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CBO

# Comparing a 355-Ship Fleet With Smaller Naval Forces

MARCH 2018

# Notes

Unless otherwise indicated, all dollars in this report are expressed in constant 2017 dollars and all years are federal fiscal years, which run from October 1 to September 30 and are designated by the calendar year in which they end.

Numbers in the text and tables may not add up to totals because of rounding.

The photograph on the cover shows the Nimitz Carrier Strike Group on a regularly scheduled deployment to the Western Pacific (Jose Madrigal, courtesy of the U.S. Navy).



www.cbo.gov/publication/53637

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# Comparing a 355-Ship Fleet With Smaller Naval Forces

## Summary

In December 2016, the Navy released a new force structure assessment (FSA) that called for a fleet of 355 ships—substantially larger than the current force of 280 ships.[1] In response to a request from the Subcommittee on Seapower and Projection Forces of the House Committee on Armed Services, the Congressional Budget Office explored the costs of achieving that goal in a previous report.[2] To expand on that analysis, CBO has estimated the costs of achieving a 355-ship fleet under two alternatives. The agency then compared those scenarios with two other alternatives involving smaller fleets. For all four alternatives, CBO explored shipbuilding and operating costs, the composition and capabilities of the fleet, and effects on the shipbuilding industry.

The four alternatives would affect the size and composition of the Navy in the following ways, CBO estimates:

- Under the first alternative, the Navy would create a 355-ship fleet by building more ships over the next 20 years, achieving the force goal by 2037. The cost to build, crew, and operate a 355-ship fleet achieved by new construction would average $103 billion (in 2017 dollars) per year through 2047.

- Under the second alternative, the Navy would attain a 355-ship fleet sooner, in about 2028, but would not achieve the composition that the service wants until 2037—by using a new-ship construction schedule similar to the schedule under the first alternative, and also by extending the service life of some large surface combatants, amphibious ships, attack submarines, and logistics ships. Its costs would average $104 billion annually through 2047.

- Under the third alternative, the Navy would maintain a fleet comparable in size and composition to today's fleet of 280 ships. It would cost an average of $91 billion annually through 2047.

- The fourth alternative would cost the least and illustrates the long-term implications of funding the Navy at roughly the level it has received historically for ship procurement. By 2047, the fleet would fall to 230 ships. In total, that alternative would cost an average of $82 billion per year over the next 30 years.[3]

### Shipbuilding Costs

CBO estimates that, over the next 30 years, meeting the 355-ship goal with new-ship construction alone would cost an average of $26.7 billion annually (in 2017 dollars). Combining that shipbuilding program with service life extension programs (commonly called SLEPs) for some existing ships to achieve a 355-ship fleet faster would cost an average of $27.5 billion annually; the costs for those SLEPs would be concentrated over the next 10 years. The smaller fleets would cost less: If the Navy was kept at its current size, shipbuilding costs would average $22.4 billion annually. By contrast, if funding for the fleet was kept at roughly historical levels, shipbuilding costs would average $16.8 billion per year (see Table 1).

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1. Department of the Navy, *Executive Summary, 2016 Force Structure Assessment (FSA)* (December 15, 2016), http://tinyurl.com/zgdk5o7. The 2016 FSA does not describe the annual ship purchases or costs needed to reach 355 ships. For further discussion, see Ronald O'Rourke, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress,* Report for Congress RL32665 (Congressional Research Service, December 22, 2017).

2. See Congressional Budget Office, *Costs of Building a 355-Ship Navy* (April 2017), www.cbo.gov/publication/52632. In its earlier report, CBO analyzed how the Navy could achieve a 355-ship fleet over 15, 20, 25, and 30 years. For this report, CBO chose a 20-year buildup for purposes of comparison because the 15-year buildup, though feasible, would put a substantial strain on the shipbuilding industrial base. In addition, even under the 15-year buildup, the Navy would not meet its force goal for attack submarines until 2035.

3. CBO does not include the costs of disposing of the ships when they are decommissioned, but such costs represent less than 2 percent of total costs.

Table 1.

## Comparing Four Alternative Navy Fleets

| | Alternative 1: 20-Year Buildup | Alternative 2: 20-Year Buildup With SLEP | Alternative 3: Today's Fleet | Alternative 4: Historical Funding |
|---|---|---|---|---|
| | **Ships Purchased, 2018–2047** | | | |
| Combat Ships | | | | |
| Aircraft carriers | 10 | 10 | 8 | 6 |
| Ballistic missile submarines | 12 | 12 | 12 | 12 |
| Attack submarines | 63 | 63 | 48 | 29 |
| Large surface combatants | 90 | 90 | 75 | 45 |
| Small surface combatants | 68 | 68 | 30 | 39 |
| Amphibious warfare ships | 30 | 30 | 24 | 13 |
| Subtotal | 273 | 273 | 197 | 146 |
| Combat Logistics and Support Ships | 57 | 57 | 47 | 31 |
| Total | 330 | 330 | 244 | 177 |
| | **Costs (Billions of 2017 Dollars)** | | | |
| Total Shipbuilding Costs Over 30 Years | 801 | 824 | 671 | 505 |
| Average Annual Shipbuilding Costs | 26.7 | 27.5 | 22.4 | 16.8 |
| New-Ship Construction | 740 | 741 | 615 | 453 |
| Average Cost per Ship[a] | 2.2 | 2.2 | 2.5 | 2.6 |
| Average Annual Operation and Support Costs | 76 | 77 | 69 | 65 |
| Increase in Annual Operation and Support Costs by 2047 Compared With Those Costs Today | 38 | 38 | 22 | 12 |
| Total Average Annual Cost for Shipbuilding and Operation and Support | 103 | 104 | 91 | 82 |
| | **Ships in the Fleet** | | | |
| 2017 | 280 | 280 | 280 | 280 |
| 2022 | 313 | 319 | 312 | 312 |
| 2027 | 334 | 351 | 308 | 310 |
| 2032 | 341 | 369 | 292 | 285 |
| 2037 | 356 | 363 | 288 | 263 |
| 2042 | 358 | 356 | 288 | 250 |
| 2047 | 358 | 357 | 280 | 230 |
| | **Measures of Capability, 2032** | | | |
| Ships Providing Peacetime Presence On-Station Overseas | 126 | 133 | 105 | 106 |
| Ships Surged to a Combat Theater After 30 Days | 190 | 205 | 162 | 159 |
| VLS Cells On-Station Overseas in Peacetime[b] | 3,000 | 3,600 | 2,500 | 2,300 |
| VLS Cells Surged to a Combat Theater After 30 Days[b] | 6,100 | 7,400 | 5,300 | 4,700 |
| | **Measures of Capability, 2047** | | | |
| Ships Providing Peacetime Presence On-Station Overseas | 128 | 127 | 97 | 83 |
| Ships Surged to a Combat Theater After 30 Days | 198 | 197 | 153 | 126 |
| VLS Cells On-Station Overseas in Peacetime[b] | 3,700 | 3,700 | 2,800 | 2,000 |
| VLS Cells Surged to a Combat Theater After 30 Days[b] | 7,200 | 7,200 | 5,700 | 4,000 |

Source: Congressional Budget Office.

Alternative 2 would extend the service life of some cruisers and amphibious ships to 45 years, some attack submarines to 42 years, and some destroyers and logistics ships to 40 years.

SLEP = service life extension program; VLS = vertical launch system.

a. Average ship costs are calculated using new-ship construction amounts only.

b. The number of VLS cells represents the missile firepower of the fleet, which serves as a proxy for offensive and defensive capability because the weapons for a variety of missions are carried in those cells.

### Operating Costs

CBO projects that the costs to operate and maintain the Navy's ships will grow faster than general inflation in the economy. On the basis of historical experience, pay for military and civilians is projected to increase faster than inflation as are costs to supply and repair the Navy's ships. As a result, CBO expects that the costs for operation and support for all of the alternatives—even a substantially smaller fleet—would be higher in 2047 in real (inflation-adjusted) terms than comparable costs for the existing fleet. By 2047, the annual cost (in 2017 dollars) of operating a 355-ship fleet would be about $38 billion (or 68 percent) more than the $56 billion the current fleet of 280 ships costs to operate. Overall, costs for the alternative that would include SLEPs would be higher in earlier years because some of the ships would be retired later than under the first alternative. A fleet that maintained the size and composition of the current fleet would cost $22 billion (or 39 percent) more in 2047. And the smallest fleet would still cost $12 billion (or 21 percent) more than the fleet costs to operate today.

