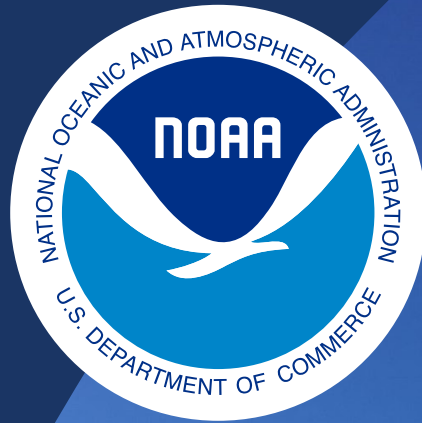


# NOAA Uncrewed Aircraft Systems Report for Fiscal Year 2023



NOAA Technical Memorandum OMAO UxS-003

<https://doi.org/10.25923/0112-7302>

## **NOAA Uncrewed Aircraft Systems Report for Fiscal Year 2023**

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*Cover Photo: An uncrewed aircraft system is recovered via hand catch with the NOAA pilot in the foreground. Photo: Amanda Bradford/NOAA*



## **About the National Oceanic and Atmospheric Administration**

The National Oceanic and Atmospheric Administration (NOAA), under the Department of Commerce, provides science, service, and stewardship to protect life, property, and Earth's natural resources. By collecting scientific data, NOAA provides daily weather forecasts, storm warnings, and climate monitoring; and facilitates fisheries management, marine commerce, and coastal restoration. NOAA uncrewed systems work is organized into Uncrewed Aircraft Systems (UAS) and Uncrewed Marine Systems.

## **About the Uncrewed Systems Executive Oversight Board**

The Uncrewed Systems Executive Oversight Board provides oversight of NOAA's UAS and Uncrewed Marine Systems efforts. It assures agency-wide strategies and initiatives are developed collaboratively and implemented consistently. It was established through the [Commercial Engagement through Ocean Technology Act of 2018](#). The Executive Oversight Board includes membership from across NOAA's line offices and reports to the NOAA Fleet Council. The Executive Oversight Board is co-chaired by the Office of Marine and Aviation Operations and Office of Oceanic and Atmospheric Research.

## **About the Uncrewed Systems Operations Center**

The [Uncrewed Systems Operations Center](#) was established in Fiscal Year (FY) 2020, following receipt of funding to improve and expand uncrewed systems operations across NOAA. The Uncrewed Systems Operations Center sits within NOAA's Office of Marine and Aviation Operations and works to expand uncrewed systems applications, transition uncrewed systems into operational use, and provides corporate support to uncrewed systems operations. Within the Uncrewed Systems Operations Center sits the UAS Division that plays a central role in all NOAA UAS operations.

## **About the Uncrewed Systems Research Transition Office**

The [Uncrewed Systems Research Transition Office](#) within NOAA's Office of Oceanic and Atmospheric Research worked to leverage the abilities of Uncrewed Systems to improve NOAA's monitoring and understanding of the global environment. The Uncrewed Systems Research Transition Office focused on the research, development, and transition of Uncrewed Systems technologies. In FY 2024, the Uncrewed Systems Research Transition Office was discontinued. All references to the Office in this report are for events and activities prior to the closure of the Office.

## **About the Annual Report**

This Annual Report is an overview of the UAS work of NOAA in FY 2023. The information presented is structured to provide insight on NOAA UAS adoption, applications, and integration. This document was developed by the Uncrewed Systems Executive Oversight Board with support from the Uncrewed Systems Operations Center.

## **Acknowledgements**

This report was crafted by Ashley Hann, Max Anderson, Laura Dwyer, Justin Blancher, Chesna Cox, Allan Knox, Jesse Reich, Melissa Cook, Jennifer Doerr, Julia Waldsmith, Bryan Costa, Jim O’Sullivan, Colm Sweeney, Bianca Bairer, Brian Cole, Martin Getrich, Mike Gallagher, and Lisa Nakamura.

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# Forward

Dear Readers,

On behalf of the NOAA Uncrewed Systems Executive Oversight Board, we are pleased to present NOAA’s Uncrewed Marine Systems (UMS) Highlights Report for Fiscal Year (FY) 2023. This is the inaugural edition of this report and we are excited to share NOAA’s UMS work through it. The highlights in this report showcase the diversity of NOAA mission areas met with UMS, and how UMS can enable the science, service, and stewardship of the Agency.

NOAA presently engages in the research and development of UMS to gather environmental data, as well as the transition of UMS technologies to routine operations. This also involves considering best practices for data management as well as informing the regulatory landscape of UMS use beyond NOAA. In pursuit of all these activities NOAA regularly engages with the leaders in UMS from other government, academic, and industry groups.

FY 2023 saw great growth for NOAA in the development and application of UMS. NOAA deployed UMS from Hawaii and the U.S. Pacific territories, to the Great Lakes and the Arctic. The Agency operationalized its first corporate UMS platform– the DriX uncrewed surface vehicle, and made plans to procure a second platform in FY 2024. Critical data to inform fisheries and protected species management, flood inundation modeling, nautical charts, weather forecasts, hurricane intensity models, and more was gathered in FY 2023 via UMS. The highlights in this report will provide additional detail on these activities.

As the UMS enterprise evolves, NOAA aims to remain a leader and partner on innovative and safe applications of UMS to serve society and the environment. This ongoing work along with the activities depicted in this report would not be possible without NOAA’s dedicated workforce.

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Rear Admiral Chad Cary & John Cortinas, Ph.D.

NOAA Uncrewed Systems Executive Oversight Board Co-chairs

# Table of Contents

<b>Forward</b>	iv
<b>Executive Summary</b>	vi
<b>Introduction</b>	6
<b>UAS Use and Support Across NOAA</b>	7
<b>Overview of 2023 NOAA UAS Operations</b>	9
Flight Time by Year	9
Flight Time by Region	10
Flight Time by NOAA Line Office	11
Flight Time by NOAA Program	11
Flight Time by Mission	12
<b>NOAA UAS Inventory</b>	14
<b>UAS Corporate Services</b>	14
Operations Coordination and Training	15
Safety Considerations and Airworthiness Evaluations	16
Industry Trend Analysis	17
<b>NOAA Program FY 2023 Highlights</b>	18
Emergency Beacon-Equipped UAS Support Life Saving Satellite Services	18
Turtles and Mangroves and Shorelines, Oh My! UAS as an Effective Multi-Mission Tool	19
Beyond Visual Line of Sight: UAS Operations Expand Survey Potential in Protected Areas	20
UAS Enable Efficient Inspections	21
Science at the Edge of Space: High Altitude Sampling with Balloon-Assisted UAS	22
Flying Beyond Visual Line of Sight for Science	23
<b>FY 2023 Successes and FY 2024 Outlook</b>	24

# Executive Summary

Uncrewed Aircraft Systems (UAS) are a growing asset for NOAA in providing science, service, and stewardship to protect people and the environment. In order to do this, NOAA engages in the research and development of UAS technologies, as well as the transition of UAS technologies to operations and the routine use of UAS in gathering mission-relevant data. NOAA tackles this work through partnerships with other government, academic, and industry groups throughout the UAS enterprise.

In 2023, NOAA performed over 28,000 flight minutes spread over more than 1,900 UAS flights. These flights culminated in NOAA conducting more UAS operations than any other year and over ten times more flight minutes than ten years ago in 2013. This includes operations across the Agency, NOAA mission areas, and the United States, with a diverse suite of platform types and cadre of partners.

