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Navy Large Unmanned Surface and Undersea Vehicles: Background and Issues for Congress

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SUMMARY

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Navy Large Unmanned Surface and Undersea Vehicles: Background and Issues for Congress

Among the Navy's programs for developing and acquiring unmanned surface vehicles (USVs) and unmanned underwater vehicles (UUVs) of various sizes are programs for developing two large USVs—the Large Unmanned Surface Vehicle (LUSV) and Medium Unmanned Surface Vehicle (MUSV)—and a program for a large UUV called the Extra-Large Unmanned Undersea Vehicle (XLUUV), also known as Orca. The Navy wants to develop and acquire LUSVs, MUSVs, and XLUUVs as part of an effort to shift the Navy to a more distributed fleet architecture, meaning a mix of ships that spreads the Navy's capabilities over an increased number of platforms and avoids concentrating a large portion of the fleet's overall capability into a relatively small number of high-value ships (i.e., a mix of ships that avoids "putting too many eggs into one basket"). The Navy's proposed FY2025 budget requests $54.0 million in research and development (R&D) funding for the LUSV program, $101.8 million in R&D funding for the MUSV program, $92.9 million in R&D funding for LUSV/MUSV enabling capabilities, $21.5 million in R&D funding for the XLUUV program, and $68.2 million in additional R&D funding for core technologies for UUVs including but not limited to XLUUV.

LUSV. The Navy envisions LUSVs as being 200 feet to 300 feet in length and having full load displacements of 1,000 tons to 2,000 tons, which would make them the size of a corvette (i.e., a ship larger than a patrol craft and smaller than a frigate). The Navy wants LUSVs to be low-cost, high-endurance, reconfigurable ships with ample capacity for carrying various modular payloads—particularly anti-surface warfare (ASuW) and strike payloads, meaning principally anti-ship and land-attack missiles. Each LUSV could be equipped with a vertical launch system (VLS) with 16 to 32 missile-launching tubes. Although referred to as unmanned vehicles, LUSVs might be more accurately described as optionally or lightly manned ships, because they might sometimes have a few onboard crew members, particularly in the nearer term as the Navy works out LUSV enabling technologies and operational concepts. The Navy has been using LUSV prototypes to develop LUSV operational concepts. The Navy's FY2025 budget submission programs the procurement of production LUSVs through the Navy's shipbuilding account, with the first LUSV to be procured in FY2027 at an estimated cost of $497.6 million, the next two in FY2028 at a combined estimated cost of $652.8 million (i.e., an average of about $326.4 million each), and the next three in FY2029 at a combined estimated cost of $994.3 million (i.e., an average of $331.4 million each). Under the Navy's FY2024 budget submission, procurement of LUSVs was to begin two years earlier, in FY2025. The Navy states: "This necessary [two-year] delay reduces risk associated with concurrency in requirements development, design specifications and machinery reliability testing."

MUSV. The Navy defines MUSVs as being less than 200 feet in length, with displacements of less than 500 tons, which would make them the size of a patrol craft. The Navy wants MUSVs, like LUSVs, to be low-cost, high-endurance, reconfigurable ships that can accommodate various payloads. Initial payloads for MUSVs are to be systems for supporting Intelligence, Surveillance, Reconnaissance, and Targeting (ISR-&T), Counter-ISR&T, and Information Operations (IO) missions. The Navy's FY2025 budget submission does not program the procurement of any operational MUSVs during the period FY2025-FY2029. The submission states: "The prototyping efforts with the FY 2019 MUSV hardware and software will inform decisions in preparation for the transition to an ACAT [acquisition category] program. Formalized requirements [for MUSV] will be defined through a Capability Development Document [CDD] and procurement funding will be developed as part of a decision in future budgets."

XLUUV. XLUUVs are roughly the size of a subway car. The Navy wants to use XLUUVs to, among other things, covertly deploy the Hammerhead mine, a planned mine that would be tethered to the seabed and armed with an antisubmarine torpedo, broadly similar to the Navy's Cold War-era CAPTOR (encapsulated torpedo) mine. Five "operationally relevant prototype" XLUUVs were procured in FY2019. An additional XLUUV test and training asset has also been procured. The Navy's FY2025 budget submission programs the procurement of additional XLUUVs through the Other Procurement, Navy (OPN) account, at a rate of one per year in FY2026-FY2029, with estimated procurement costs of $113.3 million, $115.6 million, $117.9 million, and $120.4 million, respectively. The Navy's FY2025 budget submission states: "Testing and delivery of the vehicles and support elements has been delayed to FY23-25 due to contractor challenges and supplier issues. The Navy is working with Boeing to mitigate schedule delays and execute risk reduction testing which initiated in FY23 through the addition of a designated test and training asset (Vehicle 0).… Fabrication awards of additional Orca XLUUV systems are planned for FY26 and out, gradually ramping up quantities in future fiscal years, depending on the progress from the first five systems."

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Introduction

This report provides background information and potential issues for Congress for three types of large unmanned vehicles (UVs) that the Navy wants to develop and procure in FY2025 and beyond:

- Large Unmanned Surface Vehicles (LUSVs);
- Medium Unmanned Surface Vehicles (MUSVs); and
- Extra-large Unmanned Undersea Vehicles (XLUUVs).

The Navy's proposed FY2025 budget requests $54.0 million in research and development (R&D) funding for the LUSV program, $101.8 million in R&D funding for the MUSV program, $92.9 million in R&D funding for LUSV/MUSV enabling capabilities, $21.5 million in R&D funding for the XLUUV program, and $68.2 million in additional R&D funding for core technologies for UUVs including but not limited to XLUUV.

The issue for Congress is whether to approve, reject, or modify the Navy's acquisition strategies and funding requests for these large UVs. The Navy's proposals for developing and procuring them pose a number of oversight issues for Congress. Congress's decisions on these issues could substantially affect Navy capabilities and funding requirements and the shipbuilding and UV industrial bases.

In addition to the large UVs covered in this report, the Navy also wants to develop and procure smaller USVs and UUVs, as well as unmanned aerial vehicles (UAVs) of various sizes. Other U.S. military services are developing, procuring, and operating their own types of UVs. Separate CRS reports address some of these efforts.[1]

Background

Navy USVs and UUVs in General

UVs in the Navy

UVs are one of several new capabilities that the Navy and other U.S. military services are pursuing to meet emerging military challenges, particularly from China. UVs can be equipped with sensors, weapons, or other payloads, and can be operated remotely, semi-autonomously, or (with technological advancements) autonomously. They can be individually less expensive to procure than manned ships and aircraft because their designs do not need to incorporate spaces and support equipment for onboard human operators. UVs can be particularly suitable for long-duration missions that might tax the physical endurance of onboard human operators, or missions that pose a high risk of injury, death, or capture of onboard human operators—so-called "three D" missions, meaning missions that are dull, dirty, or dangerous.[2]

[1] See, for example, CRS Report R45519, *The Army's Optionally Manned Fighting Vehicle (OMFV) Program: Background and Issues for Congress*, by Andrew Feickert, and CRS In Focus IF11150, *Defense Primer: U.S. Policy on Lethal Autonomous Weapon Systems*, by Kelley M. Sayler.

[2] See, for example, Ann Diab, "Drones Perform the Dull, Dirty, or Dangerous Work," Tech.co, November 12, 2014; Bonnie Robinson, "Dull, Dirty, Dangerous Mission? Send in the Robot Vehicle," U.S. Army, August 20, 2015; Bernard Marr, "The 4 Ds Of Robotization: Dull, Dirty, Dangerous And Dear," *Forbes*, October 16, 2017.

The Navy has been developing and experimenting with various types of UVs for many years, and has transitioned some of these efforts (particularly those for UAVs) into procurement programs. Even so, some observers have occasionally expressed dissatisfaction with what they view as the Navy's slow pace in transitioning UV development efforts into programs for procuring UVs in quantity and integrating them into the operational fleet.

March 2021 Campaign Framework Document for UVs

On March 16, 2021, the Department of the Navy released a "campaign framework" (i.e., overall strategy) document for developing and acquiring Navy and Marine UVs of various types and integrating them into U.S. naval operations.[3]

Smaller Navy USVs and UUVs

In addition to the large UVs covered in this report, the Navy also wants to develop and procure smaller USVs and UUVs that can be deployed from manned Navy ships and submarines to extend the operational reach of those ships and submarines. The large UVs covered in this CRS report, in contrast, are more likely to be deployed directly from pier to perform missions that might otherwise be assigned to manned ships and submarines.

Large UVs and Navy Ship Count

Because the large UVs covered in this report can be deployed directly from pier to perform missions that might otherwise be assigned to manned ships and submarines, the top-level count of the desired future number of ships in the Navy now increasingly includes two figures—one for manned ships (which remains the official "battle force ships" number for characterizing the desired future number of ships in the Navy), and an additional number for the desired future number of larger USVs and UUVs.[4]

Large UVs as Part of More Distributed Navy Fleet Architecture

The Navy wants to acquire these large UVs as part of an effort to shift the Navy to a more distributed fleet architecture, meaning a mix of ships that spreads the Navy's capabilities over an increased number of platforms and avoids concentrating a large portion of the fleet's overall capability into a relatively small number of high-value ships (i.e., a mix of ships that avoids "putting too many eggs into one basket").[5] This more distributed fleet architecture is intended to

[3] Department of the Navy, *Department of the Navy Unmanned Campaign Framework*, March 16, 2021, 37 pp. See also Megan Eckstein, "Navy, Marines Unveil How They Will Buy and Operate Future Pilotless Aircraft and Crewless Ships," *USNI News*, March 16, 2021; Gina Harkins, "Why You Should Trust Drone Ships and Unmanned Tech, According to the Navy," *Military.com*, March 16, 2021; Stew Magnuson, "Just In: Navy, Marine Corps Unmanned Framework Calls For 'Capabilities' Over Platforms," *National Defense*, March 16, 2021; Seapower Staff, "Navy, Marine Corps Release Unmanned Campaign Plan," *Seapower*, March 16, 2021; Jordan Wolman, "Looking to the Future of Combat and Competition, Navy Releases Much-Anticipated Campaign Plan on Unmanned Systems," *Inside Defense*, March 16, 2021.