### Capabilities of the Different Fleets

CBO compared the four alternative fleets using several standard measures of capability. Not surprisingly, the larger fleets would provide the most capability, whereas the smallest fleet would provide the least. To measure capability during peacetime, CBO used the number of ships providing forward presence (those on patrol overseas in peacetime) and the number of vertical launch system (VLS) cells—missile tubes—on those ships. For a wartime measure, CBO used the number of ships that could be "surged" (that is, rapidly deployed) overseas within 30 days and the number of VLS cells on those ships. Because the alternative that includes SLEPs would retain more cruisers and destroyers in the fleet—retiring ships later than the other alternatives—and they carry large numbers of VLS cells, it would increase the fleet's VLS inventory by 20 percent by 2032 for less than 2 percent additional cost compared with the 355-ship alternative without SLEPs.

### Implications for the Shipbuilding Industry

CBO anticipates that shipyards would need to make significant investments in facilities and infrastructure to build the larger fleets. For the smaller fleet alternatives, maintaining the Navy at its current size would require little change to the industrial base that builds warships, whereas a fleet based on historical funding would lead to less ship construction business for the shipyards, with the possibility that one or more could leave the industry.

## What Alternatives Did CBO Consider?

Of the four alternatives CBO explored, the first would meet the Navy's goal for a larger fleet by 2037 solely by building more ships. In terms of the composition of the fleet, it would meet the separate goals that the Navy set in its 2016 FSA: 12 aircraft carriers, 66 attack submarines, 104 large surface combatants, 52 small surface combatants, and 38 amphibious ships (see Table 2).

The second alternative would relax the Navy's specific goals for each type of ship, allowing the service to achieve a 355-ship fleet by 2028—nine years sooner than the first alternative (see Figure 1). This alternative would use a schedule for new-ship construction similar to the one called for under the first alternative, but it would achieve a larger fleet sooner by extending the service life of a number of surface combatants, amphibious ships, attack submarines, and logistics ships. Specifically:

- All 22 of the Navy's CG-47 class cruisers would be retired later than in the first alternative and would serve for 45 years, whereas 11 of those ships are currently slated to retire after 33 to 38 years of service.
- The oldest DDG-51 destroyers, designated as Flight I and II, would serve for 40 years, rather than the currently planned 35.
- The existing class of LSD-41 and LSD-49 amphibious ships would serve for 45 years, rather than the planned 40, as would a small number of logistics ships.
- A small number of Improved Los Angeles class nuclear-powered submarines would be refueled and serve in the fleet for 10 additional years.

The advantage of SLEPs is that they would maintain capable ships in service for a relatively modest cost. The disadvantage is that the ships would be older and thus might not have the most up-to-date combat systems; therefore, they would not be as capable as equivalent new ships. (For a more detailed discussion of ship service life extensions and reactivations, see Box 1 on page 6.)

Table 2.

## Inventory Under the Navy's Goals and Four Alternatives, 2047

| | Navy's 2016 FSA Goals | Alternative 1: 20-Year Buildup | Alternative 2: 20-Year Buildup With SLEP | Alternative 3: Today's Fleet | Alternative 4: Historical Funding | Memorandum: Fleet in 2018 |
|---|---|---|---|---|---|---|
| Combat Ships | | | | | | |
| Aircraft carriers | 12 | 12 | 12 | 10 | 10 | 11 |
| Ballistic missile submarines | 12 | 12 | 12 | 12 | 12 | 14 |
| Attack submarines | 66 | 68 | 68 | 55 | 40 | 55[a] |
| Large surface combatants | 104 | 104 | 103 | 87 | 59 | 88 |
| Small surface combatants | 52 | 52 | 52 | 22 | 29 | 22[b] |
| Amphibious warfare ships | 38 | 39 | 39 | 33 | 26 | 32 |
| Subtotal | 284 | 287 | 286 | 219 | 176 | 222 |
| Combat Logistics and Support Ships | 71 | 71 | 71 | 61 | 54 | 58 |
| **Total** | **355** | **358** | **357** | **280** | **230** | **280** |

Source: Congressional Budget Office.

Alternative 2 would extend the service life of some cruisers and amphibious ships to 45 years, some attack submarines to 42 years, and some destroyers and logistics ships to 40 years.

FSA = force structure assessment; SLEP = service life extension program.

a. Includes guided missile submarines.

b. Includes mine countermeasures ships.

The third alternative would maintain a fleet of about 280 ships through 2047. This alternative is designed to roughly maintain the size and composition of the current fleet.

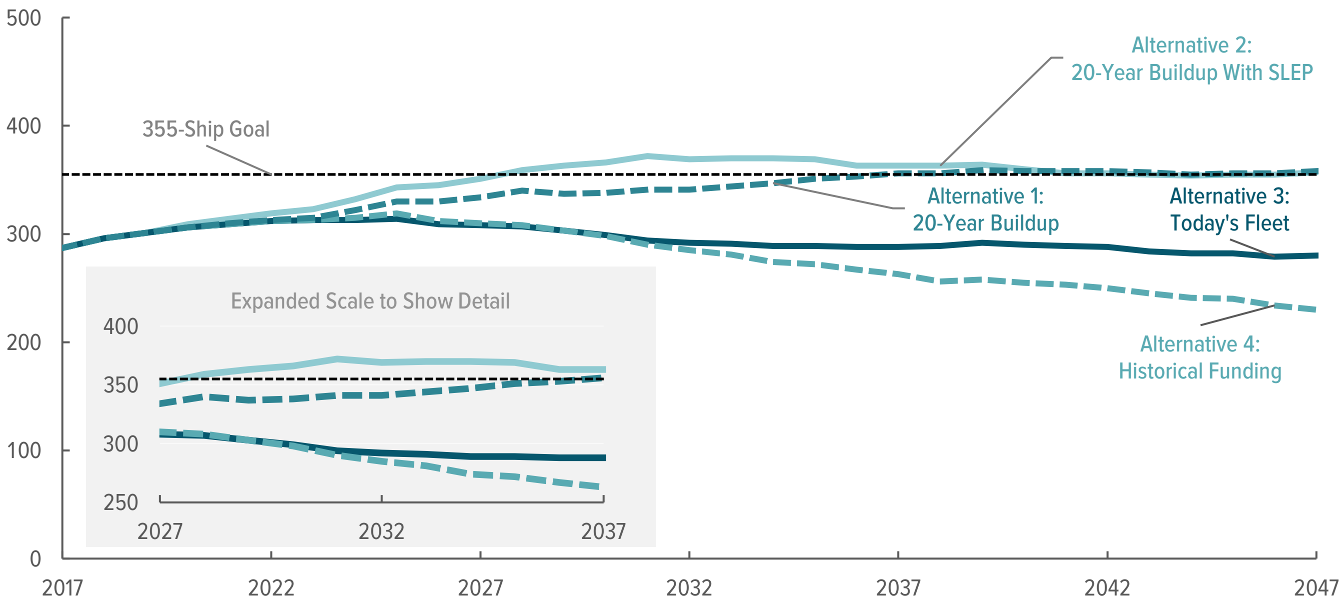
The fourth alternative would constrain the Navy's shipbuilding funding to a little more than the average of the past 30 years, or about $16.5 billion per year (in 2017 dollars). Because shipbuilding costs have historically outpaced inflation, even if the budget was held constant in inflation-adjusted dollars, fewer ships could be procured, resulting in a fleet of 230 ships at the end of three decades. Even with the smaller fleet alternatives, the momentum of current shipbuilding programs would cause the fleet to grow to more than 300 ships in the 2020s before slowing rates of ship purchases reduced the size of the fleet in the 2030s and 2040s.

