Beyond the Battlefield

Deploying UAS for Environmental and Scientific Research

By Alyce Moncourtois, Content Marketing

Could a drone that is used to scout for enemy activity on the battlefield also help count endangered seals in Alaska? What about relaying communications from a remote area to an emergency response center? For the past 50 years, our innovative engineers have been asking these types of questions to provide our customers with new ways of achieving their goals. The same features and capabilities AeroVironment's unmanned aircraft systems provide to troops on the front line could address a host of missions beyond the military.

"We realized decades ago that our UAS could serve a much wider set of customer needs than defense," said Scott Newbern, AeroVironment's chief technology officer. "We understood that defense customers represented the earliest adopters of our UAS technology, and the experience we would gain by supporting them would give us the ability to support missions in science and nature and beyond. AeroVironment's UAS technology was easily adaptable for scientific applications, and several aircraft characteristics made them ideally suited for this purpose."

The ability to fly quietly and undetected in military missions is also a huge advantage when applied to wildlife management. It means that these UAS can fly much closer to capture high quality images and collect data without disturbing the animals under observation. Because they are electric, the aircraft avoid greenhouse gas emissions, thereby reducing their environmental impact, which is beneficial in both military and scientific scenarios. In addition, UAS have the ability to maneuver in places that could be difficult to access or even hazardous to humans, or where a human presence may adversely affect the animals. Furthermore, when used in emergency situations, the aircraft can relay communications quickly and accurately to a command response center.

AeroVironment has contributed in a number of ways to the advancement of scientific research. These are just a few of our stories.

Researching Wildlife in Hawaii

Several scientific missions took place in Hawaii in 2014 and 2015 using Puma as the "eyes in the sky." Scientists conducted research in the northwestern Hawaiian islands using Puma deployed from the National Oceanic and Atmospheric Administration (NOAA) ship Hi'ialakai, and again from Oscar Elton Sette. Researchers from NOAA and the U.S. Fish & Wildlife Service evaluated Puma's ability to perform

Puma sits on a Hawaiian beach ready for its next flight, August 2015. Photo credit: NOAA

Puma is deployed for aerial surveillance in Hawaii, June 2014. Photo credit Justin Rivera/ NOAA

surveys of monk seals, sea turtles, sea birds and vegetation and to look for marine debris in the Papahānaumokuākea Marine National Monument.

Todd Jacobs, one of the NOAA research scientists, said that "with each mission we tried to improve our ability to 'see' and obtain better imagery of the wildlife. Our intent was to advance our research techniques without disturbing the wildlife or putting humans in harm's way."

The scientists were able to identify animals on the beach and in the water, identify mother-pup pairs, and get a sense of the age class of the animals, which are important items for population monitoring.

"In 2015, we used improved imaging features," Jacobs stated. "We tested a beta version of the i45 Mantis sensor suite and mapped one of the atolls in 2D and 3D LiDAR, which greatly improved the imagery results of the animal populations."

Puma proved to be a critical tool for this environmental research because it could fly lower and slower than manned aircraft and was very quiet, allowing for data gathering without disturbing wildlife. The data collected by Puma was extremely valuable to the preservation of the animal species in their natural habitat.

"These missions validated that Puma could be used successfully," said Jacobs. "We were able to use the aircraft in the Monument for a variety of missions without harming the environment to get data that we wouldn't otherwise get. We were able to survey in remote coves for monk seals and turtles in conditions that we may not have been able to safely land people."

Counting Sandhill Cranes in Colorado

In another research project, scientists with the U.S. Geological Survey (USGS) and the U.S. Fish and Wildlife Service used Raven to count Sandhill cranes that visit the Monte Vista National Wildlife Refuge in Colorado's San Luis Valley.

In 2012, several Raven systems were deployed for aerial surveillance of these birds to estimate the population migrating through the reserve. The cranes move through the refuge in early spring and can be counted while congregated in this area on their migratory route.