[4] For additional discussion, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

[5] For additional discussion, see CRS Report RL32665, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, by Ronald O'Rourke.

support the implementation of the Navy's new operational concept, called Distributed Maritime Operations (DMO). DMO is discussed further in another CRS report.[6]

Restructured Acquisition Strategies

In marking up the Navy's proposed FY2020-FY2022 budgets, the congressional defense committees expressed concerns over whether the Navy's acquisition strategies provided enough time to adequately develop concepts of operations and key technologies for these large UVs, particularly the LUSV, and included legislative provisions intended to address these concerns. In response to these markups, the Navy restructured its acquisition strategy for the LUSV program so as to comply with these legislative provisions and provide more time for developing operational concepts and key technologies before entering into serial production of deployable units. Land-based testing of propulsion equipment intended for the LUSV and MUSV forms a key element of the restructured acquisition strategy.

Prototypes

The LUSV and MUSV programs are building on USV prototypes and other development work done by the DOD's Strategic Capabilities Office (SCO). SCO's effort to develop USVs was called Ghost Fleet, and its LUSV development effort within Ghost Fleet was called Overlord.[7] **Figure 1** shows USV prototypes that have supported or are scheduled to support the LUSV and MUSV programs. **Figure 2** shows one of those prototypes, the Sea Hunter medium displacement USV.

Surface Development Squadron

In May 2019, the Navy established a surface development squadron to help develop operational concepts for LUSVs and MUSVs. The squadron was initially to consist of a Zumwalt (DDG-1000) class destroyer and one Sea Hunter prototype. A second Sea Hunter prototype was

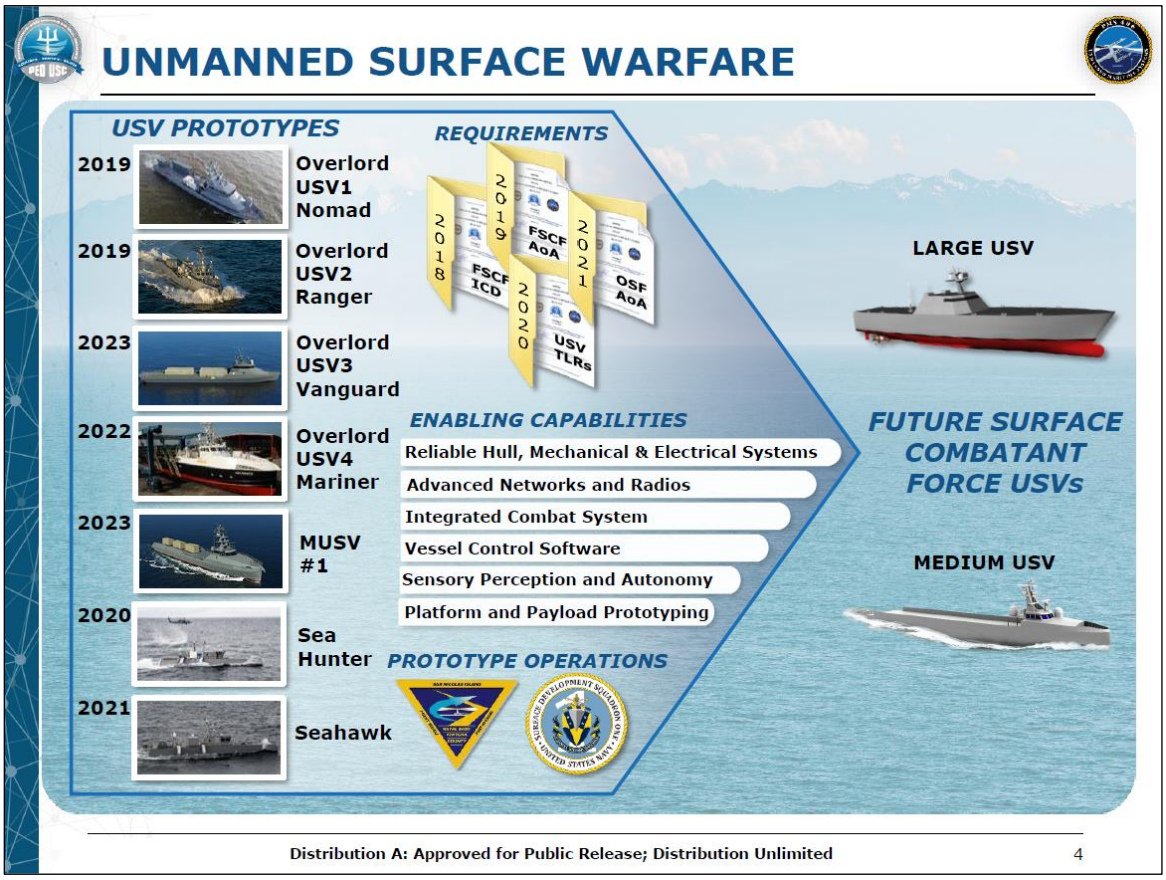
[6] See CRS In Focus IF12599, *Defense Primer: Navy Distributed Maritime Operations (DMO) Concept*, by Ronald O'Rourke.

[7] A January 12, 2022, press report stated

> Project Overlord, an experimental unmanned surface vehicle program, has completed its work and has been shut down by the Strategic Capabilities Office, a secretive research and development organization within the Pentagon, a Navy official revealed today.
>
> Its conclusion is a significant milestone, marking a period of transition between the Pentagon's research and development enterprise and a complete entry into the Navy's fleet.
>
> Overlord, which produced four vessels in total that will be transferred to the Navy's developmental squadrons, ended in December with a capstone demonstration, Capt. Pete Small, program manager for unmanned maritime systems, told attendees at the Surface Navy Association's national symposium.
>
> "What did we gain out of that?" Small said referring to Project Overlord. "The first thing we gained is the platforms. We're getting those free of charge… It's something on the order of $370 million" over three years invested by the SCO into unmanned vessels.
>
> That includes not just the platforms, but the technology and capabilities held within the ships, such as the control software. With the SCO's activities complete, the Overlord vessels will be transferred to the Surface Warfare Development Squadron this month.
>
> (Justin Katz, "SCO Ends Project Overlord, Shifts Unmanned Vessels to Navy," *Breaking Defense*, January 12, 2022. See also PEO Unmanned and Small Combatants (PEO USC) Public Affairs, "Strategic Capabilities Office Transfers Overlord Unmanned Surface Vessels to U.S. Navy," Naval Sea Systems Command, March 3, 2022.)

reportedly to be added around the end of FY2020, and LUSVs and MUSVs would then be added as they become available.[8]

Figure 1. Prototypes Supporting the LUSV and MUSV Programs



Source: Slide 4 of Navy briefing entitled "PMS 406 Maritime Unmanned Systems, CAPT Pete Small," briefing to Surface Navy Association (SNA) annual symposium, January 12, 2022.

LUSV, MUSV, and LXUUV Programs in Brief

LUSV Program

Overview

The Navy envisions LUSVs as being 200 feet to 300 feet in length and having full load displacements of 1,000 tons to 2,000 tons, which would make them the size of a corvette (i.e., a ship larger than a patrol craft and smaller than a frigate). The Navy wants LUSVs to be low-cost, high-endurance, reconfigurable ships with ample capacity for carrying various modular payloads—particularly anti-surface warfare (ASuW) and strike payloads, meaning principally anti-ship and land-attack missiles. Each LUSV could be equipped with a vertical launch system

[8] See, for example, Megan Eckstein, "Navy Stands Up Surface Development Squadron for DDG-1000, Unmanned Experimentation," *USNI News*, May 22, 2019; David B. Larter, "With Billions Planned in Funding, the US Navy Charts Its Unmanned Future," *Defense News*, May 6, 2019. See also Michael Fabey, "USN Seeks Path for Unmanned Systems Operational Concepts," *Jane's Navy International*, May 16, 2019.

(VLS) with 16 to 32 missile-launching tubes.[9] Although referred to as UVs, LUSVs might be more accurately described as optionally or lightly manned ships, because they might sometimes have a few onboard crew members, particularly in the nearer term as the Navy works out LUSV enabling technologies and operational concepts.[10]

Figure 2. Sea Hunter Prototype Medium Displacement USV

Source: Photograph credited to U.S. Navy accompanying John Grady, "Panel: Unmanned Surface Vessels Will be Significant Part of Future U.S. Fleet," *USNI News*, April 15, 2019.

The Navy states that "LUSV is a key enabler of the Navy's Distributed Maritime Operations (DMO) concept, which includes being able to forward deploy and team with individual manned combatants or augment battle groups. LUSV will complement the Navy's manned combatant force by delivering increased readiness, capability and needed capacity at lower procurement and sustainment costs and reduced risk to sailors."[11] As mentioned earlier, DMO is discussed further in another CRS report.[12]

The Navy's FY2025 budget submission programs the procurement of production LUSVs through the Navy's shipbuilding account, with the first LUSV to be procured in FY2027 at an estimated cost of $497.6 million, the next two in FY2028 at a combined estimated cost of $652.8 million (i.e., an average of about $326.4 million each), and the next three in FY2029 at a combined

[9] Source: Navy FY2022 program briefing on LUSV and MUSV programs for CRS and CBO, July 14, 2021.

[10] For further description of LUSV, see *Department of Defense, Fiscal Year (FY) 2025 Budget Estimates, Navy, Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4*, March 2024, pp. 21-22, 23-24, and 27 (PDF pages 97-98, 99-100, and 103 of 1520).

[11] *Department of Defense, Fiscal Year (FY) 2025 Budget Estimates, Navy, Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy*, March 2024, p. 21 (PDF page 97 of 1520).

[12] See CRS In Focus IF12599, *Defense Primer: Navy Distributed Maritime Operations (DMO) Concept*, by Ronald O'Rourke.

estimated cost of $994.3 million (i.e., an average of $331.4 million each).[13] Under the Navy's FY2024 budget submission, procurement of LUSVs was to begin two years earlier, in FY2025. The Navy states: "This necessary [two-year] delay reduces risk associated with concurrency in requirements development, design specifications and machinery reliability testing."[14]

LUSV Prototypes

Figure 3, **Figure 4**, and **Figure 5** show photographs of LUSV prototypes.

