27 percent in 2021. Across all billets, there will be only a slight rise in seniority.
- **No need to supplement the agricultural tail**. Because ENs have long had a relatively junior personnel profile, there is more than enough agricultural tail to support the small growth and slight rise in seniority that we expect to observe for this rating.

- **Excessive sea-tour lengths.** Our analysis suggests that in 2013 all four sea tours (in a hypothetical 30-year career) will be at or above the Navy's policy limit for sea-tour length: the Sea/Shore Flow model predicts sea tours of 65, 65, 48, and 67 months. To constrain sea-tour lengths to the de facto and policy limits would require 419 additional shore billets.

Details regarding the future demand for ENs. We expect that future demand for this rating will be significantly affected by the following:

- The commissioning of additional LPD-17s (there were three in 2007 and the ship plan calls for this to rise to nine by 2012) and the LHD-8 (one was scheduled to be commissioned in 2008). Together, these new ships result in requirements rising by 310.
- New LCSs. BAs rise from eight in 2007 to 440 in 2018.
- The commissioning of additional destroyers (DDG 51 Flt IIA). Billets on this class are expected to rise from 220 in 2007 to 330 in 2011.
- The commissioning of the fleet's 12th carrier and increasing use of ENs on newer carriers. In 2007 (with 11 carriers) there were 260 ENs on carriers. When the 12th carrier is added in a decade, we expect that BAs on carriers will equal 315.
- The retirement of the fleet's frigates. There is an average of eight ENs on each FFG-7 (the actual number depends on, among other things, whether the ship is part of the Naval Reserve). The decommissioning of the frigates will eliminate 242 EN billets.

GSE Gas Turbine Electrical

In 2007, there were 1,136 BAs for this rating, 56 percent of which were on ships and submarines. Requirements for this rating are relatively senior: 28 percent of the BAs are in the fleet and 40 percent of all BAs for the rating are E6 or E7. (This is an especially high figure given that E7 is the highest paygrade in the rating; GSE feeds into the GS rating beginning at the paygrade E8).

We expect this rating to be characterized by

- **Strong growth in fleet requirements**. BAs on ships and submarines are expected to grow from 633 in 2007 to 726 in 2012.

Reductions in non-fleet requirements. Over the FYDP, GSE BAs in commands other than ships and submarines are expected to decline from 503 to 441.

- **Increasing seniority.** The proportion of fleet requirements that are E6 or above is expected to grow from about 28 percent in 2007 to 50 percent in 2037.
- **The need for substantial increases in the rating's agricultural tail above the billets that are currently planned**. Our analysis indicates that the Service will need to add more than 220 junior billets to those that we have identified as future BAs.
- **Excessive sea-tour lengths.** Our analysis suggests that, as early as 2013, the second and third sea tours for GSEs will be problematic. The second sea tour is expected to be 58 months (which is pushing against the policy limit of 60 months), and the third sea tour is expected to be 50 months (which exceeds the policy limit of 48 months). To constrain sea-tour lengths to the policy limits will require 42 additional shore billets.
- **Future demand for GSEs.** The increasing demand for GSEs is due to the commissioning of ten new DDG-51 (Flt IIA) destroyers (each of which has six BAs for GSEs), 53 additional LCSs (each of which has two GSEs), the LHD-8 amphibious assault ship (which requires nine GSEs). Reductions in demand for GSEs will result from the decommissioning of FFG-7 frigates (which average between five and six GSEs per hull—fewer on NRF frigates).

GSM Gas Turbine Mechanical

At the end of 2007, there were 2,882 BAs for GSMs, of which 63 percent were on ships and submarines. This rating is somewhat more junior than the average: 23 percent of the BAs for GSMs are for E6s and E7s (the mean for this measure across all ratings is 26 percent). Like the GSE rating, GSMs feed into the GS rating beginning at E8.