The UAS Annual Report is an annually produced report that provides an overview of NOAA's UAS activities. This report focuses on activities in Fiscal Year (FY) 2023 and is the third iteration of the report. It contextualizes NOAA's use of UAS across NOAA's six line offices:

- Office of Marine and Aviation Operations (OMAO)
- Office of Oceanic and Atmospheric Research (OAR)
- National Marine Fisheries Service (NMFS)
- National Weather Service (NWS)
- National Ocean Service (NOS)
- National Environmental Satellite Data and Information Service (NESDIS)

Stories from each line office highlighting the breadth and depth of NOAA's UAS work can be found in this report. For example, readers can dive deeper into how NOAA is using UAS to survey protected species and habitats, inform its life-saving satellite services, inspect critical infrastructure, and gather atmospheric samples from hard-to-access regions.

This year's report also highlights select corporate services available to NOAA to support safe and efficient UAS use across NOAA including operations coordination, training, safety considerations, airworthiness evaluations, and industry trend analysis. Further detail is provided on NOAA's activities in 2023 and on the Agency's current UAS inventory.

# Introduction

Uncrewed Aircraft Systems (UAS) are a growing resource for NOAA in gathering mission critical data, and serving as a force multiplier to NOAA's traditional observation methods. UAS enable data collection at lower costs and increased safety. They often allow NOAA to gather data in hard to access, or previously inaccessible, regions. In doing so, NOAA is better able to meet its missions and provide science, service, and stewardship to protect people and the environment.

In Fiscal Year (FY) 2023, NOAA UAS operators conducted more flights and flight minutes than any other year on record (Figure 1). This included routine operations of proven UAS technologies to make observations, along with efforts dedicated towards advancing the research and development of UAS technologies, which gather oceanic and atmospheric data. NOAA personnel regularly partnered with industry and academic leaders in UAS technologies to innovatively address NOAA data needs and improve human capabilities using UAS technology at-large. While FY 2023 was a year of growth for NOAA in the realm of UAS, the application of UAS technology is expected to expand. Many of the research conducted, partnerships developed, and other steps taken in FY 2023 will lay the groundwork for continued innovation for NOAA in employing UAS technologies to meet Agency mission needs.



*Image 1: An uncrewed aircraft system is recovered via hand catch on a small boat with the NOAA pilot in the foreground. Photo: Kym Pano/NOAA*



# UAS Use and Support Across NOAA

NOAA accomplishes its diverse missions through its six line offices, all of which either use UAS for mission execution, or support UAS operations across the agency. A brief summary of each line office’s role follows in table 1.

*Table 1: UAS use and support within NOAA by line office.*

Line Office	UAS Use and Support
Office of Marine and Aviation Operations (OMAO)	<ul style="list-style-type: none"> <li>• facilitates across-NOAA projects to enhance UAS use.</li> <li>• executes UAS operations to support NOAA missions.</li> <li>• provides technical expertise to research missions.</li> <li>• provides UAS platform and services to UAS users.</li> <li>• trains UAS operators and increases proficiency on UAS platforms.</li> <li>• operates UAS to evaluate platforms and integrate sensors.</li> <li>• tracks and manages NOAA UAS usage and resources.</li> <li>• transitions UAS into operational use across NOAA’s broad mission space.</li> <li>• coordinates and ensures compliance with airspace regulations and protocol.</li> </ul>
Office of Oceanographic and Atmospheric Research (OAR)	<ul style="list-style-type: none"> <li>• supports cross-NOAA UAS research and development.</li> <li>• develops and utilizes UAS to gather meteorological, atmospheric, and oceanic information in research laboratories and program offices.</li> <li>• tests and evaluates the use of UAS platforms and architecture to collect scientific data to understand complex systems that support Earth Sciences.</li> <li>• gathers and transitions data into societally useful tools.</li> <li>• supports the transition planning process for UAS into operational use across NOAA’s broad mission space through the development of transition plans, processes, tools, and resources.</li> </ul>
National Marine Fisheries Services (NMFS)	<ul style="list-style-type: none"> <li>• tests and evaluates the use of UAS platforms to assess and manage living marine resources and their habitat.</li> <li>• gathers data on living marine resources and incorporate it into the fisheries and protected species management processes.</li> <li>• deploys UAS to increase safety and efficiency, and to reduce cost of fisheries and protected species surveys.</li> <li>• assesses marine mammal and endangered species populations through low disturbance surveys.</li> <li>• assesses entanglement status and response strategy in emergency, protected species entanglement responses.</li> </ul>

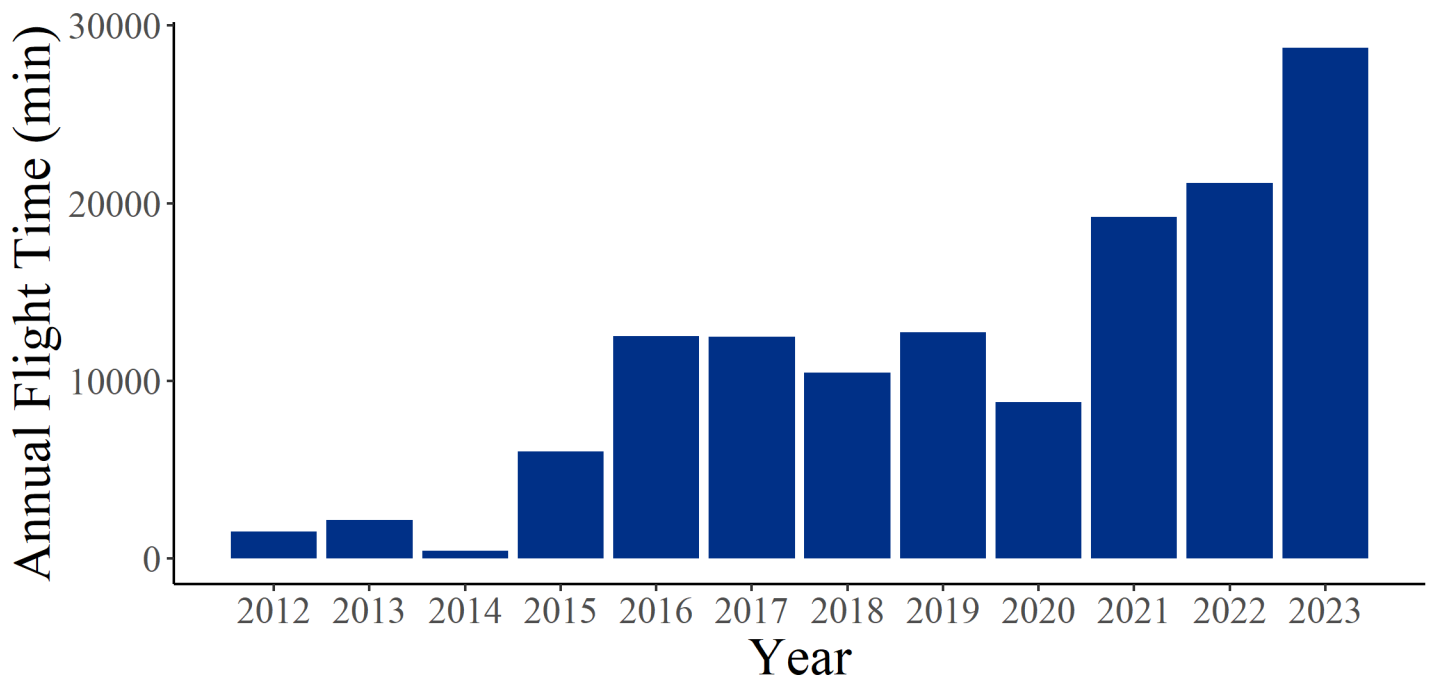
Line Office	UAS Use and Support
<p>National Ocean Service (NOS)</p>	<ul style="list-style-type: none"> <li>• collects coastal and shoreline habitat data for incorporation into analytical tools.</li> <li>• develops procedures and protocols for UAS use during emergency response scenarios.</li> <li>• performs living marine resource surveys of national marine sanctuaries.</li> <li>• gathers data for coastal and habitat mapping projects.</li> <li>• enhances remote sensing for habitat mapping and characterization.</li> <li>• improves data models and visualization tools for managers through UAS-data incorporation.</li> <li>• collects data with minimal disturbance in national marine sanctuaries and national monuments.</li> <li>• expands open water surveys for marine debris and marine wildlife.</li> <li>• identifies and locates marine archeological sites.</li> <li>• supports enforcement efficiency in highly-protected reserves.</li> <li>• engages in collaborative disentanglement efforts, as regional representatives, to reduce threats to sanctuary wildlife and responders.</li> <li>• surveys coastal waters for harmful algal bloom detection and monitoring.</li> <li>• evaluates effectiveness of ecosystem restoration projects through high resolution habitat monitoring.</li> </ul>
<p>National Weather Service (NWS)</p>	<ul style="list-style-type: none"> <li>• demonstrates the utility of UAS for weather event surveying (tornado, flooding, ice events, etc.) and other operations.</li> <li>• gathers pre- and post-weather event data.</li> <li>• performs maintenance inspections of NOAA equipment and property.</li> </ul>
<p>National Environmental Satellite, Data, and Information Service (NESDIS)</p>	<ul style="list-style-type: none"> <li>• enhances acquisition of global environmental data to support the environment, security, and economic quality of life.</li> <li>• reduces human exposure to extreme environmental conditions.</li> <li>• calibrates and validates satellite derived records.</li> <li>• provides high-resolution and site-specific data to replace and augment satellite data.</li> <li>• gathers data and incorporate into predictive models, historic reconstructions, and other products.</li> </ul>