Figure 3. USV Prototypes

Source: Photograph from briefing slide entitled "UMS [unmanned maritime systems] at Sea," slide 4 of 5 (including cover slide) of Navy briefing entitled "PMS 406 Unmanned Maritime Systems, Program Overview, August 2021, prepared for Sea-Air-Space Exposition. The briefing slide states that the photograph shows "Overlord USVs Ranger & Nomad on the West Coast."

Analysis of Alternatives (AOA)

The Navy conducted an analysis of alternatives (AOA) to compare the cost-effectiveness of the LUSV to a range of alternative surface platforms, including modified naval vessel designs such as amphibious ships, expeditionary fast transport (EPF) ships, and expeditionary sea base (ESB) ships, modified commercial vessel designs such as container ships and bulk carriers, new naval vessel designs, and new commercial vessel designs.[15]

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[13] *Department of Defense, Fiscal Year (FY) 2025 Budget Estimates, Navy, Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy*, March 2024, p. 27 (PDF page 103 of 1520).

[14] U.S. Navy, *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2025*, March 2024, pp. 11-12.

[15] See, for example, Megan Eckstein, "US Navy Considers Alternatives to Unmanned Boats with Missiles," *Defense News*, March 22, 2022. The Navy stated in 2021 that

> As directed in the FY 2021 National Defense Authorization Act [Section 227(e) of H.R. 6395/P.L. 116-283 of January 1, 2021], the Navy is conducting a Distributed Offensive Surface Fires AoA [analysis of alternatives] to compare the currently planned large unmanned surface vessel (LUSV) with an integrated missile launcher payload against a broad range of alternative surface platforms and capabilities to determine the most appropriate vessel to deliver additional missile capability and capacity to the surface force.

(continued...)

Figure 4. LUSV Prototype

Source: Cropped version of photograph accompanying Mallory Shelbourne, "6 Companies Awarded Contracts to Start Work on Large Unmanned Surface Vehicle," *USNI News*, September 4, 2020. The caption to the photograph states in part: "A Ghost Fleet Overlord test vessel takes part in a capstone demonstration during the conclusion of Phase I of the program in September." The photo is credited to the U.S. Navy.

Figure 5. LUSV Prototype

Source: Cropped version of photograph accompanying Mallory Shelbourne, "6 Companies Awarded Contracts to Start Work on Large Unmanned Surface Vehicle," *USNI News*, September 4, 2020. The caption to the photograph states in part: "A Ghost Fleet Overlord test vessel takes part in a capstone demonstration during the conclusion of Phase I of the program in September." The photo is credited to the U.S. Navy.

(Statement of Frederick J. Stefany, Acting Assistant Secretary of the Navy for Research, Development and Acquisition (ASN (RD&A)) and Vice Admiral James W. Kilby, Deputy Chief of Naval Operations, Warfighting Requirements and Capabilities (OPNAV N9) and Lieutenant General Eric M. Smith, Deputy Commandant, Combat Development and Integration, Commanding General, Marine Corps Combat Development Command, before the Subcommittee on Seapower of the Senate Armed Services Committee on Department of the Navy Fiscal Year 2022 Budget Request for Seapower, June 8, 2021, p. 14.)

See also Jason Sherman, "Navy Considering Alternatives to LUSV, Packing Amphibs, Commercial Designs More with Long-Range Missiles," *Inside Defense*, April 9, 2021.

September 4, 2020, Contract Awards

On September 4, 2020, DOD announced the following six contract awards for industry studies on the LUSV:

> Huntington Ingalls Inc., Pascagoula, Mississippi (N00024-20-C-6319); Lockheed Martin Corp., Baltimore, Maryland (N00024-20-C-6320); Bollinger Shipyards Lockport LLC, Lockport, Louisiana (N00024-20-C-6316); Marinette Marine Corp., Marinette, Wisconsin (N00024-20-C-6317); Gibbs & Cox Inc., Arlington, Virginia (N0002420C6318); and Austal USA LLC, Mobile, Alabama (N00024-20-C-6315), are each being awarded a firm-fixed price contract for studies of a Large Unmanned Surface Vessel with a combined value across all awards of $41,985,112.
>
> Each contract includes an option for engineering support, that if exercised, would bring the cumulative value for all awards to $59,476,146.
>
> —The contract awarded to Huntington Ingalls Inc. [HII] is $7,000,000;
>
> —the contract awarded to Lockheed Martin Corp. is $6,999,978;
>
> —the contract awarded to Bollinger Shipyards Lockport LLC, is $6,996,832;
>
> —the contract awarded to Marinette Marine Corp. is $6,999,783;
>
> —the contract awarded to Gibbs & Cox Inc. is $6,989,499; and
>
> —the contract awarded to Austal USA LLC is $6,999,020.
>
> Work will be performed in various locations in the contiguous U.S. in accordance with each contract and is expected to be complete by August 2021, and if option(s) are exercised, work is expected to be complete by May 2022.
>
> Fiscal 2020 research, development, test and evaluation (Navy) funds in the amount $41,985,112 will be obligated at time of award and will not expire at the end of the current fiscal year.
>
> These contracts were competitively procured via Federal Business Opportunities (now beta.SAM.gov) with eight offers received. The Naval Sea Systems Command, Washington, D.C., is the contracting activity.[16]

A September 4, 2020, press report about the contract awards stated

> "These contracts were established in order to refine specifications and requirements for a Large Unmanned Surface Vessel and conduct reliability studies informed by industry partners with potential solutions prior to release of a Detail Design and Construction contract," Navy spokesman Capt. Danny Hernandez told USNI News in a statement.
>
> "The studies effort is designed to provide robust collaboration with government and industry to assist in maturation of platform specifications, and ensure achievable technical requirements are in place for a separate LUSV DD&C competition."…
>
> "The LUSV studies will support efforts that facilitate requirements refinement, development of an affordable and effective platform; provide opportunities to continue maturing the performance specifications and conduct analysis of alternative design approaches; facilitate reliability improvements and plans for government-furnished

[16] Department of Defense, "Contracts For Sept. 4, 2020," accessed September 8, 2020. The announcement is posted as a single, unbroken paragraph. In reprinting the text of the announcement, CRS broke the announcement into the smaller paragraphs shown here to make the announcement easier to read.

equipment and mechanical and electrical systems; and support development of cost reduction and other affordability initiatives," Hernandez said.[17]

July 29, 2022, Contract Modifications

On July 29, 2022, the Navy awarded modifications to the six contracts discussed above, as follows:

> Huntington Ingalls Inc., Pascagoula, Mississippi, is awarded a $13,071,106 firm-fixed-price modification to previously awarded contract N00024-20-C-6319 for continued studies of a large unmanned surface vessel. This contract modification includes options which, if exercised, would bring the cumulative value of this contract modification to $ 15,071,106. Work will be performed in Pascagoula, Mississippi, and is expected to be completed by September 2024. If all options are exercised, work will continue through September 2024....
>
> Lockheed Martin Corp., Baltimore, Maryland, is awarded an $11,320,904 firm-fixed-price modification to previously awarded contract N00024-20-C-6320 for continued studies of a large unmanned surface vessel. This contract modification includes options which, if exercised, would bring the cumulative value of this contract modification to $15,070,904. Work will be performed in Moorestown New Jersey, and is expected to be completed by September 2024. If all options are exercised, work will continue through September 2024....
>
> Marinette Marine Corp., Marinette, Wisconsin, is awarded a $10,212,620 firm-fixed-price modification to previously awarded contract N00024-20-C-6317 for continued studies of a large unmanned surface vessel. Work will be performed in Marinette, Wisconsin, and is expected to be completed by September 2024....
>
> Bollinger Shipyards Lockport LLC, Lockport, Louisiana, is awarded a $9,428,770 firm-fixed-price modification to previously awarded contract N00024-20-C-6316 for continued studies of a large unmanned surface vessel. This contract modification includes options which, if exercised, would bring the cumulative value of this contract modification to $13,958,770. Work will be performed in Lockport, Louisiana, and is expected to be completed by September 2024. If all options are exercised, work will continue through September 2024....
>
> Austal USA LLC, Mobile, Alabama, is awarded a $9,115,310 firm-fixed-price modification to previously awarded contract N00024-20-C-6315 for continued studies of a large unmanned surface vessel. This contract modification includes options which, if exercised, would bring the cumulative value of this contract modification to $13,285,309. Work will be performed in Mobile, Alabama, and is expected to be completed by September 2024. If all options are exercised, work will continue through September, 2024....
>
> Gibbs & Cox Inc., Arlington, Virginia, is awarded an $8,981,231 firm-fixed-price modification to previously awarded contract N00024-20-C-6318 for continued studies of a large unmanned surface vessel. This contract modification includes options which, if exercised, would bring the cumulative value of this contract modification to $15,071,231. Work will be performed in Arlington, Virginia, and is expected to be completed by September 2024.[18]

[17] Mallory Shelbourne, "6 Companies Awarded Contracts to Start Work on Large Unmanned Surface Vehicle," *USNI News*, September 4, 2020. See also Paul McLeary, "Navy Awards Study Contracts On Large Unmanned Ship—As Congress Watches Closely," *Breaking Defense*, September 4, 2020.

[18] Department of Defense, "Contracts For July 29, 2022," accessed August 29, 2022. See also Rich Abott, "Navy Continues Six LUSV Study Contracts," *Defense Daily*, August 5, 2022.