We expect this rating to be characterized by

- **Modest increases in fleet requirements through 2012, followed by substantial declines and increases**. BAs on ships and submarines, which stood at 1,748 in 2007, are expected to grow to 1,862 in 2012. BAs are then expected to fall to 1,652 in 2016, rise to 1,796 in 2024, and fall to 1,267 in 2037. See table XX below.

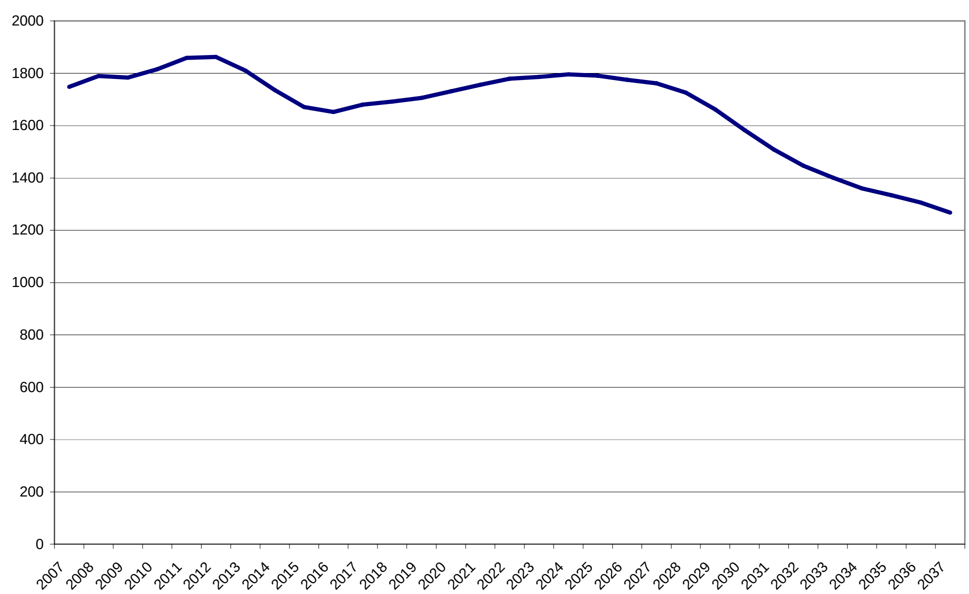
- **A substantial decline in non-fleet requirements.** BAs for commands other than ships and squadrons (and net of TPPH and students), which had stood at 890 in 2007, are expected to decline to 778 by 2012.

- **Seniority rates that are virtually unchanged**. At the end of the 30-year shipbuilding plan, the proportion of GSM BAs that are E6 or E7 will be 23 percent—the same rate as in 2007.

- **No need for increases in the rating's agricultural tail above the billets that are currently planned**.

- **Excessive sea-tour lengths.** Our analysis suggests that, as early as 2013, the second and third sea tours for GSEs will be problematic. The second sea tour is expected to be 60 months, and the third sea tour is expected to be 64 months, which exceeds the policy limit of 48 months. To constrain sea tour lengths to the de facto and policy limits would require 80 additional shore billets.

Table 11 GSM BAs on ships and submarines



Future demand for GSMs. The increasing demand for GSMs over the next few years is due to the commissioning of the DDG-51 (Flt IIA) (each has 16 or 17 billets for GSMs), the LHD-8 (each has 21 billets for GSMs), and the LCSs (each has two BAs for GSMs). The reduction in demand for GSM that will occur in the middle of the next decade is associated with the decommissioning of the Perry (FFG-7) class of frigates (each has 11 GSMs). The decline in demand during the 2020s and 2030s will occur because of the decommissioning of the CG-47s (each with 25 GSMs) and the DDG-51s (Flt I) (each with 17 GSMs).

OS Operations Specialist

At the end of 2007, there were 7,506 BAs for OSs, of which 54 percent were on ships and submarines. This rating is of average seniority: 30 percent of the BAs for OSs are for paygrades E6 through E9 (the mean for this measure across all ratings is 29 percent).