In analyzing those alternative shipbuilding plans, CBO used existing ship designs and production lines for the first 10 years. However, because the Navy is not specific about the design of the ships it plans to purchase beyond 2027, CBO made its own assumptions about the size and capabilities of the ships; those assumptions are consistent with the ones the agency used in its analysis of the Navy's 2017 shipbuilding plan and for its report on building a 355-ship fleet.[4]

4. For example, CBO assumed that in the latter part of the 2020s, the Navy would need to design an all-new large surface combatant as well as a new small surface combatant that was similar in size to the retired Oliver Hazard Perry class frigate. See Congressional Budget Office, *An Analysis of the Navy's Fiscal Year 2017 Shipbuilding Plan* (February 2017), pp. 29–30, www.cbo.gov/publication/52324, and *Costs of Building a 355-Ship Navy* (April 2017), p. 5, www.cbo.gov/publication/52632. Some senior Navy officials have also argued that the Navy should use existing ship designs to increase the size of the fleet. See Sydney J. Freedberg, "Build More Ships, But Not New Designs: CNO Richardson on McCain Plan," *Breaking Defense* (January 17, 2017), http://tinyurl.com/gmsxhp3. By contrast, others envision a future fleet composed of several types of ships that are quite different from what the Navy plans to buy. See Megan Eckstein and Sam LaGrone, "Trio of Studies Predict the

Figure 1.

## Annual Inventory of Battle Force Ships Under Four Alternatives




Source: Congressional Budget Office.

Alternative 2 would extend the service life of some cruisers and amphibious ships to 45 years, some attack submarines to 42 years, and some destroyers and logistics ships to 40 years.

SLEP = service life extension program.

### Ship Purchases and Shipbuilding Costs of Alternative Fleets

To build and maintain a 355-ship fleet would require the purchase of 330 new ships over the next 30 years. Extending the service life of some ships to reach that goal sooner would not preclude the need to buy the same number of new ships over the 30-year period, although the timing of ship purchases under the two larger fleet alternatives would be somewhat different. Specifically, through the 2020s, building the 355-ship fleet without a SLEP—the first alternative—would entail purchasing ships at an average rate of 12 to 13 per year. By contrast, building the 355-ship fleet with a SLEP—the second alternative—would involve purchasing ships at an average rate of 11 to 12 per year. In the 2030s, when those ships with extended service life were retired, the SLEP alternative would require building ships at an average rate of 10 per year, whereas the first alternative would involve building at a rate of 9 ships per year (see Figure 2 on page 8).

Overall shipbuilding costs for the first two alternatives would be substantially higher than the amounts the Navy has spent historically or even recently. By CBO's estimate, the first alternative would cost $26.7 billion per year to pay for all the activities in the shipbuilding account that would be needed to achieve a 355-ship fleet. The second alternative would cost slightly more—$27.5 billion per year, which would also include the costs of the SLEPs for various ships. Those figures are more than 60 percent higher than the amounts the Navy has spent on shipbuilding over the past 30 years and more than 25 percent higher than the amount appropriated for 2017.

Maintaining the fleet at its size today—the third alternative—would require fewer purchases than building a larger one. It would require the Navy to purchase an average of 7 to 8 ships per year in the 2020s and then to buy 7 to 9 ships per year in succeeding decades. Building a smaller fleet—the fourth alternative—would involve

U.S. Navy Fleet of 2030," USNI News (February 14, 2017), https://tinyurl.com/hv3t77h; and Senator John McCain, *Restoring American Power: Recommendations for the FY 2018–FY 2022 Defense Budget*, https://tinyurl.com/gt8o4cq.

Box 1.

## Extending the Service of Ships in the Fleet and Reactivating Decommissioned Ships

Senior Navy officials, Members of Congress, and some independent naval analysts have raised the possibility of extending the service life of existing ships or reactivating decommissioned ships—rather than relying on new-ship construction alone—to reach the goal of a 355-ship fleet sooner. Of the two options, extending the service life of ships currently in the fleet would be the easier task.

### Extending the Service Life of Ships

For nonnuclear surface ships—surface combatants, amphibious warfare ships, and logistics ships—extending their service life would simply require investing more resources to overhaul the ships. At the end of its service life, a ship is usually retired because its hull, mechanical, and electrical systems (commonly called HM&E systems) need substantial repairs and its combat systems are obsolete. Maintenance on Navy ships is conducted daily by the crew and periodically in a shipyard both for minor overhaul periods that last a few months and for major overhauls that occur at less frequent intervals but can put a ship in a repair yard for a year or more. Extending the service life of surface ships would require one of those longer overhauls as well as an evaluation of, and possibly upgrades to, the ships' combat systems and sensors.

As a technical matter, extending the service life of a nonnuclear ship is not difficult. Essentially, two issues must be addressed to extend service life. First, the Navy must maintain the ship in good working order so that its HM&E systems operate as intended. That requires an assessment of any corrective work needed and the money to pay for the overhaul, as well as the necessary time in a shipyard to perform the work (assuming that there are shipyards with the time and space available to perform the needed work). Second, the combat systems of the ship might need to be replaced or upgraded.

The decision to improve an older ship's combat systems is informed by the missions the Navy wants the ship to perform and the amount of money the Navy is willing to spend to have those capabilities. To have the ability to engage in actions against other highly capable navies of some countries could require spending large sums to install the most advanced radars, sensors, and weapons on the ship. If the ship is meant to perform a more modest set of missions, the combat systems could require a less robust set of improvements. (Many ships are retired from the U.S. Navy and go on to serve in the navies of other nations, which invariably upgrade the material condition and combat systems of those ships but at different standards from the United States.)

Extending the service life of nuclear-powered ships—aircraft carriers and submarines—is a far more complicated matter. Nuclear-powered aircraft carriers cannot serve beyond their 50-year life span without a refueling overhaul. When those ships are 23 years old (their midlife), such an effort costs more than $4 billion dollars. The reactor cores are refueled and many other systems on the ship are replaced. Undertaking a second refueling overhaul on a Nimitz class carrier when the ship is 50 years old has never been tried and would probably be prohibitively expensive: Many more systems on the ship would require repairing, replacing, or upgrading than was the case at its midlife.

That may not be the case for some of the Navy's attack submarines. The service is currently studying the technical

Continued

even fewer ship purchases. That alternative would require purchasing an average of 7 to 8 ships per year in the 2020s, but by the end of the decade, purchases would fall to 4 to 5 ships per year through the 2030s. That low level of shipbuilding would be the consequence, in part, of the Navy's plan to purchase Columbia class ballistic missile submarines, which CBO projects will cost more than $7 billion each, and the real growth in the cost of naval ships over time. Those factors combined with fixed budgets would lead to fewer ship purchases.

Shipbuilding costs for the smaller fleet alternatives would more closely align with recent spending. Average costs for the third alternative would be $22.4 billion per year, slightly more than the 2017 appropriation. The costs for the fourth alternative—at $16.8 billion per year—would conform closely, though not precisely, to average historical shipbuilding budgets. [5]

5. CBO estimates the cost of ships on the basis of the relationship between the weight and cost of analogous existing ships. The resulting amount is then adjusted for factors such as the production efficiencies that occur as more ships of the same type are built simultaneously at a given shipyard and additional

Box 1. Continued

**Extending the Service of Ships in the Fleet and Reactivating Decommissioned Ships**

issues—such as hull life—and maintenance challenges involved in refueling and substantially extending the service life of Los Angeles class attack submarines. (The Congressional Budget Office does not have the means to conduct an independent assessment.) Over the next 10 years, the Navy plans to retire 28 attack and guided missile submarines, far more than any other category of ship (see the table). If many of those could remain in the fleet—CBO's SLEP alternative incorporates five service-life extensions of attack submarines—then perhaps the Navy could achieve a 355-ship fleet sooner than 2028, and also reduce the largest shortfall that it faces in achieving its goals for particular types of ships.