# Overview of 2023 NOAA UAS Operations

*Note: All statistics provided in the Overview of 2023 NOAA UAS Operations section depict data in Calendar Year (CY) not Fiscal Year (FY).*

## Flight Time by Year

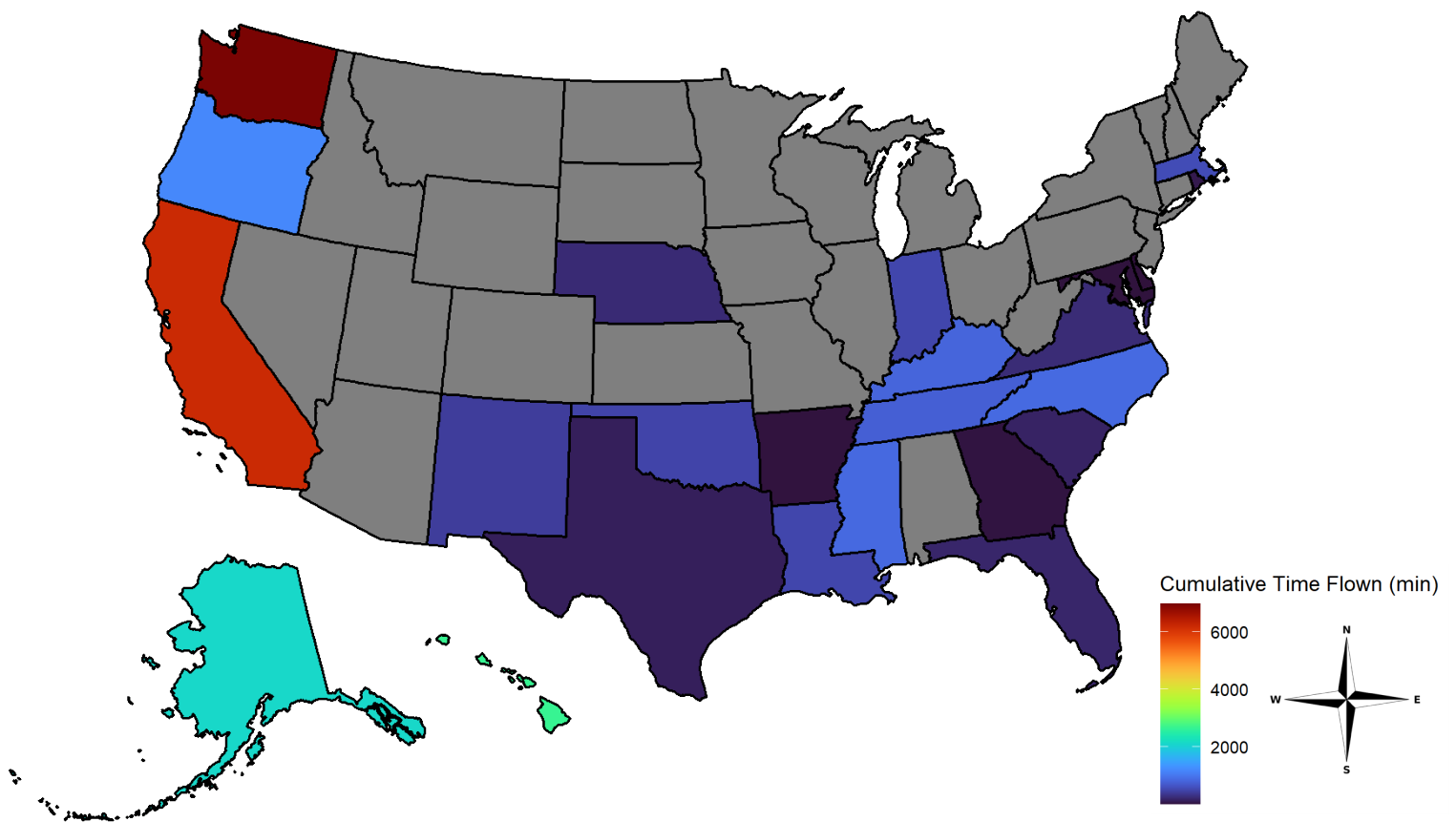
NOAA has steadily increased its UAS usage over the last 10 years (Figure 1). In 2023, NOAA performed over 28,000 flight minutes spread over more than 1,900 UAS flights. This is 7,500 more flight minutes flown than in 2022, and over 10 times the number of minutes flown 10 years ago in 2013.



*Figure 1: Flight time in minutes by NOAA UAS users from 2012 to 2023.*

## Flight Time by Region

NOAA UAS operations occurred across the United States and U.S. Exclusive Economic Zone in 2023, with flight minutes logged in 24 states (Figure 2). The highest flight times were logged in the West Coast (specifically California and Washington), Hawaii, and Alaska. Southeastern coastal states also saw higher numbers of UAS flight time. Federally mandated surveys in regions with protected marine resources contribute to increased UAS flight time in Hawaii and Alaska, as well as along the West and Southeast Coasts. Increased flight time in Oklahoma is associated with an increase in UAS-based weather research and storm damage surveys.