We expect the rating will be characterized by

- **Modest declines in fleet requirements**. BAs on ships and submarines are expected to fall from 3,989 in 2007 to 3,588 in 2012.
- **Small reductions in non-fleet requirements.** Over the FYDP, OS BAs in commands other than ships and submarines are expected to decline from 3,517 to 3,433.
- **Sharply increasing seniority.** The proportion of fleet requirements that are E6 or above is expected to grow from about 17 percent in 2007 to 31.5 percent in 2037. For all billets, this figure rises from 29.6 percent in 2007 to 38 percent in 2037.
- **The need for substantial increases in the rating's agricultural tail**. In 2007, requirements for OSs included 900 E3s and 1,271 E4s. By 2037, the Service's immediate workload requirements will stand at only 644 BAs for E3s and 779 BAs for E4s. We estimate that to sustain a viable agricultural tail in the face of sharply increasing seniority for this community, the Ser-

vice will need to add 756 more E3s (to the 644 already planned) and 521 more E4s (to the 779 that are already planned).[35]

- **A small need to increase the shore billets necessary to prevent excessive sea-tour lengths.** Our analysis suggests that, in 2013, only sea tours for the most senior OSs will be problematic. We predict the fourth tour for this rating will be no less than 60 months (which exceeds the policy limit of 48 months). We estimate that to constrain sea-tour lengths to the policy limit would require 13 additional shore billets for senior personnel.

Future demand for OSs Increasing demand for OSs will come from the commissioning of the following ships:

Class	OS requirement per ship
Ford class CVNs	59
CG-Xs	28*
DDG-51 Flt IIAs	22
LCSs	7
LHD-8 amphibious assault ship	81
LPD-17s	18
T-AKE	3
Reductions in demand for OSs are associated with the decommissioning of the following:	
FFG-7s	16
LHA-1	34
CG-47	28
DDG-51	22

* We estimated requirements for the CG(X) by setting them equal to those for the CG-47.

The potential for shifting personnel from shore to sea. We do not find that there is any opportunity for reducing shortages in this rating by eliminating shore billets (either to make the rating more sea-centric or to reduce the total number of billets for the rating). The principal

35 The Service could create a viable agricultural tail by adding these minimum numbers of billets only if it were to promote personnel in the E3 and E4 paygrades as soon as they meet the Navy's time in service (TIS) and time in grade (TIG) requirements for advancement (e.g., 24 months TIS for promotion to E4, and 36 months TIS for promotion to E5).

challenge in managing this community is likely to be the sharp increase in the seniority of requirements for OSs. Of the senior enlisted in this rating who are working on shore, the great majority are in billets for which their rating is required (this figure is 81 percent for E7s and E8s). Moreover, more than three-quarters of senior personnel on shore are in billets that are either inherently governmental or exempt from commercial competition.

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Appendix B: Background on BAT and requirements data

The Billet Analysis Tool

The Billet Analysis Tool (BAT) can be used to study a wide range of military (active duty and reserves) and civilian manpower requirements issues. The current version provides the ability to quickly determine the manpower implications (both in terms of billets and costs) of changes to the Navy's force structure, shore/support infrastructure, and manning level policies. BAT allows users to group and display results at several levels of detail and by many descriptors (e.g., from appropriation categories to rating/paygrade levels). This enables community managers to examine the impact of force structure changes to individual ratings or management communities—to determine, for example, if the paygrade structure or sea/shore mix is executable under current plans and policies.

Data sources

The ship list

Data on the 30-year ship procurement/retirement plan were provided by N81. This spreadsheet contained 576 current and future ships along with each ship's

- Category
- Type
- Class
- Hull number
- Expected service life
- Commission/expected commission date
- Decommission/expected decommission date
- Age (i.e., of each ship between 2007 and 2037).

There are some missing data in this spreadsheet, principally for future ships where items such as hull number are not present.

Integrated Ship Database

The second source of information is the Integrated Ship Database (ISD) spreadsheet. These data are regularly compiled by CNA from various sources, including the Navy Vessel Registrar

(NVR). The ISD spreadsheet lists all of the Navy's current and past ships, as well as some that are currently authorized or are under construction. Along with each ship, the ISD lists ship name; hull number; type; category; UIC; ship status; award date; keel date; launch date; delivery date; commission date; decommission date; and stricken date.