MUSV Program

Overview

The Navy defines MUSVs as being less than 200 feet in length, with displacements of less than 500 tons, which would make them the size of a patrol craft. The Navy wants MUSVs, like LUSVs, to be low-cost, high-endurance, reconfigurable ships that can accommodate various payloads. Initial payloads for MUSVs are to be systems for supporting Intelligence, Surveillance, Reconnaissance, and Targeting (ISR-&T), Counter-ISR&T, and Information Operations (IO) missions.[19]

The Navy states that "MUSVs will support the Navy's ability to produce, deploy and disburse ISR&T/C-ISR&T/IO capabilities in sufficient quantities and provide/improve distributed situational awareness in maritime Areas of Responsibility (AORs)…. The MUSV will be a key enabler of the Navy's Distributed Maritime Operations (DMO) concept."[20] As mentioned earlier, DMO is discussed further in another CRS report.[21]

The Navy is pursuing the MUSV program as a rapid prototyping effort under what is known as Section 804 middle tier acquisition authority.[22] The Navy's FY2025 budget submission does not program the procurement of any operational MUSVs during the period FY2025-FY2029. The submission states: "The prototyping efforts with the FY 2019 MUSV hardware and software will inform decisions in preparation for the transition to an ACAT [acquisition category] program. Formalized requirements [for MUSV] will be defined through a Capability Development Document [CDD] and procurement funding will be developed as part of a decision in future budgets."[23]

July 2020 Contract Award

On July 13, 2020, the Navy announced that it had awarded "a $34,999,948 contract to L3[Harris] Technologies, Inc. for the development of a single Medium Unmanned Surface Vehicle (MUSV) prototype, with options to procure up to eight additional MUSVs. The award follows a full and open competitive procurement process. Funding is in place on this contract for the initial prototype. With all options exercised, the contract is valued at $281,435,446 if additional funding is provided in future budget years."[24] The Navy reportedly stated that there were five competitors

[19] For further description of MUSV, see *Department of Defense, Fiscal Year (FY) 2025 Budget Estimates, Navy, Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4*, March 2024, pp. 1311, 1313-1314, and 1318 (PDF pages 1387, 1389-1390, and 1394 of 1520).

[20] *Department of Defense, Fiscal Year (FY) 2025 Budget Estimates, Navy, Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4*, March 2024, p. 1313 (PDF page 1389 of 1520).

[21] See CRS In Focus IF12599, *Defense Primer: Navy Distributed Maritime Operations (DMO) Concept*, by Ronald O'Rourke.

[22] This is a reference to Section 804 of the FY2016 National Defense Authorization Act (S. 1356/P.L. 114-92 of November 25, 2015), which provided rapid prototyping authority. For more on this authority, see "Middle Tier Acquisition (Section 804)," MITRE, undated, accessed June 27, 2024, at https://aida.mitre.org/middle-tier/; and "Acquisition Process, Middle Tier Acquisition (Section 804)," AcqNotes, updated September 25, 2022, accessed June 27, 2024, at http://acqnotes.com/acqnote/acquisitions/middle-tier-acquisitions.

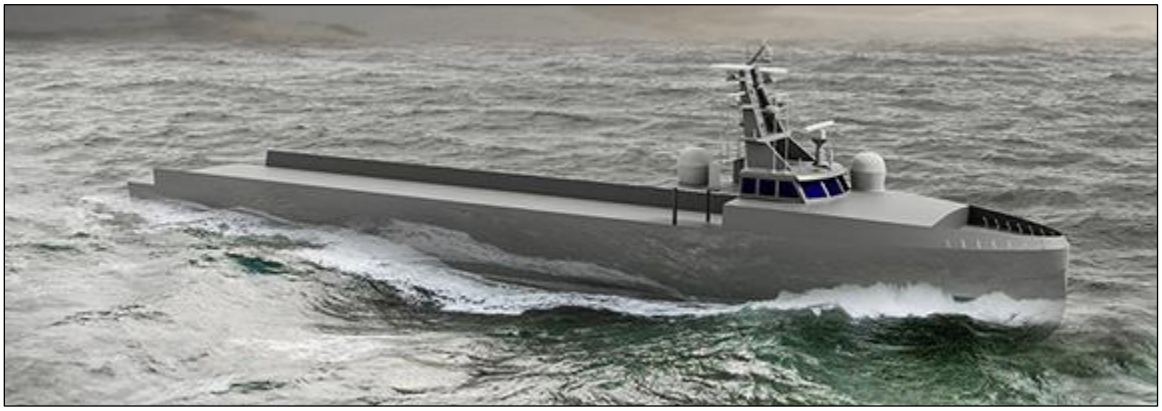
[23] *Department of Defense, Fiscal Year (FY) 2025 Budget Estimates, Navy, Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4*, March 2024, p. 13184 (PDF page 1394 of 1520).

[24] PEO Unmanned and Small Combatants Public Affairs, "Navy Awards Contract for Medium Unmanned Surface Vehicle Prototype," Naval Sea Systems Command, July 13, 2020.

for the contract, but did not identify the other four.[25] **Figure 6** shows a rendering of L3Harris's design concept. L3Harris states that

> will integrate the company's ASView™ autonomy technology into a purpose-built 195-foot commercially derived vehicle from a facility along the Gulf Coast of Louisiana. The MUSV will provide intelligence, surveillance and reconnaissance to the fleet while maneuvering autonomously and complying with international Collision Regulations, even in operational environments.…
>
> L3Harris will be the systems integrator and provide the mission autonomy and perception technology as the prime contractor on the program. The program team includes Gibbs & Cox and Incat Crowther who will provide the ship design and Swiftships will complete the construction of the vehicle.[26]

Figure 6. Rendering of L3Harris Design Concept for MUSV



Source: L3Harris Technologies, "L3Harris Technologies Awarded Medium Unmanned Surface Vehicle Program from US Navy," August 18, 2020. See also Richard R. Burgess, "Navy's Medium USV to Be Based on Commercial Vehicle," *Seapower*, August 19, 2020.

June 2024 Sources Sought/Request for Information (RFI)

On June 17, 2024, the Navy issued a Sources Sought/Request for Information (RFI) for MUSVs that states

> The Navy is conducting market research in accordance with FAR [Federal Acquisition Regulation] Part 10 to determine if resources/sources exist that can satisfy the Navy's assessment of deploying a number Medium Unmanned Surface Vehicles (MUSVs) in a given timeframe. For the purposes of this RFI, PMS 406 is interested in vessels less than 200 feet in length and under 500 tons displacement that can meet the payload details specified in Government Furnished Information to be provided by separate correspondence. PMS 406[27] is contemplating an accelerated approach with industry to

[25] Rich Abott, "L3Harris Wins $35 Million MUSV Prototype Contract," *Defense Daily*, July 13, 2020. See also Sam LaGrone, "Navy Awards Contract for First Vessel In Its Family of Unmanned Surface Vehicles," *USNI News*, July 14 (updated July 15), 2020; Paul McLeary, "Navy Inks Deal For New Unmanned Fleet," *Breaking Defense*, July 13, 2020.

[26] L3Harris Technologies, "L3Harris Technologies Awarded Medium Unmanned Surface Vehicle Program from US Navy," August 18, 2020. See also Audrey Decker, "First MUSV Platform Will Feature Broad Payload Area," *Inside Defense*, January 20, 2022.

[27] PMS 406 is the Unmanned Maritime Systems office within the Naval Sea Systems Command (NAVSEA), the Navy office that oversees the acquisition of surface ships, submarines, and their combat systems.

leverage existing, manned or unmanned surface ship designs that can be modified to enable rapid delivery of an unmanned or optionally unmanned surface ship capability.

In accordance with 10 U.S.C. Section 7309, neither the vessel nor any major component of its hull or superstructure may be constructed in a foreign shipyard.

For this RFI, an accelerated schedule requires using an existing proven design with only minor modifications, or even converting existing U.S.-built vessels. For the purposes of this RFI, a clean-sheet design is not an option. Navy seeks delivery of the first vessel within 12 months after contract award to allow for Test and Evaluation, and delivery of all remaining vessels by 24 months after contract award. A maximum procurement of 7 MUSVs is contemplated for this RFI. A single vendor could provide between 1 and 7 vessels.

The objective of this RFI is to assess industry's ability to provide a materiel solution within an accelerated timeframe at an affordable cost. The Navy is seeking information to help determine the interest, technical and manufacturing capabilities, technical quality of solutions, knowledge, experience level, and qualifications of industry to meet the Government's needs to build or convert up to seven MUSVs. Additionally, the Navy is interested in technical, administrative, and business risks in pursuit of the desired solution. Respondents should identify their materiel solutions, as well as the time and cost drivers, for providing the desired solutions. Solutions that only cover a portion of the desired end product are welcome. Specific questions are included in the GFI package required to answer this RFI. You do not need to answer every question, but please indicate by number the questions to which your responses apply.[28]

XLUUV Program

Overview

The XLUUV program, also known as the Orca program, was established to address a Joint Emergent Operational Need (JEON). The Navy defines XLUUVs as UUVs with a diameter of more than 84 inches, meaning that XLUUVs are to be too large to be launched from a manned Navy submarine.[29] Consequently, XLUUVs (**Figure 7** and **Figure 8**) will instead transported to a forward operating port and then launched from a pier. The Department of the Navy's March 16, 2021, unmanned campaign framework document states that the XLUUV will be designed "to accommodate a variety of large payloads…."[30] The Navy testified on March 18, 2021, that mines will be the initial payload for XLUUVs.[31] More specifically, the Navy wants to use XLUUVs to, among other things, covertly deploy the Hammerhead mine, a planned mine that would be

[28] "Medium Unmanned Surface Vehicle (MUSV) Sources Sought/Request for Information," June 17, 2024, accessed June 27, 2024, at https://sam.gov/opp/06b02e2d221148338f7ddab6e4a5d756/view. See also Justin Katz, "Navy Eyeing Industry for Readily Available Medium USVs," *Breaking Defense*, June 20, 2024.

