

NOAA Uncrewed Systems

Maximizing Value for Science-based Mission Support

Strategic Plan 2021-2025



**National Oceanic and
Atmospheric Administration**
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NOAA Science & Technology Focus Areas:

Uncrewed Systems ■ Artificial Intelligence ■ 'Omics ■ Cloud ■ Citizen Science ■ Data



NOAA Uncrewed Systems Strategic Plan

Maximizing Value for Science-based Mission Support

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Introduction

The National Oceanic and Atmospheric Administration (NOAA) Uncrewed Systems (UxS) Plan presents a notional five-year plan (2021-2025) for coordinating and expanding NOAA's uncrewed aircraft and marine systems (together "uncrewed systems" or "UxS")¹ operations across the agency. This plan - dependent on the availability of resources - describes how NOAA will bring together the different UxS components across the organization into relationships that will maximize, and in some cases expand the collection and utilization of critical, high accuracy, and time-sensitive data by increasing the application and use of uncrewed aircraft and marine systems to improve the quality and timeliness of NOAA science, products, and services.

This plan builds on the framework presented in the NOAA Uncrewed Systems Strategy of five overarching goals with corresponding objectives to specify a deliberate and transparent approach to strengthening and centralizing key support functions, expanding UxS applications across NOAA's mission portfolio, sustaining research and accelerating the transition of research to operations, expanding partnerships, and increasing workforce proficiency in UxS use and operations. Of particular importance is increasing NOAA's capacity for operational use of UxS, applications of airborne and maritime platforms that sustainably support on-going mission priorities such as hydrographic surveying, acoustic fish stock assessment, collection of data needed for management of commercial fisheries and conservation and recovery of protected species, making critical environmental observations, and weather forecasting.

The UxS Plan is informed by inputs received from two virtual workshops. The NOAA UxS Workshop, May 19-21, 2020 included over 60 subject matter experts from NOAA who provided more than 600 comments and suggestions on implementing the NOAA UxS Strategy. From August 4-6, 2020, the Consortium for Ocean Leadership (COL) convened over 125 stakeholders and experts for a UxS community workshop to provide input to NOAA and to identify opportunities for collaboration between NOAA and industry, academia, nonprofit organizations, and other federal agencies. Feedback from both workshops significantly influenced the final content of the plan.

This Plan uses the same approach that has guided NOAA to the initiation of using UxS technology in its operations and research during the past 20 years. NOAA will build on this success by increasing efforts to transition the most promising UxS platforms to operations and will capitalize on UxS technology to assist NOAA missions where technically feasible and beneficial. This plan does not recommend consolidating all of NOAA's UxS-

NOAA Uncrewed Systems Goals

Goal 1: Coordinate and Support UxS Operations at an Enterprise Level.

Goal 2: Expand UxS Applications Across NOAA's Mission Portfolio.

Goal 3: Accelerate Transition of UxS Research to Applications.

Goal 4: Strengthen and Expand UxS Partnerships.

Goal 5: Promote Workforce Proficiency in UxS Use and Operations.

related funding to be managed by one line office or program. Rather, the Office of Marine and Aviation Operations (OMAO) will leverage the fiscal year (FY) 2021 appropriations of \$13.7million to continue providing centralized UxS coordination, support, and guidance for UxS across NOAA. This plan describes a scalable funding model to use available resources and accommodate any increased funding to further evaluate emerging technologies, manage uncrewed systems acquisitions, and determine cost-effective opportunities to carry out NOAA mission-critical activities. The future scope of NOAA's UxS coordinated enterprise will depend on the level of future resources available for sustainable UxS research and operations across NOAA. This plan provides details on activities that will contribute to the achievement of each goal and objective. NOAA uses both a centralized and de-centralized structure to conduct research and development, and transition successful technologies into operations, applications, commercialization, and other uses. Research and development is funded and conducted within individual line offices and by NOAA's corporate research and development office within the Office of Atmospheric Research (OAR). NOAA has just begun to benefit from this approach, but much research and development is needed to transition fully the ever-changing UxS technologies into full operational activities. This plan will be evaluated and revised as necessary to consider new developments and challenges. Elements of the plan may be adapted, and new actions or objectives may be added as appropriate.

¹ Uncrewed systems are vehicles—airial, terrestrial, or marine—and associated elements, such as sensors and communications software, that can execute data-collection missions without a human presence aboard. They are typically controllable or programmable, self-powered, untethered, and operate on a continuum from attended to fully autonomous. This strategy also includes Remotely Operated Vehicles which are typically deployed from ships and receive power and operator instructions from a tether.