*Figure 2: A map showcasing the flight time of NOAA UAS in minutes during 2023 per state. Warmer colors indicate more flight time in a region, while cooler colors indicate less flight time. Gray regions represent states where no NOAA UAS flight time was recorded.*

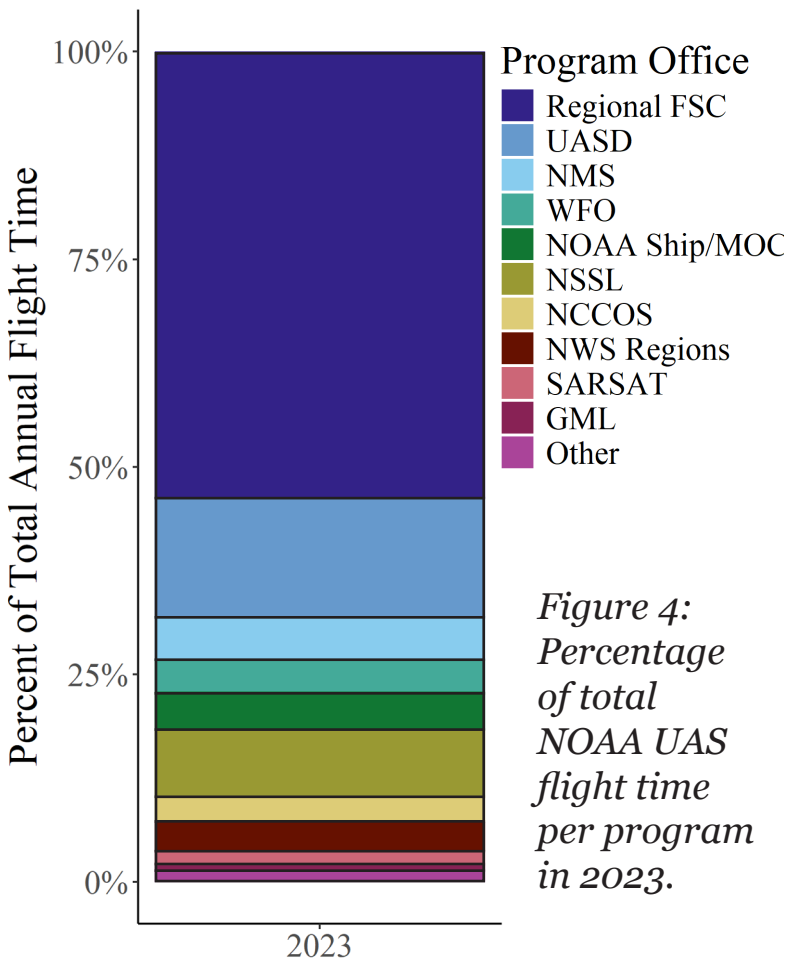
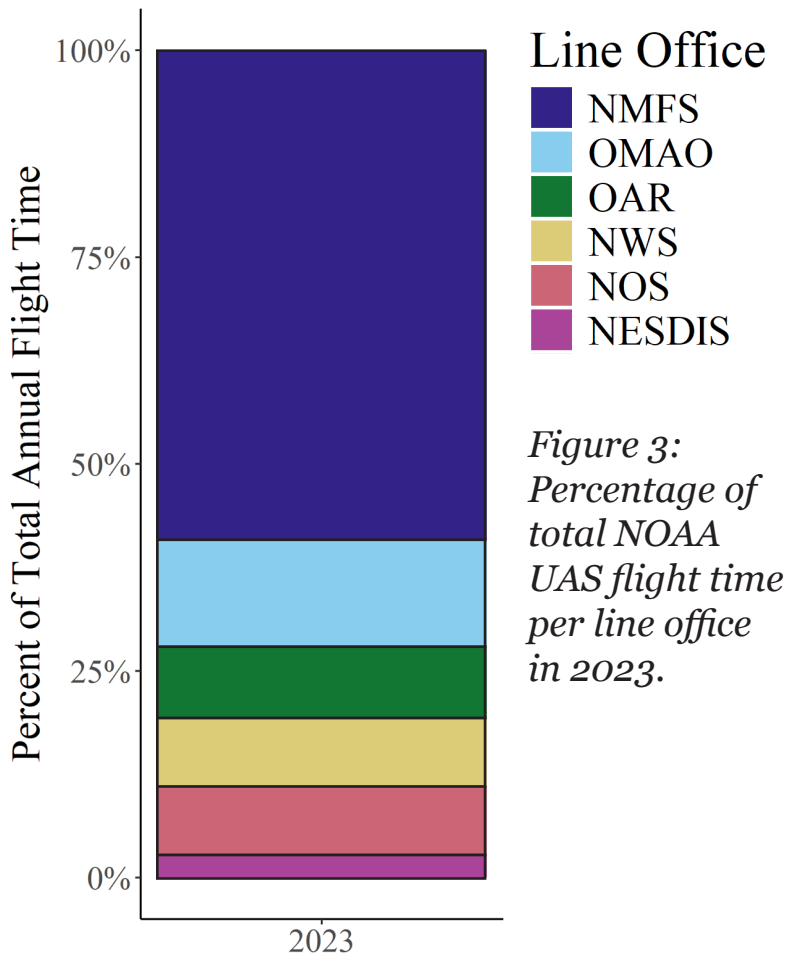
## Flight Time by NOAA Line Office

UAS was used by all NOAA line offices in 2023 (Figure 3). Vignettes of how each line office and their programs used UAS to support NOAA missions can be found in the Highlights section of this report. In 2023, NMFS flew more than 70 percent of all NOAA UAS flights and made up more than 50 percent of NOAA UAS flight time. See a breakdown of NMFS flight time by program in the following section. OAR, NWS, NOS, and NESDIS all increased their flight time from 2022 to 2023, with NOS nearly tripling theirs.

## Flight Time by NOAA Program

Within NOAA's line offices are a diverse suite of program offices, field offices, divisions, and operational centers. NOAA applies a diverse use of UAS technology in support of a wide selection of mission objectives. Collectively, over 20 unique programs and divisions used UAS to complete their duties in 2023 (Figure 4). 68 new pilots were trained with multiple new programs stood up.

In 2023, NMFS programs performed a significant amount of flight time, with the Alaska Fisheries Science Center logging more time than any other NOAA program (more than 8,700 minutes, Figure 5).



Acronyms: FSC—Fisheries Science Center, UASD—Uncrewed Aircraft Systems Division, NMS—National Marine Sanctuary, WFO—Weather Forecast Office, MOC—Marine Operations Center, NSSL—National Severe Storms Lab, NCCOS—National Center for Coastal Ocean Science, NWS—National Weather Services, SARSAT—Search and Research Satellite Aided Tracking, GML—Global Monitoring Laboratory

## Program



Acronyms: AFSC—Alaska Fisheries Science Center, NEFSC—Northeast Fisheries Science Center, SEFSC—Southeast Fisheries Science Center, SWFSC—Southwest Fisheries Science Center

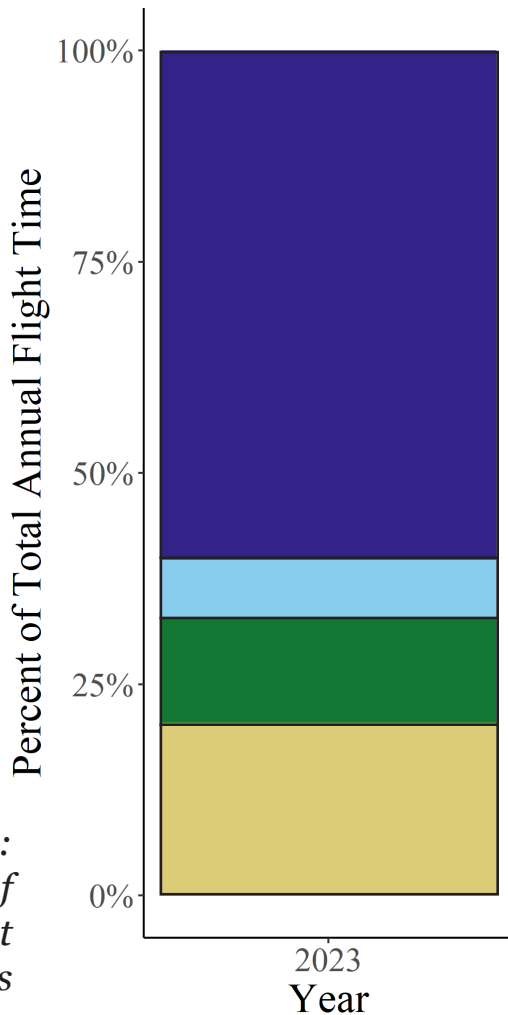


Figure 5: Percentage of NMFS UAS flight time across programs in 2023.