Data imbedded in BAT

Additional data are imbedded in BAT. A portion of the variables included in the model's databases are shown in the following table. These authorization and requirement estimates extend through FY 2013; after this, we use the 2013 data as a straight-line projection. These data include authorizations and requirements for two future platforms: DDX and CVN 21.

Field name	**Description**
Oewc_r	
Oewc_a	
RI	Requirements Indicator
PFAC	Primary Functional Area Code
SFAC	Secondary Functional Area Code
R_PNOBC	Primary Navy Officer Billet Classification
R_SNOBC	Secondary Navy Officer Billet Classification
R_PAQD	Officer Primary Additional Quality Designator
A_SAQD	Secondary Additional Quality Designator
AUIC	Activity UIC
Ent	
CA_REASON	Commercial Activities Reason Code
CA_FUNC	Commercial Activities Function Code
CLMT_CODE	Claimant Code
REQ_EMC	Required Enlisted Management Community
AUTH_EMC	Authorized Enlisted Management Community
occ_r0	
occ_r	Required Occupational Code
pay_r	Required Paygrade
occ_a0	
occ_a	Authorized Occupation Code
pay_a	Authorized Paygrade
A_PNEC	Primary Navy Enlisted Classification
A_SNEC	Secondary Navy Enlisted Classification
R_PNEC	Requirement Primary Navy Enlisted Classification
R_SNEC	Requirement Secondary Navy Enlisted Classification
SumOfcfy, fy1-fy7	Sum of requirements per fiscal year
SumOfa_cfy, fy1-fy7	Sum of authorizations per fiscal year

Identifying requirements for some hard cases

Some discretion was used in assigning requirements and authorizations to UICs. For legacy classes, we had no data for some of the most recently commissioned ships. For these, we used the requirements for the youngest ship in the class for which data were available. However, of the 576 ships in the 30-year ship procurement /retirement plan, there were 24 ships for which we could not define requirements or authorizations:

LMSR(mod) Lead P1	T-AGOS 19
LMSR(mod) P1	T-AGOS 20
LMSR(mod) P2	T-AGOS 21
JHSV P1	T-AGOS 22
JHSV P2	T-AGOS 23
JHSV P3	T AGOS(X) P1
JHSV P4	T AGOS(X) P2
JHSV P5	T AGOS(X) P3
JHSV P6	T AGOS(X) P4
MLP Lead P1	HSS P1
MLP P1	LHA(R)(mod) Lead P1
MLP P2	LHA(R)(mod) P1

Our estimates for these ships were provided by subject matter experts.

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Appendix C. The sea/shore rotation model

The sea/shore rotation model is a deterministic optimization model that can be thought of as operating in the following steps:

- It takes as inputs the sea-duty and shore-duty manpower requirements (or projected billets authorized) for all paygrades and assumes that these will remain constant over a 30-year horizon (which corresponds to a notional career length for an enlisted Service member who ultimately advances to E9).
- It initially assumes a personnel inventory that is equal to these requirements. That is, it assumes that the current personnel inventory aligns completely (in rating and paygrade) with the Service's manpower requirements.
- It then applies historical loss rates (the percentage of personnel in a rating who depart at each year of service) and historical gain rates (the percentage of personnel in a rating who are new to a rating at each year of service) to this hypothetical current personnel profile and projects a long-term steady-state personnel profile. (It is assumed that the number of personnel entering a rating in any given year equals the number leaving the rating.) Over the long term, the shape of the personnel profile may continue to align with manpower requirements for the rating, may become more top-heavy than requirements, or may become more bottom-heavy than requirements.
- Using the steady-state personnel profile and the manpower requirements for the rating (broken down by sea and shore), the model looks for a way to distribute personnel between sea and shore duty such that all manpower requirements can be met without Sailors serving longer sea tours than some (user-specified) set of maximum values. (The person running the model specifies maximum values for the durations of the first, second, third, and fourth sea tours in a particular rating. The model then looks for ways to fill all sea and shore billets without exceeding these sea-tour duration constraints.)