Goal 1: Coordinate and Support UxS Operations at an Enterprise Level

Achieving increased UxS value and use across NOAA will require improved coordination and support of UxS operations at the enterprise level. To ensure this goal is met, the implementation of the UxS Strategic Plan will be overseen by NOAA's UxS Executive Oversight Board (EOB), a supporting oversight board for the NOAA Fleet Council. The UxS EOB will provide executive oversight and accountability of all UxS activities in NOAA and assure that agency-wide strategies and initiatives are developed collaboratively and implemented consistently. Additionally, the EOB will develop and recommend appropriate policies and procedures for consideration and approval by NOAA leadership.

Objective 1.1: Establish an Effective and Adaptive Organizational Structure.

Successful implementation of the NOAA UxS Strategic Plan will depend on the close coordination between the EOB and the line offices. Additionally, central to an effective and adaptive organizational structure is the establishment of the Uncrewed Systems Operations Center (UxSOC) managed by NOAA's Office of Marine and Aviation Operations (OMAO) that centralizes support and coordinates UxS operations across NOAA. This organizational structure will allow NOAA to meet its mission priorities and effectively operate UxS in a way that minimizes risk, leverages capabilities, capitalizes on partnerships, streamlines corporate UxS functions, and ensures safety, security, and stewardship requirements are met. Additionally, OAR will continue developing its Office of Research, Transition, and Applications to support and coordinate NOAA's research and development activities and participation in the EOB. This organizational model is consistent with legislative direction in the Commercial

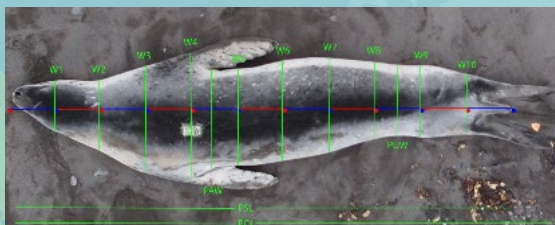
Engagement Through Ocean Technology (CENOTE) Act of 2018, P.L. 115-394, requiring NOAA to coordinate uncrewed maritime system (UMS) assessment and acquisition with the US Navy and others.

Current activities, contingent on available resources, and anticipated for completion in FY 2021 and FY 2022 include: the hiring of dedicated staff to establish core functions, expanding the unmanned aerial systems (UAS) facilities in Lakeland, Florida co-located with OMAO's Aircraft Operations Center, establishing and staffing initial capabilities for an UMS operations and training facility in Gulfport, Mississippi in partnership with OAR, National Environmental Satellite, Data, and Information Service/National Centers for Environmental Information, the state of Mississippi, and the and US Navy; creating a team at OMAO's Marine Operations Center in Newport, Oregon to coordinate intersections between UMS and ship-based activities, adding a UxS module to NOAA's Prioritization, Allocation and Scheduling System (PASS) software to facilitate the annual provisioning of NOAA UxS platforms to support priority missions; and establishing an Autonomous/Uncrewed Systems Research, Development, and Engineering program in OAR, serving the needs of all line offices.

Activities that will contribute to this objective include:

- Review governance structures to ensure appropriate and adequate processes, participants and responsibilities exist for policy formulation, oversight, and execution of the UxS program. Provide recommendations to strengthen or improve as needed.
- Develop UxS Handbook to provide a framework for the safe and efficient operation of UxS operated or sponsored by NOAA.
- Provide standard operating procedures for UxS platforms that have transitioned to operations.

Using UAS to Monitor Protected Species



NOAA's National Marine Fisheries Services (NMFS) uses small UAS to monitor protected species including North Atlantic right whales, Steller sea lions, and Cook Inlet beluga whales. UAS advantages over low altitude manned missions include reduced wildlife disturbance, lower risk, and, in many cases, lower costs. NMFS is also evaluating the use of on-board artificial intelligence, and data processing to improve products for decision makers.

<https://www.fisheries.noaa.gov/about/office-protected-resources>



Objective 1.2: Deliver Priority Core Services Including Cybersecurity, Training, and Acquisition.

NOAA has a responsibility to provide its employees, contractors, and stakeholders, with a safe and efficient data acquisition model, regardless of the platform. While NOAA has a long history of working with UxS platforms, so does its federal, industry, and academic partners. By leveraging interagency partnerships in accordance with CENOTE, NOAA can evaluate existing models and policies to strengthen its UxS infrastructure; improve training and certification, safety of operations, quality and security of data and efficiency of data collection; clarify governance; and enhance operations. NOAA will incorporate a data acquisition strategy, starting with establishing prioritized, agency-wide data needs, identifying efficient UxS-supported operations, ensuring UxS-acquired data is appropriately archived in NOAA-supported archives, and establishing NOAA's UxS data standards.