The Marine Mammal Laboratory uses UAS to collect data on marine mammal behavior, population dynamics, life history, migration patterns, distribution, and trends in abundance off the coasts of Alaska, Washington, Oregon, and California.

Significant flight time was also logged by the OMAO UAS Division (UAS Division, 4,032 flight minutes) and the OAR National Severe Storm Laboratory (2,233 flight minutes). The UAS Division often performs flights to test platforms and train UAS operators. The National Severe Storm Laboratory uses UAS in their storm damage surveys and weather research.

## Flight Time by Mission

UAS technology empowers NOAA to meet mission needs by providing access to previously inaccessible regions, increasing efficiency of survey efforts, and improving the safety of survey efforts. In doing so, NOAA can support a wide range of mission objectives with UAS (Figure 6). In 2023, a significant amount of flight time went towards animal surveys (9,917 flight minutes), training (8,970 flight minutes), storm damage surveys (2,790 flight minutes), and weather research (2,400 flight minutes).



Image 2: Imagery captured via UAS for marine mammal surveys of different cetacean species.

NOAA is mandated to perform population assessments of multiple species under the Marine Mammal Protection Act and Endangered Species Act. Animal surveys via UAS enables NOAA to meet this mandate more efficiently and safely compared to traditional methods on crewed platforms or on foot. One area that NOAA is working to advance UAS applications is storm damage surveys and weather research. Programs like the National Severe Storm Laboratory, Weather Forecast Offices, and the Atlantic Oceanographic and Meteorological Laboratory are advancing NOAA’s UAS capabilities to meet these mission needs. NOAA continuously strives to innovatively meet mission objectives in safer and more efficient ways—the flight time associated with training and aircraft/payload testing is a testament to this commitment.

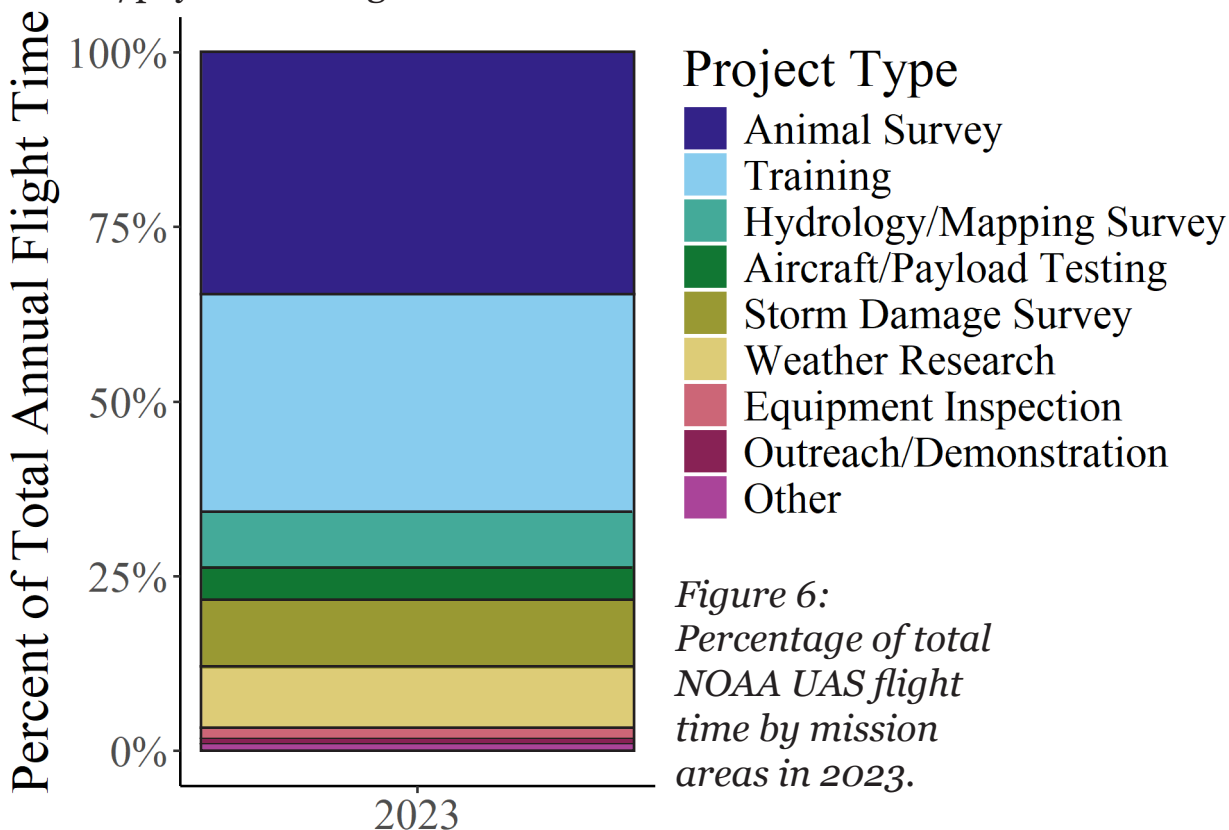


Figure 6: Percentage of total NOAA UAS flight time by mission areas in 2023.



Image 3: UAS deployed for different projects: a) equipment inspection, b) atmospheric measurements, c) storm damage, and d) animal surveys. Photos: NOAA

# NOAA UAS Inventory

NOAA owns 231 UAS across its various programs and offices. This includes over 50 unique platforms created by over 20 different manufacturers (Figure 7). Platform types include quadcopters, fixed wing, and vertical takeoff and landing. Platforms also vary by size, endurance, and payload capabilities. Given NOAA’s diverse mission areas, the variety of platforms allows NOAA to use UAS to meet multiple mission objectives in different environments.