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Appendix D. Numbers of ships by type by year

	Aircraft Carriers	Amphib's Ships	Attack Sub's	Ballistic Missile Sub's	Cmd & Support	Combat Logistics Force	Frigates	Guided Missile Sub's	Large Surface Comb'ts	LCSs	Mine Warfare	MPF(F)	Sum
FY07	11	31	52	14	17	31	30	4	74	1	14	0	279
FY08	11	32	52	14	17	31	30	4	77	4	14	0	286
FY09	11	31	53	14	17	30	30	4	79	6	14	0	289
FY10	11	31	52	14	17	30	29	4	82	9	14	0	293
FY11	11	32	52	14	17	30	29	4	84	15	14	0	302
FY12	11	33	53	14	18	29	26	4	86	21	14	1	310
FY13	10	32	54	14	19	29	20	4	86	27	14	2	311
FY14	10	31	51	14	18	30	12	4	87	33	14	3	307
FY15	11	30	51	14	18	30	5	4	88	38	14	8	311
FY16	11	30	49	14	18	30	2	4	89	44	14	9	314
FY17	11	30	49	14	19	30	1	4	91	50	13	10	322
FY18	11	30	48	14	20	30	1	4	92	55	13	11	329
FY19	12	30	49	14	20	30	0	4	93	55	11	11	329
FY20	12	30	47	14	21	30	0	4	94	55	10	11	328
FY21	12	30	47	14	21	30	0	4	95	55	7	11	326
FY22	12	31	46	14	21	30	0	4	94	55	6	11	324
FY23	12	31	46	14	22	30	0	4	94	55	2	11	321
FY24	12	31	45	14	22	30	0	4	94	55	1	11	319
FY25	12	31	44	14	20	30	0	4	93	55	0	11	314
FY26	12	31	43	14	20	30	0	2	90	55	0	11	308
FY27	12	31	42	13	21	30	0	1	90	55	0	11	306
FY28	12	31	40	13	21	30	0	0	87	55	0	11	300
FY29	12	31	40	13	21	30	0	0	85	55	0	11	298
FY30	12	31	41	12	21	30	0	0	83	55	0	11	296
FY31	12	31	43	12	20	30	0	0	80	55	0	11	294
FY32	12	31	44	12	20	30	0	0	79	55	0	11	294
FY33	12	31	46	12	20	30	0	0	79	55	0	11	296
FY34	12	31	48	12	20	30	0	0	78	55	0	11	297
FY35	12	31	49	12	20	30	0	0	79	56	0	11	300
FY36	12	31	51	12	20	30	0	0	80	56	0	11	303
FY37	12	31	52	12	20	30	0	0	79	56	0	11	303

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Appendix E: Where ratings work

Table 12. Ratings with a large proportion of billets on ships

Billet rating	Billet rating name	Number of billets	Proportion on ships
AB	Aviation Boatswain's Mate	30	0.68
ABE	Aviation Boatswain's Mate: Launching – Recovery	2,397	0.81
ABF	Aviation Boatswain's Mate: Fuels	1,853	0.78
ABH	Aviation Boatswain's Mate: Aircraft Handling	4,309	0.81
AO	Aviation Ordnanceman	3,959	0.47
AS	Aviation Support Equipment Technician	802	0.40
BM	Boatswain's Mate	2,036	0.41
CS	Culinary Specialist	3,572	0.43
DC	Damage Controlman	2,031	0.66
EM	Electrician's Mate	3,238	0.44
EN	Engineman	2,514	0.49
FC	Fire Control Technician	3,893	0.62
GM	Gunner's Mate	1,398	0.40
GS	Gas Turbine Systems Technician	79	0.38
GSE	Gas Turbine Systems Technician – Electrical	633	0.56
GSM	Gas Turbine Systems Technician – Mechanical	1,748	0.62
HT	Hull Maintenance Technician	1,419	0.50
IC	Interior Communications Electrician	1,403	0.63
MM	Machinist's Mate	6,202	0.39
MN	Mineman	368	0.42
MR	Machinery Repairman	384	0.48
OS	Operations Specialist	3,989	0.53
QM	Quartermaster	1,223	0.53
SH	Ship's Serviceman	1,523	0.64
SN	Seaman	4,658	0.50
STG	Sonar Technician – Surface	1,511	0.53
TM	Torpedoman's Mate	303	0.50