Activities that will contribute to this objective include:

- Clarify roles and responsibilities at NOAA for making cyber-related policy decisions to ensure the integrity and security of NOAA missions and compliance with federal regulations for cybersecurity.
- Implement updated standards, guidelines, and best practices for continuous improvement in NOAA's overall cybersecurity.
- Provide training for UxS operators and key stakeholders to ensure regulatory compliance and to increase UxS capabilities and proficiencies. Training protocols will be documented in the emerging UxS Handbook.
- Review acquisition protocols for UxS platforms and related services to establish standard acquisition protocols and accelerate contract timelines for UxS platforms, including related services such data buys. Consider developing centralized procurement vehicles for pre-approved platforms to simplify purchasing the most popular or widely-used airborne and maritime systems used by multiple components of NOAA.

Objective 1.3: Implement an Innovative, Robust, and Encompassing UxS Data Enterprise.

Successfully establishing an effective UxS data enterprise is central to NOAA's strategy for UxS. While some actions are underway, and some progress is expected on all tasks, fully developing, and executing this suite of actions is contingent on available resources. A key factor is the rapidly expanding volume of data produced by increasingly capable UxS platforms and sensors. Emerging NOAA agreements on Big Data and the alignment with other NOAA Science and Technology (S&T) strategies (Data, Cloud, 'Omics, Artificial Intelligence, Citizen Science) will also be critical for the UxS data enterprise.

Activities that will contribute to this objective include:

- Establish standards for UxS data structures, formats, documentation, and data exchange protocols.

- Define specific quality assurance and quality control protocols to improve and strengthen the overall integrity of UxS observations and measurements.
- Improve access to and use of data from partners providing mission support.
- Establish a data management system that integrates research and performance data to enable better transition decision-making.

Goal 2: Expand UxS Applications Across NOAA's Mission Portfolio

To ensure strategic investments in UxS applications, Goal 2 objectives rely on the prioritization and support and implementation of UxS activities that will be transitioned into operational capabilities across NOAA missions via an interdisciplinary approach. Priority will be given to activities most closely linked to NOAA mission and line office strategies, those that meet multiple NOAA mission objectives, and those that have proven to or have the potential to improve assessments, forecasts, predictions, and projections of critical features and processes related to weather, ecosystems, fisheries, protected resources, climate, and extreme events. The objectives and associated activities support a mission-driven prioritization approach that also will enable NOAA to make informed decisions on UxS platforms regarding owning and operating vs contracting for operations and data acquisition.

Objective 2.1: Establish a Requirements-Based Process to Prioritize UxS Operational Applications.

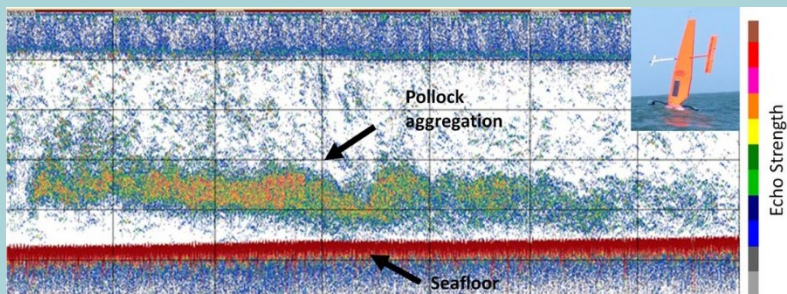
To ensure strategic investments in UxS applications, NOAA must establish a link between agency requirements and UxS capabilities across NOAA missions. With this assessment, NOAA can make more informed decisions and establish priorities across the agency on how best to invest funding and other resources on UxS activities.

Activities that will contribute to this objective include:

- Assess applications of UxS to NOAA priorities as part of a holistic observational system; identify where UxS can, or have potential to, serve as the primary data collection tool and where they serve as a force multiplier.
- Evaluate NOAA's mission areas and requirements to identify and document data and observational gaps that could be fulfilled by using UxS.
- Create an inventory/database of UxS NOAA currently has access to and those that are available through other agencies, academic institutions, and industry to set and/or guide determining priorities and inform UxS acquisition decisions.

USV's survey the nation's largest fishery during an unprecedented pandemic.