Image 4: NOAA UAS operators pilot a UAS from land. Photo: SWFSC/NOAA

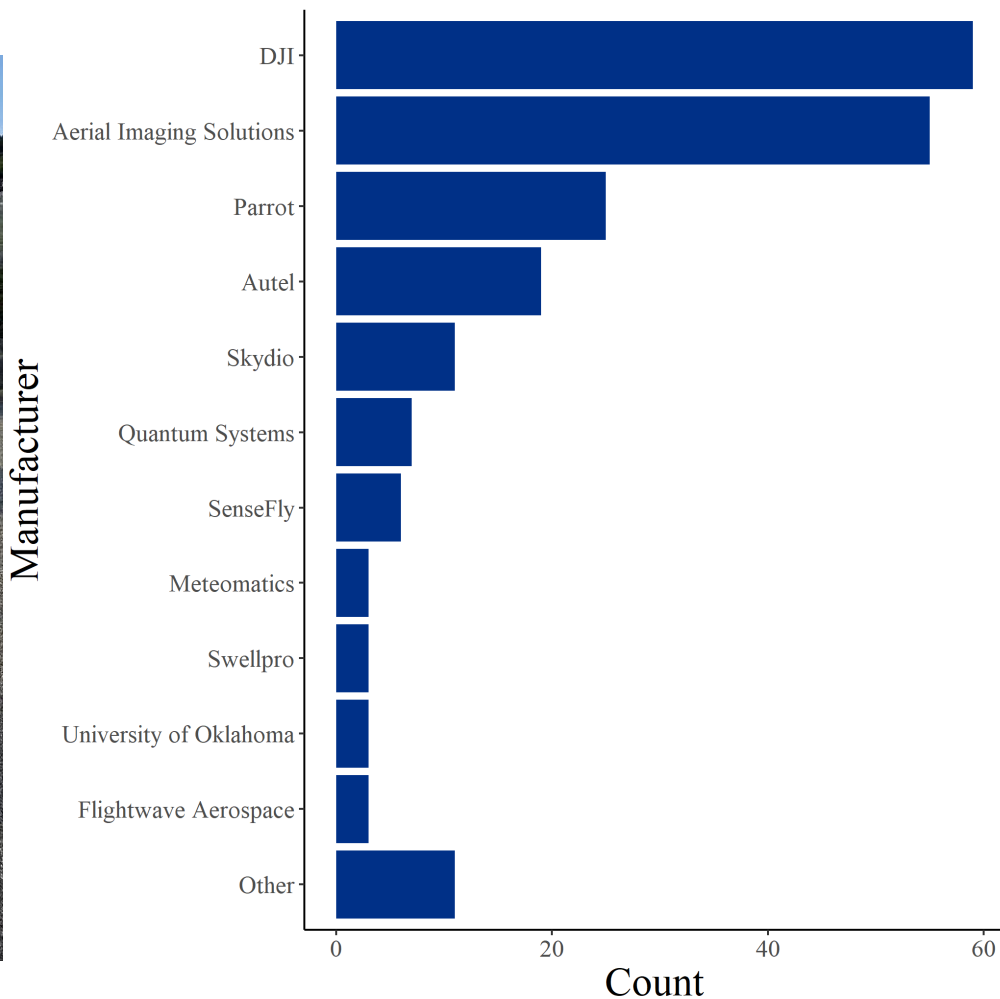


Figure 7: Number of UAS by different manufacturers owned by NOAA.

## UAS Corporate Services

NOAA provides corporate services for all NOAA UAS operations and centralized support to ensure safe, cost-effective, and compliant operations of UAS. These core services are supported by the UAS Division within the OMAO Uncrewed Systems Operations Center, and include the following: operations coordination and training, safety considerations, airworthiness evaluations, and industry trend analyses.



## Operations Coordination and Training

The UAS Division oversees the operations of UAS across all six NOAA line offices. They vet all operations through a standard and non-standard approval process, which ensures adherence to federal airspace restrictions, state regulatory guidance, and NOAA internal policy. The UAS Division uses a fleet management tracking software for UAS, pilots and maintenance. The tool tracks flights for all NOAA operations, offers project management, recommends routine maintenance based on manufacturer requirements, and monitors individual pilot qualifications and currency (ensuring NOAA pilots maintain proficiency with regular flights).

To expand UAS operations, the UAS Division provides customized training programs to develop qualified Mission Commanders and Remote Pilots in Command. These training programs include core classroom modules covering topics such as NOAA operational policies, airspace restrictions, beyond visual line of sight (BVLOS) requirements, and fleet management. Additionally, they include customized field components so users can become qualified on specific UAS platforms with hands-on training. This curriculum has been specifically developed for NOAA operations and designed to cater to the needs of the line offices, which allows the UAS Division to efficiently manage the qualification procedures of new operators while maintaining stringent safety standards. In 2023, NOAA flew over 1,900 flights, logged over 28,000 flight minutes, and trained 68 new UAS users. All of these operations were vetted, recorded, and approved by NOAA UAS experts in the UAS Division.



*Image 5: A UAS operator pilots a UAS for storm research. Photo: NSSL/NOAA*

## Safety Considerations and Airworthiness Evaluations

Before granting flight authorization to line offices for operations, the UAS Division conducts Operational Risk Management assessments to identify and mitigate potential hazards. UAS operations within NOAA are extremely diverse, such as shore vs. ship vs. small boat deployment and recovery, high altitude operations, and BVLOS. Each operation requires risk mitigation considerations. These assessments quantify risk associated with specific missions and recommend risk-control measures. This proactive approach strengthens the decision-making process of crews in the field and enhances the safety of flights.

Like all operations, UAS missions involve inherent risk, and potential mishaps may occur. Per NOAA policy, all field crews are required to report mishaps and close calls to the UAS Division. If a mishap occurs, the UAS Division takes immediate action to ensure personnel involved are



*Image 6: A UAS operator hand launches a UAS.  
Photo: NOAA*



*Image 7: A UAS Division instructor trains NOAA personnel on UAS operations. Photo: NOAA*

safe and operations are temporarily halted. The UAS Division conducts a thorough investigation, which includes a review of the approved Operational Risk Management, and interviews all crew involved in the mishap. Before resuming operations, the UAS Division makes recommendations to prevent the event from happening again and develops a Hazardous Report to document the event and the lessons learned. The UAS Division maintains a chronological collection of Hazardous Reports and plays a central role in distributing lessons learned within the line offices. These reports help to develop long term strategies to mitigate flight risk throughout all of NOAA.

The UAS Division also uses this repository of information to guide its consideration of new platforms and modifications for operational use. Each system must undergo a full airworthiness evaluation, which accounts for technical specifications, emergency procedures, regulatory compliance, checklists and documentation, and maintenance guidelines. UAS are only approved for use within NOAA once they meet stringent standards in all of these categories. In 2023, the UAS Division conducted 17 new airworthiness evaluations.

## Industry Trend Analysis

The UAS Division externally monitors the UAS industry's developments and trends. The UAS industry is relatively young and therefore dynamic compared to crewed aircraft. With technological advancements, new platforms and accessories are frequently developed and released on the market. In FY 2023 the UAS Division explored advancements in platforms with capabilities to deploy and recover from boats in marine environments, designs and modifications for safe hand-launch and recovery techniques, and more robust software services for operation approvals and tracking. The UAS Division condensed this information to NOAA by making suggestions and recommendations on the most appropriate equipment to use to meet each line office's specific mission needs.

In addition to the private industry, the UAS Division proactively monitors federal policy changes to ensure that NOAA operations remain compliant. NOAA must follow all legislation regarding UAS acquisition and deployment by Federal agencies. These legislation changes, based on evolving cybersecurity threats, technological developments, and the Nation's relationship with foreign countries that manufacture UAS. By tracking large-scale policy updates and disseminating the appropriate information among NOAA, the UAS Division ensures that line offices maintain compliance with policy and can continue important environmental data collection.

In FY 2023, the UAS Division brought all NOAA operations into compliance with the [Federal Aviation Administration's Remote Identification of Unmanned Aircraft policy](#). The UAS Division identified appropriate technological modules to update existing UAS platforms, purchased and distributed the modules, and developed guidelines for new platform acquisition, including the modules.



*Image 9: NOAA personnel prepares to hand catch a UAS at sea. Photo: NOAA*

# NOAA Program FY 2023 Highlights

## *Emergency Beacon-Equipped UAS Support Life Saving Satellite Services*

**Lead Personnel:** Allan Knox and Jesse Reich—NESDIS Search and Rescue Satellite-Aided Tracking Program

UAS serves many purposes in NOAA. In the last three years, the Search and Rescue Satellite-Aided Tracking ([SARSAT](#)) Program expanded the list of purposes to include testing out their new ground stations that would be incorporated into their SARSAT systems to detect and locate people in distress. NOAA's NESDIS contributes satellite constellations to an international satellite system that can transmit distress alert data from emergency beacons around the world. NOAA runs the U.S. elements of this program, and partners with the U.S. Coast Guard and Air Force (who serve as responders) and NASA (who provides research and development support) to rescue people. In the 2023 calendar year alone, the SARSAT Program rescued 255 people from aviation, marine, and land-based emergencies in the United States.