**Ship Retirements, 2018 to 2027**

| | |
|---|---|
| Aircraft Carriers | 2 |
| Ballistic Missile Submarines | 1 |
| Attack and Guided Missile Submarines | 28 |
| Large Surface Combatants | 13 |
| Amphibious Ships | 1 |
| Combat Logistics and Support Ships | 26 |

Source: Congressional Budget Office.

### Reactivating Decommissioned Ships

The feasibility of reactivating previously retired ships rests on the premise that doing so is more cost-effective or timely than building new ships or extending the life of older ones. The main advantage of recommissioning ships is that it rapidly increases the number of ships in the fleet. That approach also has disadvantages: Making the ships seaworthy and combat capable again would probably require a large investment of resources, and the ships' hulls would have only a limited number of years remaining once they were pressed back into service.

Naval analysts and some senior Navy officials have specifically mentioned reactivating 8 to 10 retired Oliver Hazard Perry class frigates, several Ticonderoga class cruisers, and the *Kitty Hawk*, a conventionally powered aircraft carrier that was retired in 2009. The frigates are widely considered to be the best candidates for reactivation because they were retired in the past few years, are in the best physical condition, and could be brought back into the fleet for about $200 million to $400 million per ship, according to the Navy's estimates, depending on the extent to which the service upgrades their obsolete combat systems. Reactivating the *Kitty Hawk* might quickly fill the shortfall in carriers (the Navy currently has 11 but would like to have 12). However, that reactivation would require as much as several billion dollars for repairing the ship, building and then activating another air wing, and training personnel to operate the ship's steam boiler propulsion plant, a type that no longer exists on any other ship in the fleet.

CBO did not include any ship reactivations in its analysis because reactivating the frigates is not a cost-effective way to provide the high-end capability the Navy seeks in the event of large-scale naval combat in the future. And reviving a conventionally powered aircraft carrier with a unique propulsion plant would represent a significant investment in resources for a relatively short extension of 10 years or so.[1]

1. For a discussion of historical experiences with U.S. ship reactivations, see Congressional Budget Office, *A Historical Survey of Ship Reactivations* (forthcoming).

## Manpower Requirements and Operating Costs of Alternative Fleets

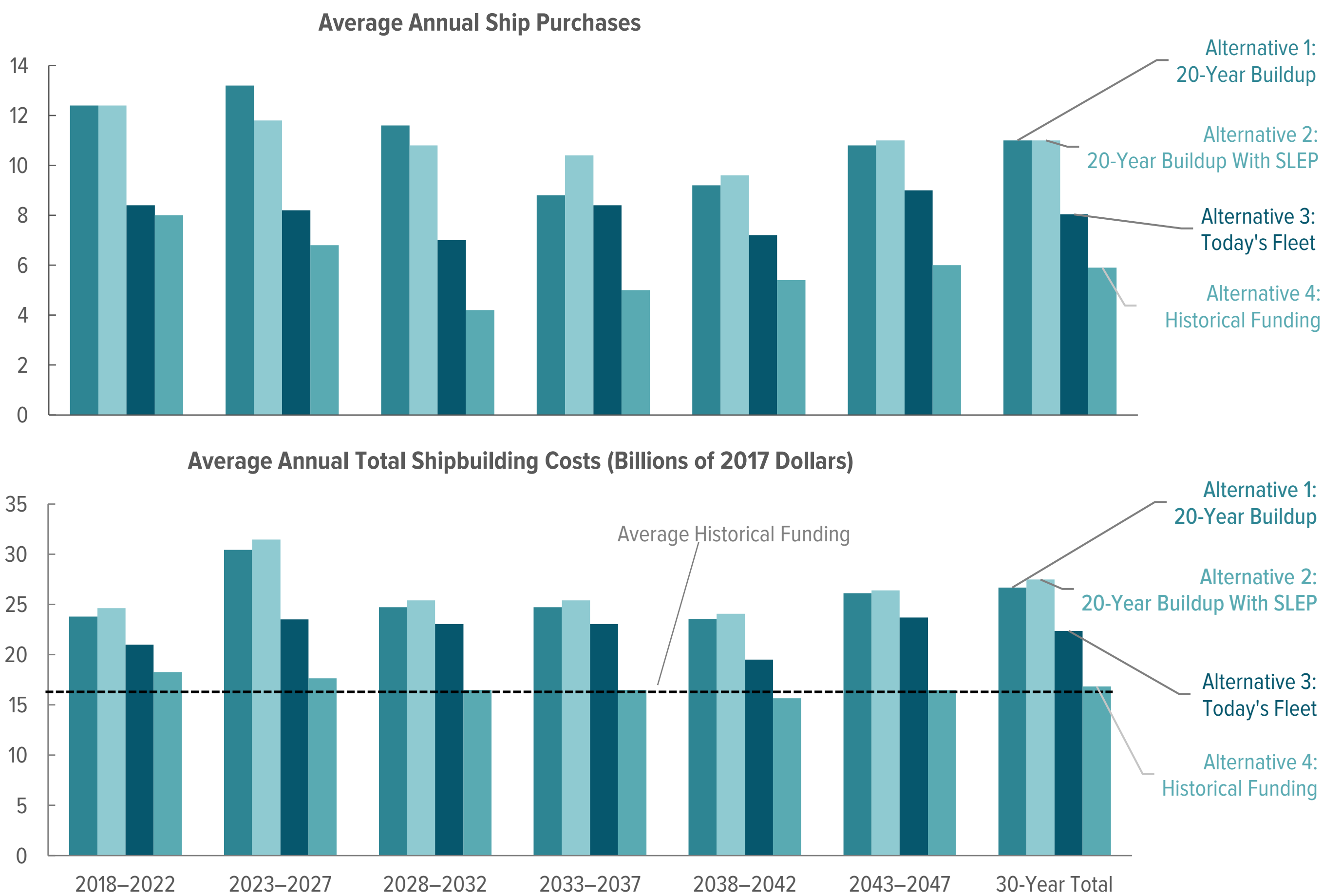
A larger fleet would require more sailors to crew the additional ships and more personnel (both military and civilian) to support those sailors. By 2047, however, the smaller fleet alternatives would require fewer personnel than the Navy has now.

Today, the Navy employs about 106,000 men and woman to crew the combat ships in its 280-ship fleet and incurs about $23 billion per year in direct operation and support costs—that is, the amount of money needed to pay the crews, to buy fuel and supplies, and to repair and maintain the ships. The Navy employs another 7,600 military and civilian personnel to operate its combat logistics and support ships. (Other operation and

efficiencies that occur as more ships are built over the duration of the production run. CBO also incorporates into its estimates a projection that labor and material costs would continue to grow faster in the naval shipbuilding industry than in the economy as a whole, as they have for the past several decades. For more detail, see Congressional Budget Office, *An Analysis of the Navy's Fiscal Year 2017 Shipbuilding Plan* (February 2017), pp. 33–36, www.cbo.gov/publication/52324.

Figure 2.

## Average Annual Ship Purchases and Costs for Naval Fleets Under Four Alternatives




Source: Congressional Budget Office.

Alternative 2 would extend the service life of some cruisers and amphibious ships to 45 years, some attack submarines to 42 years, and some destroyers and logistics ships to 40 years.