The COVID-19 pandemic resulted in cancellation of many of NOAA's Spring ship-based science operations, including the annual survey of Alaskan Pollock, the largest U.S. commercial fishery by volume. NOAA's Alaska Fisheries Science Center and Pacific Marine Environmental Laboratory quickly pivoted to an uncrewed option, partnering with Kongsberg and Saildrone to instrument and launch three USVs from California to the Bering Sea to conduct acoustic surveys of Pollock abundance (Saildrone acoustic sounding of Pollock aggregation is illustrated) - a round trip journey of 5,900 miles. Though less precise than ship-based surveys, in part because fish samples are not collected, USV surveys in Alaska are well tested and validated. The 2020 USV data are being combined with historic data from NOAA ship surveys and incorporated into Pollock stock assessment models.



<https://www.saildrone.com/news/usv-complete-milestone-alaska-pollock-survey>

Objective 2.2: Establish a Thriving UxS Community of Practice at NOAA.

Efficiently expanding the innovative use of UxS across NOAA's earth science missions will require the development and implementation of common policies, procedures, and regulations, and transparency and knowledge sharing of lessons learned. By ensuring that field methods, research approaches, and analytical successes and failures are shared broadly within the UxS community, NOAA will transition more combinations of platforms and missions to operations. Additionally, while an agency-wide coordinated UxS strategy will be led by OMAO in concert with the EOB, the line offices will continue to fund specific UxS operations and research projects as part of a larger NOAA UxS enterprise. By maintaining a repository of all NOAA-funded UxS missions, the agency can have a better understanding of the overall UxS-related costs. A consolidated financial tracking system will also provide NOAA with the data to produce cost-benefit analyses of UxS compared to other operations and help quantify economic impacts within the UxS sector.

Activities that will contribute to this objective include:

- Develop enterprise-wide financial solutions for maximizing industry contracts and serve as a portal for industry partners interested in developing agency-wide contracts that could serve multiple line offices or programs.
- Expand communication outreach and establish a repository with guidelines, best practices, and progress reports to enhance the UxS Community of Practice for sharing of research, lessons learned, and innovations.

- Develop a financial tracking system for UxS acquisition and operational costs.
- Develop and maintain a directory of UxS experts to periodically identify "best fit" adaptable platforms for NOAA scientific and operational needs.
- Collaborate with regulators, formulate streamlined procedures to improve the use of UxS during emergencies and/or extreme events.
- Implement technical exchanges, including case studies and lessons learned with other government, academic, and industry UxS operators to strengthen testing and evaluation methods.
- Work with line offices to conduct field projects throughout the transition to operations process. The level of direct UxSOC involvement will depend on the complexity of the UxS project.

Objective 2.3: Institutionalize Operational Applications Through Formal Concepts of Operations.

The UxSOC within OMAO will support the expanding use of UxS across the agency. The UxSOC will provide centralized support of UxS field operations and improve coordination of UxS operations and activities across NOAA. This effort will provide higher quality, cost-effective services for key operations that will result in higher operational performance and safety than any individual NOAA office or program can provide individually. Integral to this UxS program are formal concepts of operations (CONOPS) which ensure NOAA assets are operated in a safe and secure manner.

Activities that will contribute to this objective include:

- Develop and implement CONOPS for a range of technologies and scenarios including, but not limited to, the launch and recovery of various classes and designs of UAS from NOAA ships (including uncrewed hydrographic survey launches), for UAS operations beyond visual line of sight (BVLOS) operations in remote areas and for UMS operations to ensure compliance with relevant policies, regulations, and operational requirements to streamline future operations.
- Develop metrics for testing and evaluation to improve operational performance, cost-effectiveness, and safety of NOAA's UxS operations.

Goal 3: Accelerate Transition of UxS Research to Operations

This goal will accelerate the transition of new and emerging UxS technologies to operational use, matching and meeting operational requirements with capabilities. The foundation for accomplishing this goal requires following the procedures outline in NOAA Administrative Order (NAO) 216-105B, an identification of the requirements for UxS across NOAA, and adequate funding within line offices, the Office of Research, Transitions and Applications in OAR, and for the operations and maintenance of the operating entities. This approach preserves a dedicated research domain of UxS that enables NOAA to independently explore multiple candidate paths to operations via demonstrations and pilots, prize competitions, use of other transactional authority (OTA) for specific priority tests, cooperative research and development agreements (CRADA), and other means that support experimentation and innovation. Transition to operations for many projects will require end-to-end innovations and advances in designing and conducting field operations, data processing and management, and data analyses needed for products to meet agency mission requirements.