*Image 9: SARSAT program UAS operators prepare for operations in New Mexico.  
Photo: NOAA*

In recent years, the international program modified its satellite system to include new variables that had to be considered in detecting emergency beacons. In order to make sure emergency beacons are accurately detected, the SARSAT program partnered with NOAA's [UAS Division](#) within NOAA's [Uncrewed Systems Operations Center](#) to equip a FreeFly Astro UAS with an emergency beacon. The beacon-equipped UAS was then flown at known locations around the SARSAT program's ground stations to make sure the beacon could be accurately detected and located. The SARSAT Program did its first test runs of their new system in May of 2023 near their New Mexico-based ground station. Given the effectiveness of the test runs, the SARSAT Program plans to fly UAS to commission ground stations in Hawaii, Florida, and Guam in the years to come.

## *Turtles and Mangroves and Shorelines, Oh My! UAS as an Effective Multi-Mission Tool*

**Lead Personnel:** Melissa Cook, Jennifer Doerr–NMFS Southeast Fisheries Science Center; Julia Waldsmith, Matt Pickett, Brian Taggart–NOS National Geodetic Survey, Remote Sensing Division

While NOAA mission areas cover a wide array of oceanic and atmospheric focus areas and geographic regions, NOAA researchers are sometimes able to gather observations of value to multiple mission areas with the same UAS platform. In May of 2023, NOAA’s Southeast Fisheries Science Center ([SEFSC](#)) and National Geodetic Survey–Remote Sensing Division ([RSD](#)) were able to use UAS to perform such multi-mission operations. The team flew a Quantum Trinity 90+ and DJI Matrice 30 Thermal to assess shoreline change, sea turtle abundance, and marsh habitat in the Louisiana Barataria Basin. The Port Fourchon region of the Basin was specifically targeted as it is vulnerable to hurricanes, provides critical services for the maritime shipping industry, has diverse habitats, and has a known population of threatened green sea turtles.

Throughout the UAS operations, over 11,835 photographs and videos were taken which covered over 240 miles of the Barataria Basin. The team was able to pilot test UAS to perform in-water sea turtle abundance surveys. Sea turtle abundance surveys are traditionally performed via expensive and time consuming crewed aerial surveys. Data gathered is critical to improving sea turtle populations assessments and is mandated by the [Endangered Species Act](#). Over 60 turtles were detected and the team was able to learn how UAS can supplement and enhance sea turtle surveys. The team also piloted the use of UAS to gather coastline and jetty imagery to assess waterway navigability. Additionally, the researchers were able to gather marsh vegetation data to assess the impact of invasive black mangroves on the habitat. And finally, they performed surveys over specific regions of the port to provide post-hurricane imaging for impact assessments. Overall, the operations showcased how UAS can be an effective tool in gathering multi-use data sets.



*Image 10: A sea turtle detected via UAS. Photo: NOAA, NMFS ESA Permit 21233-04*

# Beyond Visual Line of Sight: UAS Operations Expand Survey Potential in Protected Areas

**Lead Personnel:** Bryan Costa—NOS National Centers for Coastal Ocean Science

NOAA manages a network of national marine sanctuaries to preserve the nation's marine resources and underwater heritage. This management includes assessing vessel-based activity in and near protected regions. In September 2023, NOAA's National Centers for Coastal Ocean Science (NCCOS)— in partnership with NOAA's [Office of National Marine Sanctuaries](#), California Marine Sanctuary Foundation, NOAA's [Uncrewed Systems Operations Center](#), and Overwatch Aero—completed beyond visual line of sight (BVLOS) operations to assess the feasibility of using UAS to perform vessel surveys in protected areas.

Historically, NOAA uses crewed flights with trained visual observers to perform vessel surveys. However, these surveys are difficult to routinely operate due to availability of certified platforms and trained personnel. BVLOS UAS operations provide a potential way to replace (and/or supplement) crewed flights and expand on pre-existing surveys both geographically and temporally.

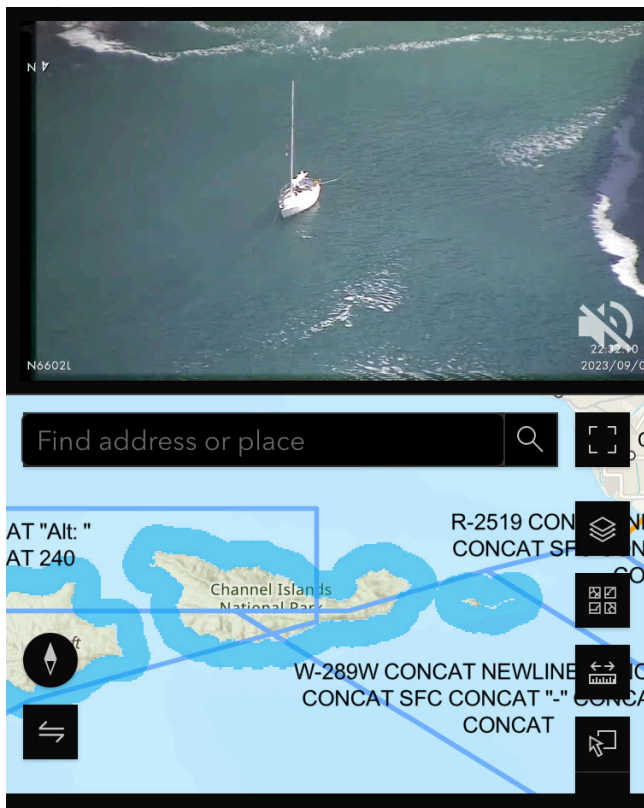


Image 11: Footage taken via UAS of a sailboat and a flight map as seen in the Overwatch Aero UAS interface. Photo: NOAA

These UAS operations took place inside the [Channel Islands National Marine Sanctuary](#) and waters adjacent to [Vandenburg Space Force Base](#). They included multiple crewed flights with two Trillium gimbaled payloads, shore-based radar and a 5 hour BVLOS UAS flight with the same payload. By utilizing multiple observing strategies, NOAA is able to assess the viability of BVLOS UAS equipped with gimbaled cameras for vessel and ocean use surveys.

Preliminary results suggest that the UAS gimbaled payload was as accurate as crewed surveys at detecting vessels, even from higher altitudes (> 1000 feet above ground level). It was also more accurate at recording vessel locations than visual observers on crewed flights, and was able to consistently observe other smaller and harder-to-detect ocean uses (e.g., surfing and kayaking). These preliminary analyses suggest that BVLOS UAS surveys could replace or augment crewed flight vessel surveys in protected areas in the future. This work also highlights a growing need at NOAA to build capacity and reduce barriers for routinely operating UAS BVLOS.