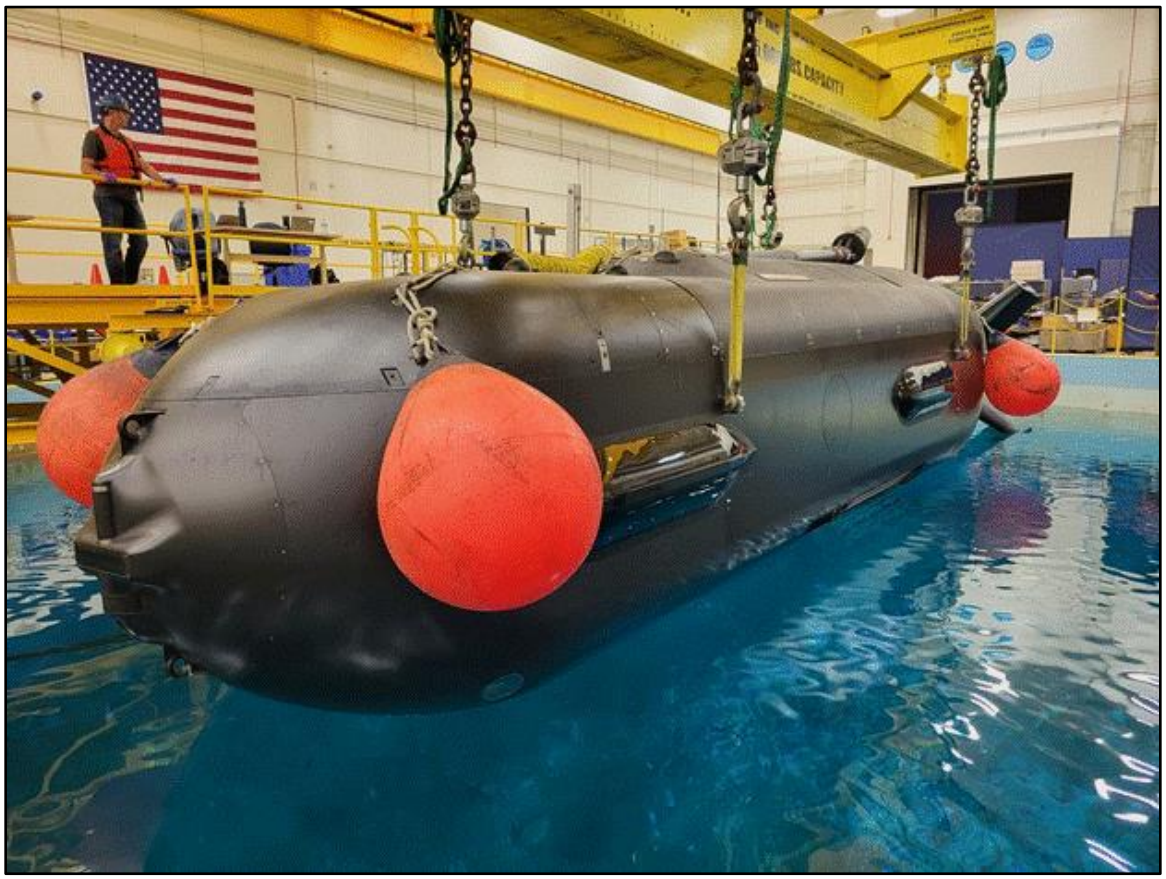
[29] Navy submarines equipped with large-diameter vertical launch tubes can launch missiles or other payloads with diameters of up to about 83 inches.

[30] Department of the Navy, *Department of the Navy Unmanned Campaign Framework*, March 16, 2021, p. 16. For further description of XLUUV, see *Department of Defense, Fiscal Year (FY) 2025 Budget Estimates, Navy, Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4*, March 2024, pp. 1217, 1219, and 1222-1223 (PDF pages 1293, 1295, and 1298-1299 of 1520).

[31] Richard R. Burgess, "Navy's Orca XLUUV to Have Mine-Laying Mission, Adm. Kilby Says," *Seapower*, March 18, 2021.

tethered to the seabed and armed with an antisubmarine torpedo, broadly similar to the Navy's Cold War-era CAPTOR (encapsulated torpedo) mine.[32]

Figure 7. XLUUV (Orca)



Source: Photograph accompanying Aaron-Matthew Lariosa, "Navy Receives First of Six Prototype Extra Large Orca Underwater Drones," *USNI News*, December 21, 2023. The caption to the photograph credits the photograph to Boeing.

The first five XLUUVs were funded in FY2019 through the Navy's research and development appropriation account. The Navy conducted a competition for the design of the XLUUV, and announced on February 13, 2019, that it had selected Boeing to fabricate, test, and deliver the first four Orca XLUUVs and associated support elements.[33] (The other bidder was a team led by Lockheed Martin.) On March 27, 2019, the Navy announced that the award to Boeing had been expanded to include the fifth Orca.[34] An additional XLUUV test and training asset has also been procured. Boeing has partnered with the Technical Solutions division of Huntington Ingalls

[32] For a discussion of the Hammerhead mine, see, for example, David Hambling, "With Hammerhead Mine, U.S. Navy Plots New Style Of Warfare To Tip Balance In South China Sea," *Forbes*, October 22, 2020. See also Kyle Mizokami, "The Navy's 'Ghost Fleet' of Robo-Subs Will Drop Deadly Surprises for Enemies," *Popular Mechanics*, June 2, 2022; Rich Abott, "Navy Orca XLUUV To Carry 34-Foot Payload Module, Buying 6th Test Vessel," *Defense Daily*, May 31, 2022; Dan Parsons, "Navy's 85-Foot Orca Unmanned Submarine Will Be A Minelayer First," *The Drive*, May 27, 21022; Audrey Decker, "Navy's XLUUV Will Fill 'Specific Mission' in INDOPACOM," *Inside Defense*, November 22, 2021.

[33] Department of Defense, *Contracts for Feb. 13, 2019*.

[34] Department of Defense, *Contracts for March 27, 2019*.

Industries (HII) to build Orca XLUUVs.[35] (Another division of HII—Newport News Shipbuilding (NNS) of Newport News, VA—is one of the Navy's two submarine builders.)

Figure 8. XLUUV (Orca)

Source: Cropped version of photograph in Government Accountability Office, *Extra Large Unmanned Undersea Vehicle[:] Navy Needs to Employ Better Management Practices to Ensure Swift Delivery to the Fleet*, GAO-22-105974, September 2022, p. 7. The caption to the photograph credits the photograph to "Navy program office."

The Navy's FY2025 budget submission programs the procurement of additional XLUUVs through the Other Procurement, Navy (OPN) account, at a rate of one per year in FY2026-FY2029, with estimated procurement costs of $113.3 million, $115.6 million, $117.9 million, and $120.4 million, respectively. The Navy's FY2025 budget submission states: "Testing and delivery of the vehicles and support elements has been delayed to FY23-25 due to contractor challenges and supplier issues. The Navy is working with Boeing to mitigate schedule delays and execute risk reduction testing which initiated in FY23 through the addition of a designated test and training asset (Vehicle 0).… Fabrication awards of additional Orca XLUUV systems are planned for FY26 and out, gradually ramping up quantities in future fiscal years, depending on the progress from the first five systems."[36]

A March 29, 2024, press report states: "After delivering an initial prototype [i.e., the test and trianing asset] in December, Boeing plans to turn over the remaining five Extra Large Unmanned Undersea Vehicles to the Navy before the end of 2025, according to company executives and service budget documents," and that despite setbacks, "the program's production line has recovered from the logistical challenges imposed by the COVID-19 pandemic and Boeing is optimistic about the future of the program, according to Ann Stevens, the company's vice president of maritime and intelligence systems."[37]

[35] See, for example, Hugh Lessig, "Shipbuilder Lends a Hand with Rise of Robot Submarines," *Defense News*, May 26, 2019.

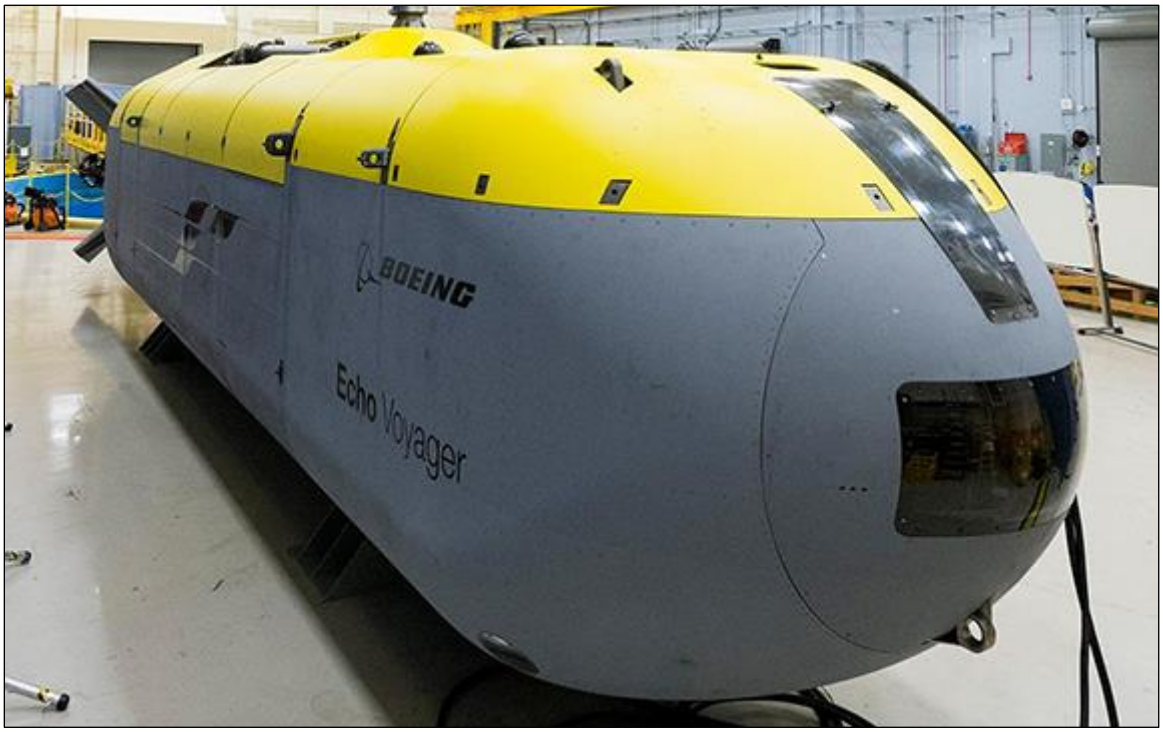
[36] *Department of Defense, Fiscal Year (FY) 2025 Budget Estimates, Navy, Justification Book Volume 2 of 5, Research, Development, Test & Evaluation, Navy, Budget Activity 4*, March 2024, p. 1217 (PDF page 1293 of 1520).