Objective 3.1: Identify and Prioritize Candidate UxS Platforms for NOAA Use.

Within NOAA, transitioning to new and emerging UxS technologies for operational use requires collaboration on research efforts to identify, prioritize and incrementally test platforms and instruments (i.e., sensors, payloads, software, communications) and evaluate various modes of operations (i.e., safety, launch/recovery, training, maintenance) to optimize the safe, effective, and sustainable application of UxS to NOAA mission priorities. Successful transition of research to operations will center around developing ideas, concepts, and then specific agreed-on transition plans. These efforts are best served with identified resources for research and operations to incrementally refine technologies (e.g., sensors, payloads, software, communications, etc.), operations (safety, launch/recovery, training, maintenance) and analytical methods to ensure the effective application of UxS platforms to NOAA mission priorities. Meeting this objective of this goal will also inform and define an agile business model for acquisition and operations (e.g., lease vs buy, etc.).

Activities that will contribute to this objective include:

- Establish a decision process and criteria for selecting and prioritizing UxS platforms - including payloads, sensors, software, and data workflows - for NOAA use.
- Conduct mission impact assessments for high priority NOAA programs and identify potential alternative technology/platform sources.
- Begin expanding UxS research activities - including payloads, sensors, software and data workflows - across NOAA's research centers, to grow expertise and identify "fit for function" UxS platforms that can support NOAA requirements.
- Prepare transition plans (pursuant to NAO 216-105B) as early as possible during UxS research and development efforts to meet NOAA operational requirements.
- Expand the range and diversity of innovative technologies potentially applicable to NOAA observing systems. Advocate and screen ideas to measure potential impacts, evaluate partnerships, make recommendations, etc.
- Support research-oriented technology development and demonstration of UxS components (power systems, sensor deployment, platform innovation, relevant software/artificial intelligence/machine learning improvements) in relevant UxS platforms and environments and in support of all NOAA line office missions.
- Advocate for and conduct regular participatory conceptualization meetings (idea-thons) to be attended by NOAA and Cooperative Institute engineers, scientists with observational needs, and external partners as appropriate.

Objective 3.2: Develop Transition Plans with Operational Partners.

NOAA will use NAO 216-105B as the basis for transitioning and coordinating research and development output to operations, applications, and commercialization for UxS across NOAA. Transition plans will be developed as early as possible to reflect the relationship between research and development and NOAA's mission and the commitment by the entities involved in the potential transition of the research and development. Prompt transition also requires adequate funding within the line offices for the operations and maintenance of the operating entities.

Activities that will contribute to this objective include:

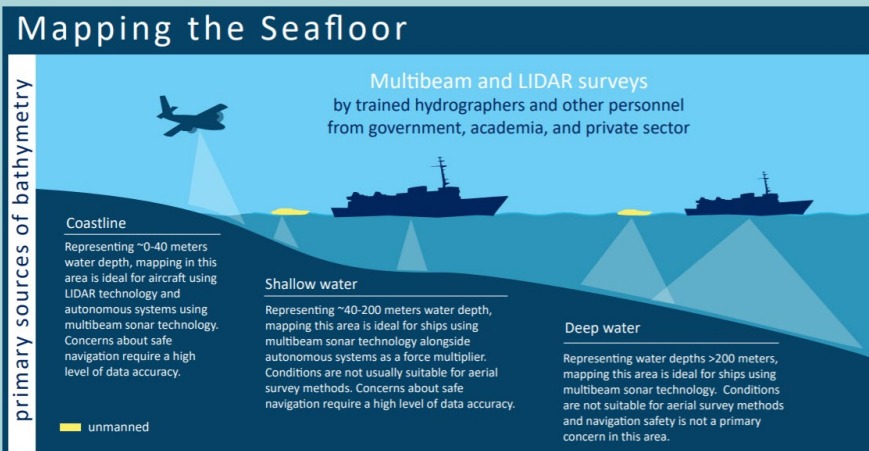
- Establish the criteria that trigger a UxS transition plan to help identify when a plan is needed.
- Based on NAO 216-105B, develop a template for a transition plan. Share existing, high-quality transition plans with the NOAA UxS community as a model for future plans.
- Identify existing and emerging commercial UxS platforms and associated operational concepts with significant potential for operational use in support of NOAA missions, and to accelerate their transition and regular utilization in NOAA.

National Strategy for Mapping, Exploring, and Characterizing the U.S. EEZ

The Presidential Memorandum on Ocean Mapping of the US Exclusive Economic Zone and the Shoreline and Nearshore of Alaska was signed in November 2019 in recognition of the value of mapping, exploration and characterization to enhance our future prosperity, health and national security.