SLEP = service life extension program.

support expenses, such as indirect costs—which include operating those ships—and overhead costs are discussed below.) Because compensation for personnel accounts for a sizable share of operating costs, when the Navy designs and builds new classes of ships, it endeavors to reduce the size of their crews to reduce costs. Those efforts have met with mixed success.[6]

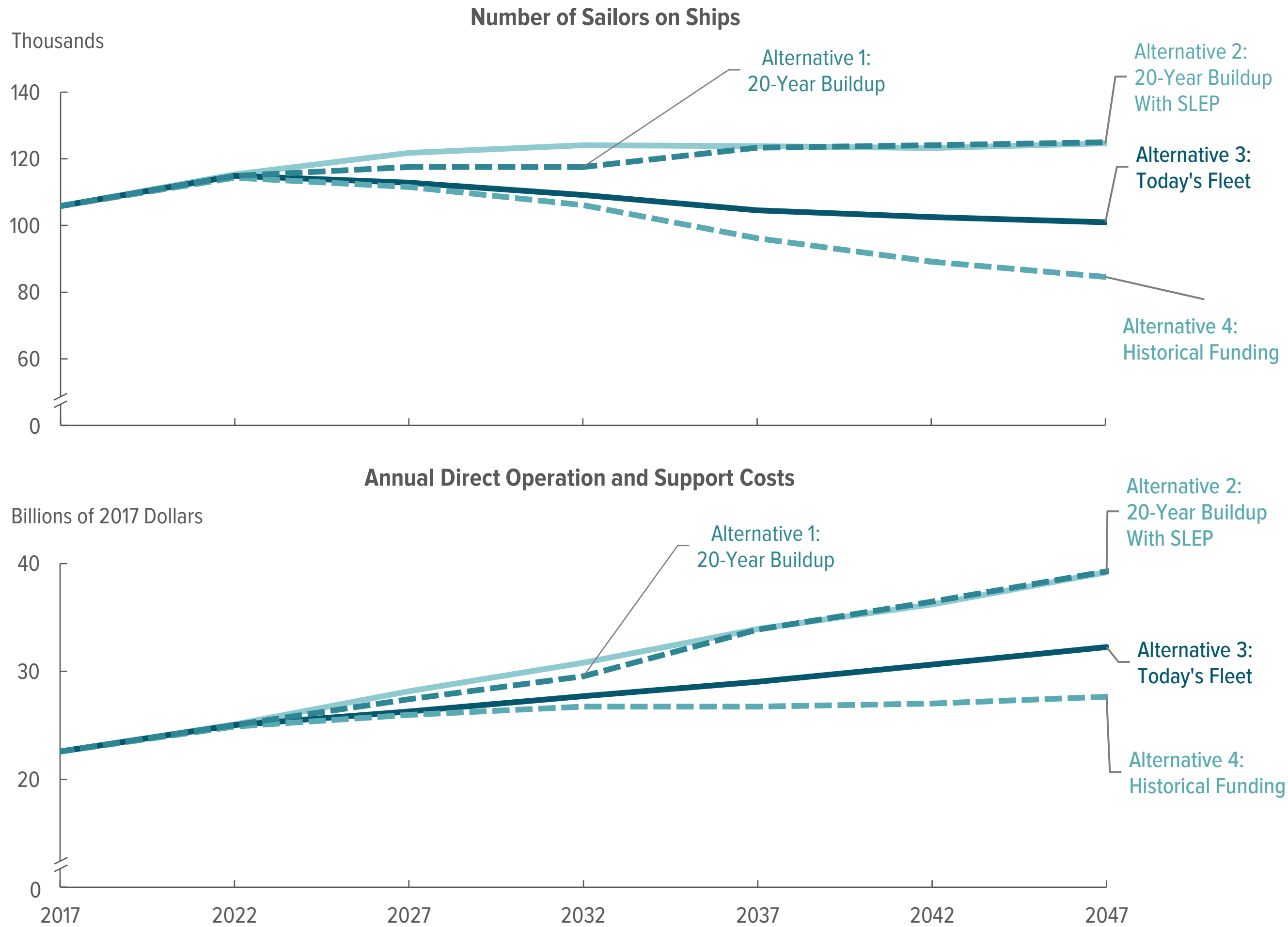
According to CBO's estimates, the combat ships in a 355-ship fleet would need crews totaling about 125,000 sailors, an increase of 18 percent over today's Navy (see Figure 3). Under the first alternative, crews for the 355-ship fleet would reach 123,000 sailors in 2037 and, as the mix of ships changed, grow to 125,000 by 2047. For the second alternative, because delayed retirements among ships that underwent SLEPs would cause the fleet size to increase more quickly, the number of sailors would climb to 123,000 by 2028 before it also reached 125,000 in 2047.

The smaller fleet alternatives offer a different picture. The third alternative would require increasing the crews for combat ships to 115,000 by 2022 before that number steadily declined to 101,000 in 2047. For the fourth alternative—the smallest fleet—crews would decline to 85,000 by 2047.

6. See Congressional Budget Office, *Costs of Building a 355-Ship Navy* (April 2017), p. 7, www.cbo.gov/publication/52632.

Figure 3.

**Number of Sailors on Ships and Operating Costs of Naval Fleets Under Four Alternatives, 2017 to 2047**




Source: Congressional Budget Office.

Direct operation and support costs represent the amount of funding needed to pay crews, buy fuel and supplies, and repair and maintain ships. CBO counts costs for combat logistics and support ships as indirect costs and, therefore, their crews and costs are excluded from this figure.

Alternative 2 would extend the service life of some cruisers and amphibious ships to 45 years, some attack submarines to 42 years, and some destroyers and logistics ships to 40 years.

SLEP = service life extension program.

However, direct operation and support costs would not follow a similar pattern: Specifically, real growth in those costs above general inflation in the economy would result in a more expensive fleet by 2047 under all four alternatives:

- Both of the 355-ship alternatives would increase direct annual operation and support costs from about $23 billion today to $39 billion by 2047. Under the second alternative, which includes the SLEPs and a slightly larger fleet in the 2020s and 2030s, the Navy would incur somewhat higher costs in those years than under the first alternative because more ships would require more crews to pay and more maintenance to perform.

- Under the third alternative, the fleet would cost $32 billion to operate by 2047, an increase of a third over the cost to operate a fleet similar to the one that exists today.

- The fleet purchased under the fourth alternative would also cost more to operate than the Navy spends today, despite having 18 percent fewer ships.

## What Are the Average Annual Costs of the Alternatives?

Altogether over the 30-year period, the total amount the Navy would spend to build and operate these alternative fleets would vary with their size. In the analysis underlying this report, CBO estimated the average annual cost of buying the ships and operating them, the cost of any additional aircraft needed to support those fleets, and the total 30-year cost in 2017 dollars.

### Average Annual Costs for Shipbuilding, Operation, and Support

The costs of the first alternative would average $103 billion per year, consisting of nearly $27 billion for new-ship construction and $76 billion for direct, indirect, and overhead operation and support (see Figure 4). (Direct costs are described above. Indirect costs include expenditures for various support units and organizations that are necessary for combat units to fight effectively. Overhead costs are expenditures for various other functions that support combat units, such as recruiting, training, acquisition offices, maintenance, and medical care.)[7]

Building the fleet faster using SLEPs would result in slightly higher average annual costs of $104 billion per year; those costs would comprise almost $28 billion for shipbuilding and $77 billion for operation and support. Maintaining the fleet at its current size would cost an average of $91 billion per year—$22 billion for new-ship construction and $69 billion for operation and support.

The smallest fleet would cost an average of $82 billion per year; those costs would consist of $17 billion for new-ship construction and $65 billion for operation and support.

### Additional Costs for Aircraft, Weapons, and Unmanned Systems

The average annual costs reported in the previous section exclude aircraft, weapons, and unmanned systems. The cost of those purchases would vary under the alternatives—the two larger fleet alternatives would have roughly similar expenses for those items, whereas the smaller fleet alternatives would involve buying fewer aircraft, weapons, and unmanned systems. For the first two alternatives, the extra costs of purchasing the aircraft needed to populate the air wing that would fly off the 12th aircraft carrier and the helicopters that would be carried by the additional surface combatants would total about $15 billion over 30 years, CBO estimates.[8] Maintaining the aircraft composition of today's fleet would require little change in the planned costs for the Navy's future aircraft purchases. The smaller fleet would result in savings of about $6 billion because fewer helicopters and fixed-wing aircraft would be purchased. The savings are not equal to the additional costs for the larger fleets because the fourth alternative would not reduce the number of carrier air wings, which account for most of the higher costs for aircraft under the larger fleet alternatives.