## ***UAS Enable Efficient Inspections***

**Lead Personnel:** Scott R. Kelly, NWS Eastern Region Systems Operation Division; Kennedy Richardson, NWS Southern Region Systems Operation Division

UAS can allow NOAA to more efficiently maintain critical infrastructure like radio towers, weather forecasting devices, and entire buildings. In FY 2023, the NWS [Eastern Region Headquarters](#) and [Southern Region Headquarters](#) continued successful operations to use UAS to conduct maintenance inspections of NOAA Weather Radio towers, Next Generation Weather Radar ([NEXRAD](#)) radomes, and other facilities. These flights were able to provide visual clues and identify issues and risks associated with the operation of NOAA Weather Radio transmissions and other facility issues like damage to NEXRAD and Weather Forecast Office roof inspections across these two NWS Regions. Using UAS to proactively identify specific maintenance issues with equipment and facilities will help minimize downtime and assure the NWS is mission ready for high-impact events.

UAS-based inspections by NOAA's NWS [System Operations Division](#) personnel can save NWS several thousands of dollars (it costs approximately \$3,000-\$6,000 to perform a manual tower climb and inspection) and weeks of potential delay per inspection waiting for a manual inspection, and may be the only option when personal safety concerns may prohibit climbing a tower. One Eastern Region Headquarters inspection determined that the equipment would have to be relocated from an unsafe repair location. The collected UAS missions imagery assisted in determining solutions and helped streamline repair and/or mitigation efforts. A Southern Region Headquarters inspection allowed the Regional Maintenance Specialist to write a very specific statement of work to provide to bidders of the contract to replace the system. UAS proved to be a valuable asset by saving costs and greatly expediting the bidding process, compared to manual inspections, while eliminating the risk associated with tower climbing.



*Image 12: Inspection of a NEXRAD radome via UAS. Photo: NOAA*

# Science at the Edge of Space: High Altitude Sampling with Balloon-Assisted UAS

**Lead Personnel:** Colm Sweeney, Bianca Baier—OAR Global Monitoring Laboratory

UAS can allow NOAA to gather atmospheric data in regions that were previously inaccessible by crewed techniques. In May of 2023, NOAA's Global Monitoring Laboratory ([GML](#)) successfully used a weather balloon-assisted glider UAS to deploy and recover an atmospheric sampling and measurement system at the edge of space. This successful deployment marked a pivotal step in a four-year effort, under the High-altitude Operational Return Uncrewed System ([HORUS](#)) project, to develop reliable and cost effective ways to monitor greenhouse gasses and their distribution in the atmosphere.



*Image 13: The HORUS glider and balloon prepared for a test flight in Colorado's Pawnee National Grasslands. Photo: NOAA*

The aforementioned operations occurred at Colorado's Pawnee National Grasslands with the UAS reaching an altitude of 90,000 feet above sea level. The UAS carried a GML science payload that collected gas samples from over 90% of the Earth's atmosphere as the system descended back to an established recovery location.

The HORUS project involved technological and regulatory advances for NOAA in the realm of UAS. Not only did the project team develop a UAS that could be launched to the edge of space, successfully collect samples, and be remotely piloted safely to a predetermined location; but it also received authorization

from the Federal Aviation Administration (FAA) to fly in the U.S. controlled airspace beyond visual line of sight ([BVLOS](#)) and above the normal flight ceiling for UAS. This milestone is the byproduct of a team of experts including the research scientists at GML and the Cooperative Institute for Research in Environmental Sciences at the University of Colorado-Boulder, UAS developers (Arizona State University, Delta Zee Solutions, RapidFlight, and Spektreworks), the NOAA Office of Research Transition and Application, and the Uncrewed Systems Operations Center. Moving forward, the HORUS allows for atmospheric sampling to occur in previously unsampled regions.



## ***Flying Beyond Visual Line of Sight for Science***

**Lead Personnel:** Tina Fuss–OMAO Uncrewed Systems Operations Center, UAS Division

NOAA has deployed UAS to gather its mission critical data for over two decades, and as UAS technology has advanced so has the agency’s capabilities in utilizing UAS as a science tool. In recent years, NOAA has become increasingly interested in expanding the reach of its UAS to fly [BVLOS](#). At present, the FAA, which regulates all UAS operations in U.S. airspace, requires all UAS operations to occur within visual line of sight of the UAS pilot or an observer. However, NOAA is able to perform specific BVLOS operations with exemptions from the FAA. NOAA’s [UAS Division](#) is working across NOAA to develop BVLOS capabilities that will improve the way the agency can deploy UAS to meet its mission needs.

In 2023, the UAS Division, in partnership with NOAA’s Pacific Marine Environmental Lab ([PMEL](#)) and Overwatch Aero, performed BVLOS and long endurance flight operations to expand the agency’s use of UAS to gather critical data. Flight operations occurred at [Vandenberg Space Force Base](#) in Lompoc, CA. The team tested PMEL’s science payloads onboard a hybrid FVR-90 Vertical Take Off and Landing-Fixed Wing UAS. The UAS completed 15 flights and 2,760 minutes of flight time, with some flights lasting over 4 hours and reaching altitudes of 350-11,000 feet above sea level.

The Vandenberg flight operations build on [earlier efforts by NOAA](#) to use UAS to measure aerosol and cloud properties. The FVR-55, a smaller counterpart of the FVR-90, was developed by L3Harris (previously Latitude Engineering, LLC) through [NOAA’s Phase I and II Small Business Innovation Research awards](#). In 2022, the smaller UAS conducted fully autonomous shipboard operations and BVLOS shore-based operations. Transitioning from the FVR-55 to the FVR-90 allows for longer duration flights and the addition of more instrumentation to the Clear and Cloudy Sky payloads. Overall, such operations move NOAA one step further in operationalizing the FVR-90 in measuring aerosol and cloud properties. The UAS Division continues to work with PMEL and other parts of NOAA to advance the agency’s BVLOS UAS capabilities.



*Image 14: The flight operations team stand behind the FVR-90 before operations at Vandenberg Space Force Base. Photo: NOAA*

# FY 2023 Successes and FY 2024 Outlook

NOAA continues to increase the amount of environmental, biological, chemical and physical data collection using UAS. These operations play a critical role in NOAA's hurricane research, emergency response, marine mammal operations, and a multitude of other capabilities, allowing operations to take place in some of the world's most remote and harsh environments. During FY 2023, NOAA conducted 92 coordinated projects, spanning from Antarctica to the Bering Sea, and Kihei, Hawaii to North Platte, Nebraska and Cape Cod, Massachusetts. NOAA flew more than 1,900 UAS flights, logging over 28,000 flight minutes, which is a 17-percent increase from FY 2022.

Safe UAS operations are a priority for NOAA, as is using UAS to collect the most reliable data to better understand the natural world. In order to accomplish this, NOAA needs a trained workforce and a capable fleet. This year, the UAS Division trained 68 new UAS operators and conducted 17 airworthiness evaluations, an increase of 96 percent, to document and review the modifications on UAS to ensure safe and reliable operations.

The outlook for NOAA UAS operations in FY 2024 is exciting. The UAS Division and Uncrewed Systems Operations Center will roll out a new initiative to provide UAS to NOAA users. This initiative will encourage the use of UAS for new and innovative data collection methods and will help establish new or expand existing UAS programs across NOAA. The three UAS platforms available through the initiative are a part of the [Blue Uncrewed Aircraft List](#) developed by the Department of Defense's Defense Innovation Unit to vet and scale commercial UAS technologies. New policy to authorize hand launch and recovery operations as well as developing a qualification for "in-the field" trainers will increase opportunities to train new operators and conduct safe missions to meet NOAA's strategic initiatives. The UAS Division and Uncrewed Systems Executive Oversight Board will continue to provide guidance, oversight, and policy input for all of NOAA's cutting-edge research operations using UAS to further advance our ability to predict and respond to changes in climate and other environmental challenges that imperil Earth's natural resources, human life, and economic vitality.

*Image 15: A UAS on the ground before takeoff. Photo: NOAA*