The supporting National Strategy for this initiative was published in June 2020 and a detailed implementation plan was published in December 2020. Mapping, exploring, and characterizing the United States EEZ will be a multi-year endeavor and require the use of new technologies including UxS to increase the scope, pace, and efficiency of mapping and sampling this extremely large area.

<https://www.whitehouse.gov/presidential-actions/memorandum-ocean-mapping-united-states-exclusive-economic-zone-shoreline-nearshore-alaska/>



- Strengthen NOAA UxS community collaborations and cooperation in the research, development, and transition of UxS technology to operations and applications through engagement with NOAA Cooperative Institutes, Integrated Ocean Observing System (IOOS) Regional Associations, Sea Grant institutions, industry, military, academia, NOAA Federal Advisory Committee Act entities, NOAA Regional Collaboration teams, technical conferences and symposia, trade association meetings and other forums to maintain and grow networks and communications to facilitate transition decision-making.

Objective 3.3: Conduct Systematic Testing and Evaluation to Ensure High Performance.

Using systematic testing and evaluation procedures, NOAA can determine how well the UxS platform meets NOAA's scientific objectives and operational requirements. Research pilot missions are a mechanism that NOAA can use to assess private sector applications for meeting NOAA requirements for systems and data, instrument hosting, research and development, and operations.

Activities that will contribute to this objective include:

- Develop guidance on testing and evaluation procedures, including a data repository and a catalog of best practices to better inform future missions and increase reliability.
- Apply testing and evaluation metrics to help establish baseline measures for evaluating operational performance, cost-effectiveness, and safety.
- Initiate research pilot missions applying testing and evaluation procedures to determine how well the most promising UxS platforms meet NOAA scientific objectives and operational requirements.

Goal 4: Strengthen and Expand UxS Partnerships

Stronger partnerships that directly support NOAA's mission will enable NOAA to accelerate the use of UxS across its mission portfolio. The objectives of this goal support an expanding culture of collaboration across academic, industry, and government sectors through CENOTE, the National Oceanographic Partnership Program, and other vehicles that will open new opportunities for sharing technologies, facilities, and personnel in applications that support NOAA's mission.

Objective 4.1: Increasingly Leverage Interagency Integration.

As the speed of innovation continues to increase, NOAA will depend on partnership models that clearly define goals, roles, and responsibilities by means such as CRADAs, OTA, small business innovative research (SBIR) programs, indefinite delivery, indefinite quantity (IDIQ) contracts, and NOAA cooperative institutes. The scope and breadth of these new partnerships will provide the vital accelerator for UxS at NOAA.

Activities that will contribute to this objective include:

- Identify capability gaps in UxS operations to help prioritize and leverage federal, private sector industries, academia, non-governmental organizations, and state and tribal governments.
- Monitor emerging UxS acquisition improvements and document lessons learned to ensure effective and sustainable outcomes.
- To the extent possible, collaborate on the completion of updated and improved UAS regulations with the Federal Aviation Administration (FAA) and other agencies to meet the rapidly

expanding use of UxS supporting NOAA mission priorities, including updated and improved international and inland navigational rules.

- Establish and maintain a repository of partnership best practices, existing agreements and agreement options, mechanisms, and vehicles to increase awareness of opportunities and initiate effective UxS interagency, academic, and private sector partnerships.
- Continue collaborating with the U.S. Coast Guard (USCG) and other agencies on updated international and inland navigational rules (codified via the Convention on the International Regulations for Preventing Collisions at SEA (COLREGs) and USCG's Inland Navigational Rules) to meet the rapidly expanding use of UMS. This action also aligns with the January 2021 S&T Memorandum of Understanding between NOAA and the U.S. Department of Homeland Security (DHS) that provides a strong foundation for these collaborations.

Objective 4.2: Strengthen Collaboration with Academia.

Strengthening collaboration with academia will allow NOAA to increase opportunities for research and development, provide relevant training in UxS as part of formal degree programs, facilitate the commercialization of UxS through public-private partnerships that include academic research institutions, facilitate engagement with other academic institutions with interest or relevant expertise in UxS and promote information sharing between academic, environmental, and military institutions to lead to more robust, mission-oriented uncrewed systems. Also, in support of this

objective and as described in CENOTE, NOAA may elect to co-locate operations or research activities with academic partners to share best practices, conduct joint training, or facilitate commercialization of uncrewed marine system technologies.