CBO did not estimate the marginal effects on costs of additional or fewer weapons and unmanned systems that might be used to arm the fleet under the different alternatives. Those costs could vary considerably depending on how the Navy employed new weapons and unmanned systems in the future. And whether the Navy is able to build a larger fleet or must accept a smaller fleet could affect the quantity and type of weapons under the different alternatives. For example, in the case of the smallest fleet alternative, because it is much smaller than the Navy would prefer, the service could choose to develop and deploy even more sophisticated weapons and unmanned systems than it might have otherwise to compensate for not meeting its desired force goal of 355 ships. At the same time, if funding limitations were to constrain the building of a larger fleet, then those same fiscal constraints might prevent the Navy from

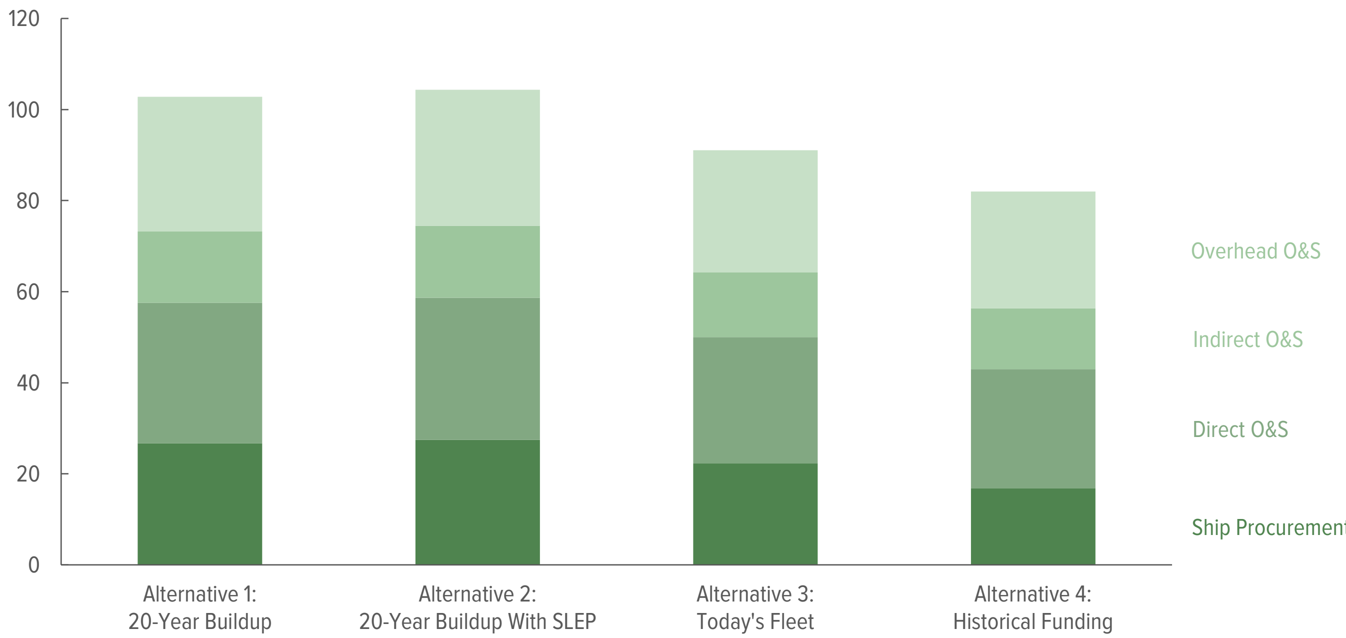
7. For operation and support costs, CBO placed every line item in the Department of Defense's (DoD's) 2017 five-year Future Years Defense Program, or FYDP, in the following categories: major combat units, support units, or administrative and overhead organizations. The costs of a combat unit, such as an infantry brigade or aircraft carrier, are direct costs. Organizations that support those major combat units, such as intelligence, maintenance, and transport units, represent the indirect costs of supporting combat. Finally, administrative and overhead costs include the costs of organizations that DoD needs to sustain and support its forces over the long run, such as recruiting and medical organizations that provide health care to active-duty soldiers, reservists, retirees, and their families. For more detail, see Congressional Budget Office, *The U.S. Military's Force Structure: A Primer* (July 2016), pp. 8–9, www.cbo.gov/publication/51535.

8. The 2016 FSA would increase the number of carriers from 11 to 12 and the number of large surface combatants from 88 to 104.

Figure 4.

**Total Average Annual Costs for Shipbuilding and Operation and Support Under Four Alternatives**

Billions of 2017 Dollars




Source: Congressional Budget Office.

Alternative 2 would extend the service life of some cruisers and amphibious ships to 45 years, some attack submarines to 42 years, and some destroyers and logistics ships to 40 years.

Overhead costs refer to expenditures for various functions that also support combat units, such as recruiting, training, acquisition offices, maintenance, and medical care. Indirect operating costs include expenditures for various support units and organizations that are necessary for combat units to fight effectively. Direct operating costs represent the amount of money needed to pay crews, buy fuel and supplies, and repair and maintain the Navy's combat ships. (CBO counts costs for combat logistics and support ships as indirect costs.)

O&S = operation and support; SLEP = service life extension program.

developing and fielding those more sophisticated weapons and unmanned systems.

### Total 30-Year Costs

For the most expensive alternative, a 20-year buildup with SLEPs, total costs—which include shipbuilding and operation and support but exclude most aircraft and weapons procurement—would be slightly more than $3.1 trillion through 2047, CBO estimates.[9] The first alternative, with all new construction, would cost slightly less than $3.1 trillion. Maintaining the fleet at its current size would cost $2.7 trillion, and the smallest fleet would cost $2.5 trillion.

9. The only costs for aircraft and weapons procurement included in these amounts are the incremental costs, discussed above, for aircraft that vary with the size of the fleet.

## How Would Capabilities Differ Under the Alternatives?

CBO compared the four alternatives using the number of ships on patrol overseas in peacetime, the number of ships that could be surged to a war within 30 days, and the number of VLS cells on those ships. The larger fleet alternatives would provide more forward presence, could surge more ships to a theater of operations in a war, and would provide many more VLS cells on-station in peacetime or in a wartime surge than the smaller fleet alternatives. CBO also compared the alternatives' effects on the fleet's average age: Throughout most of the next 30 years, the fleet with the lowest average age would be attained under the first alternative.

### Measuring Naval Power

Measuring relative naval power is a difficult task. To estimate whether it would be able to win a conflict in conjunction with other U.S. and allied military forces, the Navy relies primarily on classified war plans and classified campaign models that are subject to many assumptions. Unclassified comparisons rely more on counting the observed capabilities of ships in a fleet, both in peacetime and in a war.

Of the measures CBO used, the number of VLS cells is arguably the most meaningful because it represents the missile firepower of the fleet, which serves as a proxy for its offensive and defensive capability. VLS cells carry the weapons for a variety of missions performed by surface combatants and submarines, the number of which would vary significantly from alternative to alternative.

A weakness of using the number of VLS cells to measure capability, however, is that it does not capture the capability of the Navy's most potent conventional weapon system—the aircraft carrier and its embarked air wing—nor that of the Navy's amphibious warfare ships.[10] However, there is little difference in the number of aircraft carriers among CBO's alternatives until the 2040s: All of the alternatives would maintain a carrier force of at least 11 through 2040. Thus, to compare the alternatives, CBO relied on estimates of the number of ships and VLS cells that would be available in peacetime and a 30-day wartime scenario. The measures exclude the capabilities embodied in the Navy's helicopters, unmanned systems, guns, and torpedo tubes, but those capabilities would rise and fall in rough proportion with ship counts and VLS cells across the alternatives.

Another limitation of these measures is that, over time, weapons technology will invariably improve and become more sophisticated. Thus, a fleet that is the same size as today's (and has the same number of VLS cells) would probably be far more capable in 30 years' time because the weapons, sensors, and combat systems of those ships would improve as their underlying technology evolved and improved. For example, 50 of the Navy's surface combatants currently carry relatively short-range and slow antiship missiles to destroy enemy ships. Those existing weapons—called Harpoons—are not carried in VLS cells. In the future, as the Navy developed a family of new weapons, including faster and longer-range antiship missiles that are carried in VLS cells, the offensive power of the surface combatant force would increase substantially. Similarly, the Navy still uses relatively few unmanned surface, subsurface, and aircraft systems. But decades in the future, hundreds of such systems will probably be added to the Navy's battle network, expanding the sensor reach and offensive and defense firepower of manned ship platforms. Consequently, a smaller fleet equipped with new weapons and sensor systems in the future could be more capable than the current fleet.