[37] Nick Wilson, "Boeing Aims to Complete Delivery of Initial XLUUV Set Within 2025," *Inside Defense*, March 29, 2024. Regarding the delivery of the XLUUV test and training asset in December 2023, see Aaron-Matthew Lariosa, "Navy Receives First of Six Prototype Extra Large Orca Underwater Drones," *USNI News*, December 21, 2023; Cal Biesecker, "|Navy Takes Ownership Of First Orca XLUUV; Marks Key LUSV Milestone," *Defense Daily*, December 20, 2023; Marcus Weisgerber, "The Navy Has Its First Giant Robotic Submarine," *Defense One*, December 20, 2024.

Boeing Echo Voyager

XLUUV's design was informed by (but differs in certain respects from) the design of Boeing's Echo Voyager UUV (**Figure 9**, **Figure 10**, and **Figure 11**).[38] Echo Voyager is roughly the size of a subway car—it is 51 feet long and has a rectangular cross section of 8.5 feet by 8.5 feet, a weight in the air of 50 tons, and a range of up to 6,500 nautical miles. It can accommodate a modular payload section up to 34 feet in length, increasing its length to as much as 85 feet. A 34-foot modular payload section provides about 2,000 cubic feet of internal payload volume; a shorter (14-foot) section provides about 900 cubic feet. Echo Voyager can also accommodate external payloads.[39]

Figure 9. Boeing Echo Voyager UUV



Source: Boeing photograph posted at https://www.boeing.com/defense/autonomous-systems/echo-voyager/index.page#/gallery.

The Navy states that the XLUUV

> is based off Boeing's Echo Voyager, but incorporates significant changes to support military mission requirements. This has resulted in challenges in establishing the manufacturing process, building up the industrial base, and aligning material purchases to produce the first group of prototype vehicles. Orca represents the leading edge of autonomous maritime vehicle technology and will have extended range and a

[38] See, for example, Hugh Lessig, "Shipbuilder Lends a Hand with Rise of Robot Submarines," *Defense News*, May 26, 2019.

[39] Source: Boeing product sheet on Echo Voyager, accessed May 31, 2019, at https://www.boeing.com/resources/boeingdotcom/defense/autonomous-systems/echo-voyager/echo_voyager_product_sheet.pdf.

reconfigurable, modular payload bay to support multiple payloads and a variety of missions.[40]

Figure 10. Boeing Echo Voyager UUV

Source: Boeing photograph posted at https://www.boeing.com/defense/autonomous-systems/echo-voyager/index.page#/gallery.

Figure 11. Boeing Echo Voyager UUV

Source: Navy briefing entitled "Unmanned Maritime Systems," Howard Berkof, Deputy Program Manager, Unmanned Maritime Systems, PMS 406, Distribution A: Approved for public release; distribution unlimited, October 23, 2019, slide 5.

[40] Statement of Fredrick J. Stefany, Acting Assistant Secretary of the Navy for Research, Development and Acquisition (ASN [RD&A]) and Vice Admiral James W. Kilby, Deputy Chief of Naval Operations for Warfare Systems and Lieutenant General Eric M. Smith, Deputy Commandant Combat Development and Integration & Commanding General, Marine Corps Combat Development Command, before the House Armed Services Committee Subcommittee on Seapower and Projection Forces, on Department of the Navy Unmanned Systems, March 18, 2021, p. 12.

Issues for Congress

The Navy's proposals for developing and procuring the large UVs covered in this report pose a number of oversight issues for Congress, including those discussed below.

Analytical Basis for Fleet Architecture Including Large UVs

One potential oversight issue for Congress concerns the analytical basis for the Navy's desire to shift to a more distributed fleet architecture that includes large UVs. Potential oversight questions for Congress include the following:

- What analyses led to the Navy's decision to shift toward a more distributed architecture that includes large UVs?
- What did these analyses reveal about the comparative costs, capabilities, and risks of more distributed architectures that do not include large UVs?
- How well developed and tested are the operational concepts associated with the various options for more distributed architectures that have been analyzed?

As discussed earlier, the Navy conducted an analysis of alternatives (AOA), to compare the cost-effectiveness of the LUSV to a range of alternative surface platforms, including modified naval vessel designs such as amphibious ships, expeditionary fast transport (EPF) ships, and expeditionary sea base (ESB) ships, modified commercial vessel designs such as container ships and bulk carriers, new naval vessel designs, and new commercial vessel designs.

Concept of Operations (CONOPS)

Another potential oversight issue for Congress concerns the Navy's concept of operations (CONOPS) for these large UVs, meaning the Navy's understanding at a detailed level of how it will operate and support these UVs in conjunction with manned Navy ships in both combat operations and at other times, and consequently how, exactly, these UVs will fit into the Navy's overall force structure and operations. As mentioned earlier, in May 2019, the Navy established a surface development squadron to help develop operational concepts for LUSVs and MUSVs.

Some observers have presented suggestions for LUSV or MUSV operational concepts.[41] Other observers have raised questions regarding the Navy's CONOPs for operating and supporting large UVs, particularly large USVs.[42]

Potential oversight questions for Congress include the following:

- How fully has the Navy developed its CONOPS for these large UVs? What activities is the Navy undertaking to develop its CONOPS for them?
- What is the Navy's CONOPS for operating and sustaining these large UVs, including both combat operations and day-to-day, noncombat operations?
- How sensitive are the performance requirements that the Navy has established for these large UVs to potential changes in their CONOPS that may occur as the

[41] See, for example, George Galdorisi, "A Concept of Operations for the U.S. Navy's Hybrid Fleet," Center for International maritime Security (CIMSEC), June 5, 2024.

[42] See, for example, Manal Cheema and Ariel Sarandinaki, "The Warship's Remote Operator: Who Is the Captain Now?" Lawfare, April 15, 2024; Jonathan Panter and Johnathan Falcone, "The Unplanned Costs of an Unmanned Fleet," *War on the Rocks*, December 28, 2021.\; Gregory V. Cox, "The U.S. Navy's Plans for Unmanned and Autonomous Systems Leave Too Much Unexplained," *War on the Rocks*, December 10, 2021.

> Navy continues to develop the CONOPS? How likely is it, if at all, that the Navy will have to change the performance requirements for these large UVs as a consequence of more fully developing their CONOPS? How do the Navy's acquisition strategies for these large UVs address the possibility that the UVs' performance requirements might need to evolve as the CONOPs are developed?

Acquisition Strategies, Program Risks, Cost Growth, and Schedule Delays

Overview

Another potential oversight issue for Congress concerns

- the acquisition strategies that the Navy wants to use for these programs;
- technical, schedule, and cost risks in these programs, particularly given that these platforms potentially are to operate at sea unmanned and semi-autonomously or autonomously for extended periods of time; and
- cost growth and schedule delays that have occurred in the XLUUV program.

Potential oversight questions for Congress include the following:

- How much technical, schedule, and cost risk of this kind do these programs pose, particularly given the enabling technologies that need to be developed for them?
- Are the Navy's risk-mitigation and risk-management efforts for these programs appropriate and sufficient? Are the Navy's proposed changes to the LUSV's acquisition strategy appropriate and sufficient in terms of complying with Congress's legislative provisions and providing enough time to develop operational concepts and key technologies before entering into serial production of deployable units?
- At what point would technical problems, schedule delays, or cost growth in these programs require a reassessment of the Navy's plan to shift from the current fleet architecture to a more distributed architecture?
- To what degree, if any, can these large UV programs contribute to new approaches for defense acquisition that are intended to respond to the new international security environment?

Navy UVs in General

An April 2022 Government Accountability Office (GAO) report on uncrewed maritime systems (i.e., Navy UVs) stated

> While the Navy's shipbuilding plan outlines spending more than $4 billion on uncrewed systems over the next 5 years, its plan does not account for the full costs to develop and operate these systems.
>
> Once conceived, the Navy must build these vehicles with the information technology and the artificial intelligence capabilities needed to replace crews. While the Navy has established strategic objectives for these efforts, it has not established a management approach that orients its individual uncrewed maritime efforts toward achieving these objectives. As such, the Navy is not measuring its progress, such as building the robust information technology needed to operate the vehicles. GAO has previously found that portfolio management—a disciplined process that ensures new investments are aligned

with an organization's strategic needs within available resources—enables agencies to implement strategic objectives and manage investments collectively. However, if it continues with its current approach, the Navy is less likely to achieve its objectives. In addition, the Navy has yet to:

- establish criteria to evaluate prototypes and
- develop improved schedules for prototype efforts.

With detailed planning, prototyping has the potential to further technology development and reduce acquisition risk before the Navy makes significant investments. Since uncrewed systems are key to the Navy's future, optimizing the prototyping phase of this effort is necessary to efficiently gaining information to support future decisions.[43]

LUSV

A June 2023 GAO report assessing selected major DOD weapon acquisition programs stated the following of the LUSV program:

Current Status

In May 2022, the Navy completed its Offensive Surface Fires Analysis of Alternatives, which LUSV is using to inform its requirements, according to program officials. These officials added that the Navy is making trade-offs between the capabilities the service needs and the capabilities uncrewed surface vehicles can provide in the near future. The Program Executive Office for Unmanned and Small Combatants is currently determining its acquisition strategy.

While determining its requirements and acquisition strategy, the program office plans to receive seven prototypes. To date, the program has received five—two from the Office of Naval Research, two from OSD, and one from the Navy. The Navy plans to deliver the remaining two prototypes in 2023 and 2024.

The Navy is experimenting with these prototypes to understand their capabilities, familiarize sailors with operating them, and determine if LUSV will have any potential critical technologies. The Navy completed over 100,000 nautical miles in autonomous driving with these prototypes. But the prototypes require constant monitoring offshore and hands-on crewing by humans when operating close to shore.

The Navy is working toward a milestone review in 2025, when it plans to transition LUSV to an acquisition program using the major capability acquisition pathway to begin design and development. Subsequently, the Navy plans to begin construction of the first of six production LUSVs in 2027.