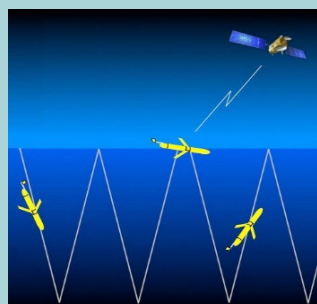
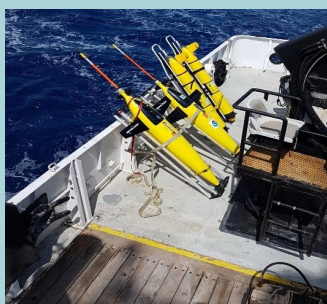
Activities that will contribute to this objective include:

- Identify mission-critical research and operational gaps that can be addressed through academic partnerships to develop innovative UxS technology solutions.
- Enhance existing and create new academic partnerships to accelerate, develop, and commercialize innovative technology solutions.

Objective 4.3: Reinforce NOAA's Growing Partnerships with the Private Sector.

Public-private partnerships offer advantages for researching, designing, and building UxS. CENOTE states that NOAA may coordinate and co-locate with an academic research institution, or consortium of academic research institutions, for "Facilitating the commercialization of unmanned maritime systems through public-private partnerships that include academic research institutions, private industry, and public safety agencies." As NOAA grows its partnership use, it will also evaluate each relationship's risks and benefits, and adjust as needed to ensure that NOAA's goals are met effectively and efficiently.

Underwater ocean gliders supporting hurricane forecasting



Underwater gliders provide ocean profile observations to help improve forecasts of hurricane tracks and intensity, especially in regions that would otherwise be under sampled or not observed at all. Even under hurricane wind conditions, data from gliders are transmitted in real-time to data distribution centers for immediate assimilation in forecast models. Since 2014, a network of gliders from NOAA, IOOS, the US Navy, and academic and private institutions has surveyed over 20 Atlantic hurricanes.

<https://research.noaa.gov/article/ArtMID/587/ArticleID/2686/After-a-busy-summer-NOAA%E2%80%99s-hurricane-gliders-are-returning-home>



Activities that will contribute to this objective include:

- Establish a clear vision and strategy for private sector partnerships to convey requirements and roles, including the purchase of systems and data, instrument hosting, research and development, and operation.
- Establish and communicate NOAA's decision criteria for selecting appropriate methods of engaging private sector partners to ensure candidate partners and vendors are well acquainted with NOAA's protocols.
- Utilize the NOAA Technology Partnership Office, SBIR program, and commercialization plans to expand private sector engagement in innovative UxS solutions, increase the speed of research and development, and meet data management and economic requirements.

Goal 5: Promote Workforce Proficiency in UxS Use and Operations

NOAA's agency-wide implementation of the S&T strategies depends on a diverse, collaborative, and well-trained workforce. The composition of people with diverse backgrounds, experiences, and expertise cultivates the creativity and innovation essential for these strategies to succeed. Equally important is an inclusive work environment that drives workforce performance and collaboration. Integrating technologies throughout NOAA's unique mission of science, service, and stewardship demands a diverse workforce to reflect, understand, and respond to the varied communities and stakeholders it serves. Taken together, these strategies will dramatically expand and improve the efficiency, effectiveness, and coordination of their development and usage across the agency. The objectives detailed below contribute to the achievement of this goal of promoting workforce proficiency. The recently signed NOAA Corps Act of 2020, Public Law 116-259, authorizes an increase in officers from 321 to 500 that will help support these objectives, and includes provisions that will enhance NOAA's ability to recruit and retain officers, and increase diversity in the workforce.

Objective 5.1: Expand Recruiting Efforts to Support NOAA UxS Activities.

The rapid pace of UxS technological advancement demands a NOAA workforce that capitalizes on diversity and inclusion, taking advantage of staff proficiencies in all facets of UxS engineering, operations, innovative data communications and management, and continued evaluation and adaptation. This objective will include expanding recruiting efforts to support these desired NOAA UxS workforce characteristics.

Activities that will contribute to this objective include:

- Identify the skills and capabilities needed to support NOAA UxS activities from research and development to full operations and target critical positions and gaps for recruitment including at historical black colleges and universities (HBCU) and minority servicing institutions (MSI) in fulfillment of NOAA's Diversity and Inclusion Strategic Plan.
- Complete evaluation of federal, academic, and private sector training programs for UxS engineers, payload integration specialists,

technicians, pilots, and policy specialists to borrow or leverage the best available qualifications and skillsets from other programs and NOAA recruitment efforts.