### Peacetime Presence and Wartime Surge by Ships

The larger fleet alternatives would provide more forward presence and could surge more ships to a theater of operations in wartime than the smaller fleet alternatives.[11] By 2032, halfway into the 30-year period covered by Navy shipbuilding plans, the first alternative would provide 126 ships for routine presence overseas, compared with the 133 ships provided by the second alternative. The use of service life extension programs in the latter case would result in a larger inventory of ships in the middle of the 30-year window and thus a greater overseas presence (see Figure 5; also see Table 1 on page 2).

By contrast, the third and fourth alternatives would provide only 105 and 106 ships, respectively. Paradoxically, compared with the alternative that would maintain the fleet at its current size, the smallest fleet alternative would have a slightly larger capacity for the presence mission in 2032 because it would include more small surface combatants (littoral combat ships and frigates), and those ships are built and operated to provide more time on-station overseas than the average Navy ship. By 2047, however, when the smallest fleet would reach its nadir, it would provide just 83 ships on-station overseas

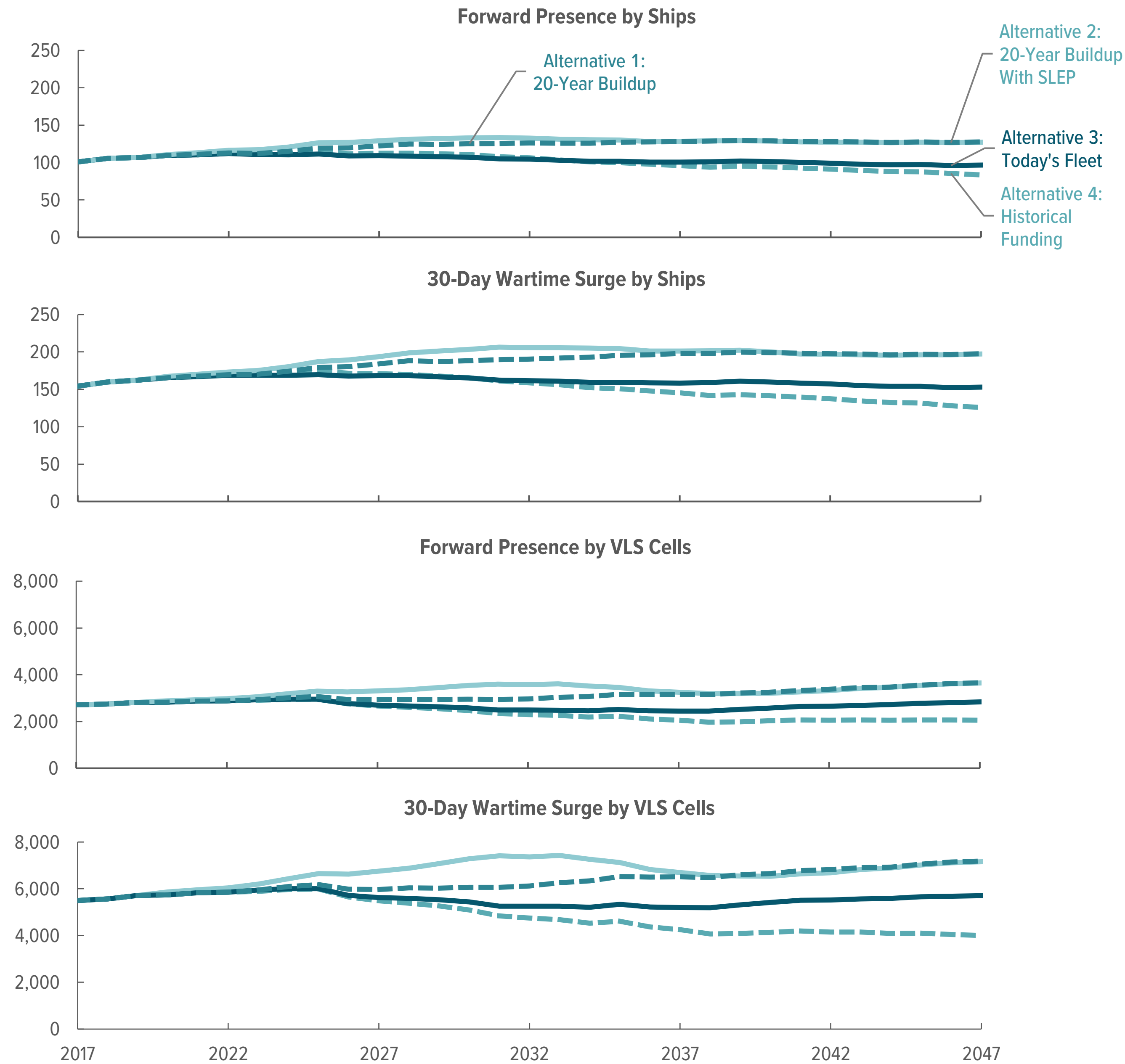
10. For an example of a dozen measures of capability and characteristics of different fleet alternatives, see Congressional Budget Office, *Options for the Navy's Future Fleet* (May 2006), pp. 59–78, www.cbo.gov/publication/17802.

11. CBO estimated the number of ships providing forward presence using the Navy's existing operational procedures. The Navy could maintain more ships overseas if it were to base more ships overseas, make greater use of dual crewing schemes on its ships, or conduct longer deployments. All of those approaches would have advantages, disadvantages, and additional costs (although the costs of expanding presence in those ways could be less than expanding the fleet). For analysis of how that could work, see Congressional Budget Office, *Preserving the Navy's Forward Presence With a Smaller Fleet* (March 2015), www.cbo.gov/publication/49989. Regardless of the boost in presence those approaches would provide, they would not materially change the number of ships available in wartime.

Figure 5.

## Various Measures of Capability Under Four Alternatives

The 20-year buildup with SLEP provides more capability sooner than the buildup without SLEP. The smallest fleet provides the least capability.




Source: Congressional Budget Office.

Alternative 2 would extend the service life of some cruisers and amphibious ships to 45 years, some attack submarines to 42 years, and some destroyers and logistics ships to 40 years.

Forward presence represents the number of ships on patrol overseas in peacetime. A wartime surge indicates how many ships can be rapidly deployed to war within 30 days.

The number of VLS cells represents the missile firepower of the fleet, which serves as a proxy for offensive and defensive capability because the weapons for a variety of missions are carried in those cells.

SLEP = service life extension program; VLS = vertical launch system.

compared with 97 for today's fleet alternative. The larger fleets would be almost the same in size and composition at that point, with the first alternative providing 128 ships and the second 127 ships.

The 30-day wartime surge of ships under all of the alternatives would generally follow the peacetime presence pattern described above.[12] By CBO's estimate, in 2032, the larger fleets of the first and second alternatives could provide 190 and 205 ships, respectively, for an overseas conflict, whereas the smaller fleets of the third and fourth alternatives would provide 162 and 159 ships. By 2047, the larger fleets would be able to surge nearly 200 ships, whereas the fleet that is comparable to today's could surge 153 and the smallest fleet 126.

**Peacetime Presence and Wartime Surge by VLS Cells**

The larger fleet alternatives would provide many more VLS cells on-station in peacetime than the smaller fleets. By 2032, the larger fleet without SLEPs would have 3,000 VLS cells on ships deployed overseas on routine patrol. The SLEP alternative would have 3,600 VLS cells on patrol, notably because many of the ships that would undergo service life extensions are surface combatants, which carry a large majority of the fleet's VLS cells. The smaller fleet alternatives would provide 2,500 and 2,300 cells, respectively. By 2047, when the alternative fleets were fully in place, the gap between the larger and smaller fleets would be more pronounced. The larger fleet alternatives, with almost the same number of VLS-carrying ships, would provide about 3,700 cells on-station in peacetime, whereas the third alternative would provide 2,800 and the smallest fleet 2,000, slightly more than half the number the 355-ship fleets would field.