Table 13. Ratings with a significant proportion of billets in squadrons

Billet rating	Billet rating name	Number of billets	Proportion in squadrons
AD	Aviation Machinist's Mate	4,441	0.67
AE	Aviation Electrician's Mate	3,301	0.67
AF	Aviation Maintenance Technician	71	0.53
AM	Aviation Structural Mechanic	6,027	0.71
AME	Aviation Structural Mechanic – Safety Equipment	1,330	0.81
AO	Aviation Ordnanceman	2,538	0.30
AT	Aviation Electronics Technician	4,167	0.45
AV	Aviation Avionics Technician	58	0.43
AW	Aviation Antisubmarine Warfare Operator	1,857	0.58
AZ	Aviation Maintenance Administrationman	1,383	0.50
PR	Parachute Rigger/Aircrew Survival Equipmentman	905	0.53

Table 14. Ratings with a significant proportion of billets on submarines

Billet rating	Billet rating name	Number of billets	Proportion in squadrons
FT	Fire Control Technician	787	0.58
STS	Sonar Technician – Submarine	1,324	0.55
MT	Missile Technician	626	0.52
MM	Machinist's Mate	3,735	0.24
ET	Electronics Technician	2,947	0.22
EM	Electrician's Mate	1,077	0.15
CS	Culinary Specialist	606	0.07
YN	Yeoman	263	0.05

Table 15. Ratings with the largest proportion of billets off of ships, submarines, and squadrons

Billet rating	Billet rating name	Number of billets	Proportion off ships, subs and squadrons
AC	Air Traffic Controller	1,941	0.79
AG	Aerographer's Mate	1,034	0.94
AN	Airman	1,017	0.94
AR	Airman Recruit	1,758	1.00
BU	Builder	2,425	1.00
CE	Construction Electrician	1,201	1.00
CM	Construction Mechanic	1,834	0.99
CN	Constructionman	28	1.00
CTA	Cryptologic Technician – Administration	708	0.90
CTI	Cryptologic Technician – Interpretive	1,958	1.00
CTM	Cryptologic Technician – Maintenance	744	0.82
CTN	Cryptologic Technician – Networks	746	1.00
CTR	Cryptologic Technician – Collection	2,604	0.85
CU	Constructionman	25	1.00
EO	Equipment Operator	1,571	0.99
EOD	Explosive Ordnance Disposal	1,021	1.00
EQ	Equipmentman	21	1.00
FN	Fireman	1,416	1.00
FR	Fireman Recruit	356	1.00
HM	Hospital Corpsman	16,336	0.93
HN	Hospitalman	7,990	0.95
IS	Intelligence Specialist	1,668	0.69
LN	Legalman	431	0.85
MA	Master at Arms	10,477	0.92
MC	Mass Communication Specialist	986	0.73
MU	Musician	759	1.00
NC	Navy Counselor	1,151	0.78
ND	Navy Diver	1,199	0.96
OC	Officer Candidates – All Types	5,064	1.00
PC	Postal Clerk	492	0.74
PS	Personnel Specialist	3,215	0.72
SB	Special Warfare Boat Operator	705	1.00
SO	Special Warfare Operator	1,778	1.00
SR	Seaman Recruit	1,725	1.00
SW	Steelworker	786	1.00
UC	Utilities Constructionman	15	1.00
UT	Utilitiesman	955	1.00
YN	Yeoman	3,584	0.66

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