In June 2022, we reported that the Navy had yet to develop schedules that would align its uncrewed maritime vehicle prototypes, including LUSV, with key investment decisions. Without a schedule to align these prototype efforts, DOD may make investment decisions for LUSV before attaining adequate knowledge.

Program Office Comment

We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. According to the program office, it took several steps to increase technical maturity, such

[43] Government Accountability Office, *Uncrewed Maritime Systems[:] Navy Should Improve Its Approach to Maximize Early Investments*, GAO-22-104567, April 2022, highlights page.

as demonstrating technologies in an operationally relevant environment, to reduce risk prior to transitioning to an acquisition program.[44]

XLUUV

The June 2023 GAO report assessing selected major DOD weapon acquisition programs stated the following of the XLUUV program:

> **Current Status**
>
> The XLUUV is $242 million, or 64 percent, over its original 2016 cost estimate, although the program reported that the contractor has reached the ceiling price for the fabrication work.
>
> Even though the Navy began the XLUUV project in 2017 to meet an urgent need, the system is on track to be over 3 years late. Navy officials said that the contractor originally planned to deliver one prototype vehicle in December 2020 and five prototype vehicles by the end of 2022. But the contractor now plans to deliver them between March 2024 and August 2024. Changes to the XLUUV to meet Navy requirements combined with challenges stemming from the COVID-19 pandemic account for some of the delays. According to Navy officials, the contractor changed the originally planned battery to meet endurance requirements. As of March 2023, the new battery has yet to be completed. In addition, the Navy has yet to identify XLUUV critical technologies.
>
> To reduce the effect of delays and gain a better understanding of the system, the Navy contracted for an unplanned sixth vehicle for $73 million, which contributed to the program's cost growth. The Navy plans to use this vehicle to test the system while it awaits the delivery of the five originally planned vehicles. However, this prototype vehicle does not have the planned battery or payload module, which is used to carry critical systems or weapons.
>
> The Navy plans to use the major capability acquisition pathway with the intention to purchase more XLUUVs at some point in the next several years. In September 2022, we recommended that the program conduct production readiness reviews prior to additional purchases beyond the six planned XLUUVs; the Navy agreed with our recommendation.
>
> **Program Office Comments**
>
> We provided a draft of this assessment to the program office for review and comment. The program office provided technical comments, which we incorporated where appropriate. The program office stated that it is developing the first-ever autonomous uncrewed diesel-electric submarine. It noted that while the program experienced delays, it is moving faster than a traditional development effort. The program office also acknowledged the need to enhance the supplier base and stated that it is assessing potential critical technologies to inform future procurements.[45]

A September 2022 GAO report on the XLUUV program states

> The Navy is attempting to rapidly deliver five Extra Large Unmanned Undersea Vehicles (XLUUV) to the fleet for deploying undersea mines without the need for sailors. However, the XLUUV effort is at least $242 million or 64 percent over its original cost estimate and at least 3 years late. The contractor originally planned to deliver the first vehicle by December 2020 and all five vehicles by the end of calendar year 2022. The Navy and the

[44] Government Accountability Office, *Weapon Systems Annual Assessment[:] Programs Are Not Consistently Implementing Practices That Can Help Accelerate Acquisitions*, GAO-23-106059, June 2023, p. 170.

[45] Government Accountability Office, *Weapon Systems Annual Assessment[:] Programs Are Not Consistently Implementing Practices That Can Help Accelerate Acquisitions*, GAO-23-106059, June 2023, p. 173.

contractor are in the process of revising the delivery dates. But both expect the contractor to complete and deliver all five vehicles between February and June 2024.

The contractor did not demonstrate its readiness to fabricate XLUUV because it was not required to do so. For acquisition programs, DOD and Navy typically conduct a production readiness review. While XLUUV is a prototype and not an acquisition program, the Navy plans to field the vehicles quickly. Key differences between the XLUUV and the contractor's prototype, the Echo Voyager, required the contractor to redesign critical components. Rather than address issues before starting fabrication, the contractor did not identify the full impact of these issues until after fabrication began. Then, significant delays were exacerbated by the COVID-19 pandemic. Further, the Navy has begun assessing the possibility of adding more capability and vehicles to this effort. If the Navy forgoes a production readiness review for its next XLUUV purchase, it risks beginning fabrication without information to assess the contractor's cost, schedule, and performance targets.

The Navy determined that XLUUV was critical to fulfilling an emergent need, which, under DOD policy, generally requires a capability be provided within 2 years. However, the Navy did not develop a sound business case, including cost and schedule estimates, to ensure that it could deliver the vehicles quickly to the fleet because XLUUV is a research and development effort. According to DOD urgent capability acquisition best practices, an acquiring organization should make cost and schedule trade-off decisions to get solutions to the fleet faster. Without more complete cost and schedule estimates, the Navy does not have the information it needs for decision-making and, thus, could continue experiencing cost overruns and schedule delays as it builds the XLUUV.[46]

Industrial Base Implications

Another oversight issue for Congress concerns the potential industrial base implications of these large UV programs as part of a shift to a more distributed fleet architecture, particularly since UVs like these can be built and maintained by facilities other than the shipyards that currently build the Navy's major combatant ships. Potential oversight questions for Congress include the following:

- What portion of these UVs might be built or maintained by facilities other than shipyards that currently build the Navy's major combatant ships?[47]
- To what degree, if any, might these large UV programs change the current distribution of Navy shipbuilding and maintenance work, and what implications might that have for workloads and employment levels at various production and maintenance facilities?

Potential Implications for Miscalculation or Escalation at Sea

Another oversight issue for Congress concerns the potential implications of large UVs, particularly large USVs, for the chance of miscalculation or escalation in when U.S. Navy forces

[46] Government Accountability Office, *Extra Large Unmanned Undersea Vehicle[:] Navy Needs to Employ Better Management Practices to Ensure Swift Delivery to the Fleet*, GAO-22-105974, highlights page. See also Anthony Capaccio and Julie Johnsson, "US Navy's Giant Underwater 'Orca' Drone Is Running Years Late," *Bloomberg*, June 14, 2022.

[47] For an opinion piece addressing this issue, see Collin Fox, "Distributed Manufacturing for Distributed Lethality," Center for International Maritime Security (CIMSEC), February 26, 2021.

are operating in waters near potential adversaries. Some observers have expressed concern about this issue.[48]

Legislative Activity for FY2024

Summary of Congressional Action on FY2024 Funding Request

Table 1 summarizes congressional action on the Navy's FY2024 funding request for the LUSV, MUSV, and XLUUV programs and their enabling technologies. Funding for UUV core technologies (line 77) develops technologies for various Navy UUVs, including but not limited to XLUUV.

Table 1. Congressional Action on FY2024 Large UV Funding Request

Millions of dollars, rounded to the nearest tenth

		Authorization			Appropriation		
Research and development funding	**Request**	**HASC**	**SASC**	**Enacted**	**HAC**	**SAC**	**Enacted**
PE 0603178N, Large Unmanned Surface Vessels (LUSVs) (line 28)	117.4	117.4	117.4	117.4	113.1	117.4	113.1
PE 0605512N Medium Unmanned Surface Vehicles (MUSVs) (line 93)	85.8	85.8	85.8	74.2	74.2	70.1	149.1
PE 0605513N, Unmanned Surface Vehicle (LUSV/MUSV) Enabling Capabilities (line 94)	176.3	176.3	176.3	172.0	172.0	161.7	161.7
PE 0604536N, Advanced Undersea Prototyping (line 88) [XLUUV]	104.3	104.3	104.3	82.6	82.6	69.7	69.7
PE 0604029N, UUV Core Technologies (line 77)	71.2	71.2	71.2	71.2	75.2	67.2	71.2

Sources: Table prepared by CRS based on FY2024 Navy budget submission and committee and conference reports and explanatory statements on the FY2024 National Defense Authorization Act and the FY2024 DOD Appropriations Act.

Notes: PE is program element (i.e., a line item in a DOD research and development account). **HASC** is House Armed Services Committee; **SASC** is Senate Armed Services Committee; **HAC** is House Appropriations Committee; **SAC** is Senate Appropriations Committee. Funding for UUV core technologies (line 77) develops technologies for various Navy UUVs, including but not limited to XLUUV.

[48] See, for example, Jonathan Panter, "Naval Escalation in an Unmanned Context," Center for International maritime Security (CIMSEC), April 26, 2023; David Axe, "Autonomous Navies Could Make War More Likely," *National Interest*, August 17, 2020; David B. Larter, "The US Navy Says It's Doing Its Best to Avoid a 'Terminator' Scenario in Quest for Autonomous Weapons," *Defense News*, September 12, 2019; Evan Karlik, "US-China Tensions—Unmanned Military Craft Raise Risk of War," *Nikkei Asian Review*, June 28, 2019. See also Thomas Shugart, "Uncrewed But Confident: Forging New Rules of the Road to Avoid Accidental Escalation," *War on the Rocks*, May 1, 2024; Thomas Shugart, *Autonomy and International Stability: Confidence-Building Measures for Uncrewed Systems in the Indo-Pacific*, Center for a New American Security (CNAS), March 2024, 27 pp.; *Impact of Unmanned Systems to Escalation Dynamics*, Center for Naval Analyses (CNA), undated, 2 pp (summary of a longer CNA report; includes a reference to "near-term unmanned systems (2017-2025)").

FY2024 National Defense Authorization Act (H.R. 2670/S. 2226/P.L. 118-31)

House

The House Armed Services Committee, in its report (H.Rept. 118-125 of June 30, 2023) on H.R. 2670, recommended the funding levels shown in the HASC column of **Table 1**.