In wartime, those numbers would increase substantially. In 2032, the SLEP fleet would provide 7,400 VLS cells in 30 days, whereas using new construction alone to build a bigger Navy would provide 6,100. The smaller fleets of the third and fourth alternatives could provide 5,300 and 4,700 cells. By 2047, the larger fleets would be able to surge almost 7,200 cells, whereas the smallest fleet would provide only 4,000.

12. All Navy ships are in one of the following categories at any given time: on deployment overseas, in transit to or from an overseas deployment, in maintenance, in one of several levels of training, or in their homeports and designated as surge-ready. Ships in the last category and those on deployment and in transit would be available to surge to a theater of operations within 30 days.

**Average Age**

The average age of the Navy's current fleet is 18.2 years—nearly the halfway point in that force's notional service life of 36 years. (The halfway point is referred to here as the half-life.) With any inventory, an average age well above the half-life would generally imply that many pieces of equipment may soon have to be replaced or refurbished over a short span of time to prevent the inventory from shrinking. In addition, older fleets tend to cost more to maintain than younger fleets.

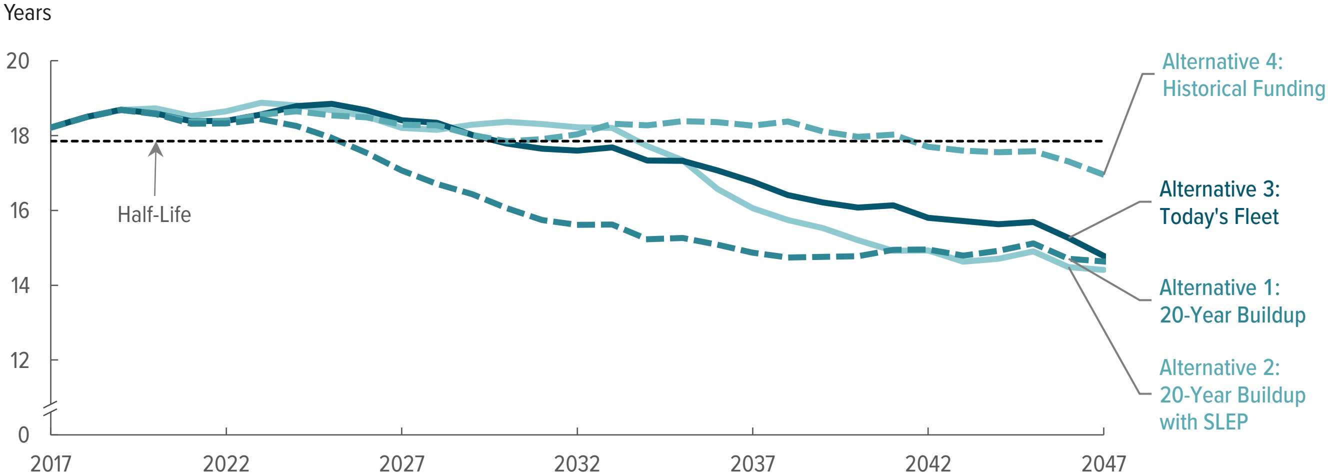
All of the alternatives that CBO examined would result in ships that were older, on average, than those in the current fleet during the next 10 years, but the fleet would get younger thereafter as more new ships replaced older ships (see Figure 6). Specifically, throughout most of the next 30 years, the fleet with the lowest average age would be attained under the first alternative, which would reach 355 ships within 20 years by relying on new construction alone. After 2027, it would result in an average age that is well below the half-life. The SLEP and today's fleet alternatives would maintain the average age of the fleet above the half-life until the 2030s, and the historical funding alternative would have the oldest average age throughout most of the projection period. As new ships were purchased and built, the average age of the fleet under each alternative would decline; by 2047, all would result in fleets that are younger than they are today.

## What Are the Implications for the Industrial Base?

All of the Navy's new-ship construction is performed by five large and two smaller private shipyards. Two of the large shipyards are owned by Huntington Ingalls Industries: Ingalls Shipbuilding, which builds large surface combatants and amphibious warfare ships for the Navy, as well as the national security cutter for the Coast Guard; and Newport News Shipbuilding, which builds nuclear-powered aircraft carriers and submarines. (Newport News also refuels those aircraft carriers at the midpoint of their service life, when the reactors typically run out of nuclear fuel.) General Dynamics owns the other three large shipyards: Bath Iron Works, which builds large surface combatants; Electric Boat, which builds nuclear-powered submarines; and National Steel and Shipbuilding Company—better known by its acronym, NASSCO—which builds various types of combat logistics and support ships. The two smaller shipyards are Fincantieri Marinette Marine, which builds the

Figure 6.

**Average Annual Age of the Fleet Under Four Alternatives**




Source: Congressional Budget Office.

The half-life is the midpoint in a fleet's notional service life. An average age well above the half-life generally implies that many ships may soon have to be replaced or refurbished over a short period to prevent the size of the fleet from declining.

SLEP = service life extension program.

steel monohull variant of the littoral combat ship (with Lockheed Martin as the prime integrator and provider of the combat systems); and Austal USA, which builds the aluminum trimaran version of the littoral combat ship as well as the expeditionary fast transport, which until recently was known as the joint high speed vessel—a fast ferry that the Navy uses for intratheater transport.

In its prior report, CBO discussed at length what shipbuilders would need to do to build a 355-ship fleet.[13] That discussion still applies to the two larger fleet alternatives discussed in this report. Specifically, the shipbuilding yards, especially those that build submarines and aircraft carriers, would need to invest up to $4 billion in facilities and infrastructure to accommodate the higher shipbuilding rates that a larger fleet would entail.

For the smaller fleet alternatives, however, the implications for the industry are quite different. Maintaining the approximate size and composition of today's fleet would not require significant investment or change to those shipyards, other than the normal continual improvements to shipbuilding processes that any builder of naval vessels would pursue as technology advanced and lessons were learned.

For the fleet constrained to historical funding levels, the lower shipbuilding rates could cause one or more of those yards to exit the business of building naval vessels, which could force them to close. (Most of the private yards rely almost entirely on business from the Navy for their revenue.) After 2026, the smaller fleet alternative would involve building only slightly more than five ships per year on average, which is less than one ship per yard per year. It is not clear whether that would be enough business to keep all seven yards open, although if it were, the workforces in those yards would shrink to reflect the reduced activity. Alternatively, if a smaller number of ships were built in fewer yards, so that each surviving shipyard was constructing more than one ship per year, more efficient production could be achieved, which could result in somewhat lower costs for ship construction than CBO reported here. However, if industry consolidation was not done efficiently, it could lead to higher costs.

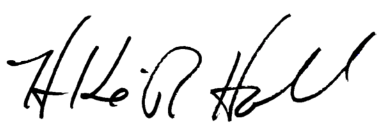
13. See Congressional Budget Office, *Costs of Building a 355-Ship Navy* (April 2017), pp. 8–11, www.cbo.gov/publication/52632.

# About This Document

This Congressional Budget Office report was prepared at the request of the Chairman and Ranking Member of the Subcommittee on Seapower and Projection Forces of the House Committee on Armed Services. In keeping with CBO's mandate to provide objective, impartial analysis, the report makes no recommendations.

Eric J. Labs of CBO's National Security Division wrote the report with guidance from David Mosher and Edward Keating. Raymond Hall of the Budget Analysis Division produced the ship cost estimates with guidance from Sarah Jennings. Daria Pelech of CBO provided comments on the report, as did Benjamin Friedman of George Washington University and Dakota Wood of the Heritage Foundation. (The assistance of external reviewers implies no responsibility for the final product, which rests solely with CBO.)

Jeffrey Kling and Robert Sunshine reviewed the report, Loretta Lettner edited it, and Jorge Salazar prepared it for publication. An electronic version of the report and supplemental material are available on CBO's website (www.cbo.gov/publication/53637).



Keith Hall
Director
March 2018