- Successfully recruit staff for critical core functions at the UxSOC and in other key UxS supporting positions across NOAA by collaborating with NOAA programs and networking with key partners to ensure hiring of highly qualified personnel and effective UxS operations.

Objective 5.2: Establish Formal Training and Certification.

Formal training and certification programs can develop the skills and capabilities necessary for the safe and efficient operation of NOAA's UxS program. They can be useful for people who are just starting their careers, as well as for people who already have years of experience and want to ensure a viable career path. Establishing formal training and certification pathways is critical to long-term success of NOAA's UxS program.

Activities that will contribute to this objective include:

- Document proficiency standards, training, and certification requirements specific to UxS types to ensure personnel operating UxS are trained appropriately to support NOAA missions.
- Identify existing federal, academia, and private sector training programs that meet NOAA UxS training and certification requirements to augment and strengthen NOAA's UxS training program.
- Identify institutions that provide opportunities for temporary assignments focused on UxS design, development, and operations to provide on-the-job training for NOAA UxS personnel.
- Continue to partner with and leverage best practices from other federal, academic, and private sector training programs for UxS engineers, technicians, pilots, researchers, and other UxS personnel.

Objective 5.3: Include NOAA UxS Assignments as a Retention Tool.

Rotational assignments can develop and enhance employees' knowledge, skills, and abilities and facilitate their professional development and growth. The use of rotational assignments often provides a dual advantage by providing developmental opportunities for employees while providing program offices with assistance while filling gaps in resources. Rotational assignments can also be a useful retention tool and can encourage employee engagement and loyalty by providing opportunities to learn new skills, acquire new knowledge, work with knowledgeable colleagues, and contribute to interesting projects.

Activities that will contribute to this objective include:

- Leverage existing programs for NOAA rotational assignments to provide opportunities to maintain proficiency in UxS payload integration and sensor design, mission planning and execution, operations, and data and information management.
- Leverage existing programs for UxS rotational assignments for personnel exchanges between NOAA and partner organizations to provide opportunities to maintain proficiencies in platform launch/recovery, mission planning sensor design, payload integration, operations, data management, and other designated priority skills.
- Develop formal NOAA Corps liaison assignments between NOAA and other federal agencies, academic institutions, and the private sector to enhance professional development in UxS technologies in the Federal government.

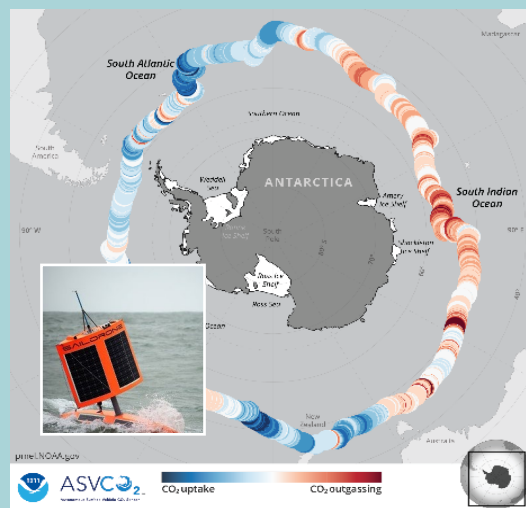
Conclusion

NOAA is committed to the continued development and implementation of UxS technologies to address complex challenges across its multiple missions. The NOAA UxS Strategic Plan presents a detailed description of how the goals and objectives in the UxS Strategy can be accomplished. Together with our advances in all of NOAA's Science and Technology focus areas - Data, Cloud, 'Omics, Artificial Intelligence, Citizen Science, NOAA's UxS activities will significantly improve performance and demonstrate our exceptional environmental science leadership.

USV circumnavigates Antarctica in search for carbon dioxide and other climate data

A specially outfitted USV from Saildrone became the first unmanned system to circumnavigate Antarctica in 2019, a 196-day mission covering 13,670 miles – a technological feat that was unfathomable just a decade ago. Saildrone vehicle SD1020 (insert) was equipped with a suite of sensors to measure key climate variables, including one developed by NOAA to measure carbon fluxes. Data collected is helping scientists understand the Southern Ocean's role in the global carbon budget. Sea-air CO₂ from the circumnavigation is illustrated (credit: NOAA PMEL). The mission was sponsored by Li Ka Shing Foundation and included collaborators from around the world.

<https://www.noaa.gov/news/saildrone-is-first-to-circumnavigate-antarctica-in-search-for-carbon-dioxide>





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