H.Rept. 118-125 states

> *Briefing on lessons learned from the demonstration of Unmanned Surface Vessels supporting Fifth Fleet*
>
> Advances in unmanned surface vessel technologies have allowed for new concepts of operation particularly in lower-end maritime security missions. The committee recognizes Task Force 59's successful demonstration of autonomous vessels during the Digital Horizon exercise in support of the Fifth Fleet in the U.S. Central Command area of operations for various maritime security applications. The committee similarly recognizes the successes of the Overlord program in demonstrating and prototyping additional unmanned capabilities. The committee remains interested in the Navy's plans to incorporate lessons learned from these integration and experimentation efforts into the fleet. Specifically, the committee is interested in understanding the Navy's plan to further develop integration of autonomous surface vessels based on the findings from the demonstrations and experiments conducted in support of U.S. Central Command.
>
> Therefore, the committee directs the Chief of Naval Operations to submit a report to the congressional defense committees not later than March 31, 2024, on the increased utilization of Medium Unmanned Surface Vessels (MUSVs) and Small Unmanned Surface Vessels (SUSVs) to address gaps in lower-end maritime security missions. The report shall include:
>
> (1) information on future vessel capabilities or requirements;
>
> (2) planned acquisition strategies for additional MUS[V]s and SUS[V]s;
>
> (3) strategies for integrating data management and visualization tools at scale; and
>
> (4) future demonstration efforts. (Pages 50-51)

Senate

The Senate Armed Services Committee, in its report (S.Rept. 118-58 of July 12, 2023) on S. 2226, recommended the funding levels shown in the SASC column of **Table 1**.

Enacted

The conference report (H.Rept. 118-301 of December 6, 2023) on H.R. 2670/P.L. 118-31 of December 22, 2023, recommended the funding levels shown in the authorization enacted column of **Table 1**. The recommended reduction of $11.552 million for line 93 is for "Program delays," the recommended reduction of $4.281 million for line 94 is for "Prior year underexecution," and the recommended reduction of $21.725 million for line 88 is for "Program delays." (Page 1453)

FY2024 DOD Appropriations Act (H.R. 4365/S. 2587/Division A of H.R. 2882/P.L. 118-47)

House

The House Appropriations Committee, in its report (H.Rept. 118-121 of June 27, 2023) on H.R. 4365, recommended the funding levels shown in the HAC column of **Table 1**.

The recommended reduction of $4.320 million for line 28 is for "Prior year underexecution." (Page 204)

The recommended reduction of $11.552 million for line 93 is for "Program delays." (Page 207)

The recommended reduction of $4.281 million for line 94 is for "Prior year underexecution." (Page 207)

The recommended reduction of $21.725 million for line 88 is for "Program delays." (Page 207)

The recommended increase of $4.0 million is for "Program increase—tactical data links and networks." (Page 206)

Senate

The Senate Appropriations Committee, in its report (S.Rept. 118-81 of July 27, 2023) on S. 2587, recommended the funding levels shown in the SAC column of **Table 1**.

The recommended reduction of $15.670 million for line 93 is for "MUSV prototype delays" ($3.918 million), "MUSV requirements development excess to need" ($4.7 million), and "Dock and sea trials ahead of need" ($7.052 million). (Page 212)

The recommended reduction of $14.549 million for line 94 is for "Overestimation of product development" ($7.0 million) and "Overestimation of support and management" ($7.549 million). (Page 212)

The recommended reduction of $69.7 million for line 88 is for "Basing equipment ahead of need" ($20.7 million), "XLUUV spares maintenance ahead of need" ($3.338 million), and "DT&E [developmental test and evaluation] ahead of need" (10.567 million). (Page 212)

The recommended net reduction of $4.0 million for line 77 includes recommended reduction of $14.0 million for "Prior year carryover" and a recommended transfer into line 77 of $10.0 million from line 69 in the Defense Wide research and development for "AUKUS innovation initiatives."[49] (Page 212)

S.Rept. 118-81 states

> *Open Autonomous Underwater Vehicle Software Architecture.*—The Committee notes the significant proposed Navy investment to develop and acquire a variety of unmanned surface vehicles [USVs] and unmanned undersea vehicles [UUVs] as part of an effort to shift the Navy to a more distributed fleet architecture. The fiscal year 2024 President's budget request contains more than $867,117,000 in research, development, test and evaluation funding in fiscal year 2024 and $4,409,700,000 in the Future Years Defense

[49] AUKUS is a trilateral arrangement for enhanced security cooperation announced in September 2021 by the governments of Australia, the UK, and the United States. The effort includes, among other things, enhanced cooperation on certain military technologies. For more on technology cooperation under AUKUS, see CRS Report R47599, *AUKUS Pillar 2: Background and Issues for Congress*, by Patrick Parrish and Luke A. Nicastro.

> Program for the development and procurement of such systems. The Committee is concerned that despite this and previous significant investments, the request also reflects significant programmatic setbacks for many of these same systems and technologies, including: the truncation of the Barracuda UUV, pausing the Knifefish UUV program prior to production, the cancelation of the Snakehead UUV program, delivery delays for the first Medium USV, and ongoing additional requirements definition for the Large USV. Further, the Committee notes that the Extra Large UUV [XLUUV] program, which is supposed to deliver five XLUUVs to the fleet, is at least $242,000,000 or 64 percent over its original cost estimate and over 3 years late.
>
> In contrast, the Committee is also aware that the Navy's Anguilla Large UUV program is using a fundamentally different development approach from other Navy USVs and UUVs. This program is executing on time and on budget and reached mission capable status only 4 years after its initial design review. This approach is known as the Open Autonomous Underwater Vehicle [OpenAUV] software architecture, which features the payload controller extensible [PCX] modular open architecture. While recognizing each vehicle will require a tailored approach, the Committee believes that establishing the OpenAUV and PCX architectures as the Navy technical standard for UUVs and USVs would enable greater speed and flexibility in fielding, upgrading, modifying, and sustaining these vehicles for a range of missions. In addition, broader adoption of the OpenAUV architecture would enable greater commercial participation and competition opportunities through the lifecycle of a USV or UUV platform. The Committee is encouraged that the Navy recognizes the potential utility of broader OpenAUV applicability based on the successful integration of the OpenAUV architecture on one Razorback UUV.
>
> Therefore, the Committee directs the Secretary of the Navy to assess the feasibility and advisability of: establishing the OpenAUV and PCX architectures as the Navy standard for UUVs and USVs; accelerating OpenAUV integration on more Razorback UUVs; requiring USV and UUV program managers to review Navy's OpenAUV lessons learned, incorporate best practices, and engage in technical exchanges with performers; implementing OpenAUV on Snakehead UUVs; and maximizing full-and-open competition on UUV and USV solicitations with OpenAUV architectures prescribed. The Secretary is directed to submit this assessment to the congressional defense committees not later than 120 days after the date of enactment of this act. (Pages 214-215)

Enacted

The explanatory statement for Division A of H.R. 2882/P.L. 118-47 of March 23, 2024, provides the funding levels in the appropriation enacted column of **Table 1**.

The reduction of $4.32 million for line 28 is for "Prior year underexecution" (PDF page 211 of 314).

The net reduction of $63.33 million for line 93 includes a reduction of $3.918 million for "MUSV prototype delays," a reduction of $4.7 million for "MUSV requirements development excess to need," a reduction of $7.052 million for "Dock and sea trials ahead of need," and an increase of $79.0 million for "Program increase" (PDF page 215 of 314).

The reduction of $14.549 million includes a reduction of $7.0 million for "Overestimation of product development," and a reduction of $7.549 million for "Overestimation of support and management" (PDF page 215 of 314).

The reduction of $34.605 million for line 88 includes a reduction of $20.7 million for "Basing equipment ahead of need," a reduction of $3.338 million for "XLUUV spares maintenance ahead of need," and a reduction of $10.567 million for "DT&E [developmental test and evaluation] ahead of need" (PDF page 214 of 314).

The net unchanged amount for line 77 includes a reduction of $4.0 million for "Prior year carryover" and an increase of $4.0 million for "Program increase—tactical data links and networks" (PDF page 214 of 314).

The explanatory statement states

> OPEN AUTONOMOUS UNDERWATER VEHICLE SOFTWARE ARCHITECTURE
>
> The agreement directs the Secretary of the Navy to assess the feasibility and advisability of: (1) establishing one or more government-reference open-system architecture standards, such as the OpenAUV and PCX architectures, and/or commercial open-system architecture standards as the Navy standard or standards for Unmanned Underwater Vehicles (UUVs) and Unmanned Surface Vessels (USVs); (2) accelerating such standard or standards on Razorback and Snakehead UUVs; (3) maximizing full-and-open competition on UUV and USV solicitations with such standard or standards prescribed; and (4) requiring USV and UUV program managers to review Navy's OpenAUV lessons learned, incorporate best practices, and engage in technical exchanges with the performers. The Secretary is directed to submit this assessment to the congressional defense committees not later than 120 days after the enactment of this Act. (PDF page 222 of 314)

Legislative Activity for FY2025

Summary of Congressional Action on FY2025 Funding Request

Table 1 summarizes congressional action on the Navy's FY2025 funding request for the LUSV, MUSV, and XLUUV programs and their enabling technologies. Funding for UUV core technologies (line 77) develops technologies for various Navy UUVs, including but not limited to XLUUV.

Table 2. Congressional Action on FY2025 Large UV Funding Request

Millions of dollars, rounded to the nearest tenth

		Authorization			Appropriation		
Research and development funding	**Request**	**HASC**	**SASC**	**Enacted**	**HAC**	**SAC**	**Enacted**
PE 0603178N, Large Unmanned Surface Vessels (LUSVs) (line 28)	54.0						
PE 0605512N Medium Unmanned Surface Vehicles (MUSVs) (line 94)	101.8						
PE 0605513N, Unmanned Surface Vehicle (LUSV/MUSV) Enabling Capabilities (line 95)	92.9						
PE 0604536N, Advanced Undersea Prototyping (line 89) [XLUUV]	21.5						
PE 0604029N, UUV Core Technologies (line 77)	68.2						

Sources: Table prepared by CRS based on FY2025 Navy budget submission and committee and conference reports and explanatory statements on the FY2025 National Defense Authorization Act and the FY2025 DOD Appropriations Act.

Notes: PE is program element (i.e., a line item in a DOD research and development account). **HASC** is House Armed Services Committee; **SASC** is Senate Armed Services Committee; **HAC** is House Appropriations

Committee; **SAC** is Senate Appropriations Committee. Funding for UUV core technologies (line 77) develops technologies for various Navy UUVs, including but not limited to XLUUV.

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