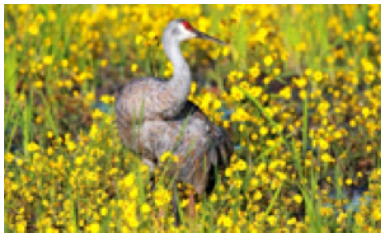
The Raven missions were successful and demonstrated the utility of the Raven system to be an effective means of conducting aerial counts of the migrating cranes. According to one scientist, "In the case of the Sandhill cranes, which spread out over several square miles of staging area, aerial surveys are the only viable way to obtain reliable population estimates."

Raven also proved to be a safer (for both birds and low-flying pilots) and more cost-effective method for conducting these assessments, with the least risk of disturbing migrating birds.

A USGS scientist summed it up this way, "Basically, if the drones don't scare the birds and the imagery is clear enough for counting cranes, the drones can quickly cover more territory and see more 'at a glance' than field personnel on the ground. That not only saves time, money, and fuel, but could

USGS scientist gets Raven ready for flight, 2014. Photo credit: USGS

Scientist releases Raven into the air, 2014. Photo credit: USGS



Sandhill Crane. Photo: Madeline Poster/Audubon Photography Awards

also generate more precise estimates. Plus, some places are just difficult to access on foot, while a drone can simply fly in."

Researching Sea Lions in Alaska

The Alaska Ecosystems Program (AEP) of the National Marine Mammal Laboratory (NMML) conducted a joint research cruise in the Aleutian Islands, in March 2012, with the Geophysical Institute (GI), University of Alaska Fairbanks, to study the winter diet of Steller sea lions and test the feasibility of using unmanned aircraft as a survey platform. An early version of Puma was used for this research project.

On March 4, researchers and scientists boarded the RV Norseman in Adak, Alaska, to begin a 3-week Aleutian Islands research cruise. The crew included AeroVironment's Taylor Nobles.

"The flight operations were both highly challenging and genuinely rewarding," said Nobles. "March weather throughout the Bering Sea was as unpredictable as the sea lions, but Puma handled them with ease. We sailed throughout the entire chain, to the furthest end of Attu Island, flying Puma over ground rarely touched by mankind...an incredible experience to say the least."

Flights were conducted surveying Steller sea lion terrestrial haulouts in the Aleutian Islands — haulouts are land sites where the sea lions go to get out of the water and rest. Missions were flown under 525 ft. in altitude when over land and generally under 300 ft. on approach to the sea lion haulout. Images were taken while flying just offshore or circling the haulout.

Puma flew a total of nine missions over seven days and covered nine sea lion sites. The air vehicle was hand-launched from the vessel and retrieved by landing it in the water. The Puma flights during this research cruise were the most comprehensive to date for testing the use of unmanned aircraft to survey Steller sea lions. The exercises provided valuable baseline information on animal response, survey techniques, and flight operations from land and vessels in the Aleutian Islands.

Exploring Ice-Breaking Navigation in Antarctica

In support of Operation Deep Freeze in Antarctica, an AeroVironment team traveled with the U.S. Coast Guard and NOAA, leaving Hobart, Tasmania, Australia on December 30, 2015, to deploy Puma AE from the Coast Guard Cutter Polar Star for environmental and scientific exercises.

Every year, the heavy icebreaker Polar Star travels to Antarctica's McMurdo Sound to open up shipping lanes needed to resupply the National Science Foundation's McMurdo Station and other facilities on Ross Island. But, this time was different. Puma's "eyes in the sky" replaced the previous method of using Coast Guard helicopters to survey the surrounding ice before navigating the safest and most efficient routes.

AeroVironment sent a team – Sean Colvin, Kris Waters, and Kevin Vollbrecht – to support the mission. NOAA's Todd Jacobs was also on this mission.

"Puma provided critical scouting intelligence to help the Coast Guard's Polar Star conduct icebreaking

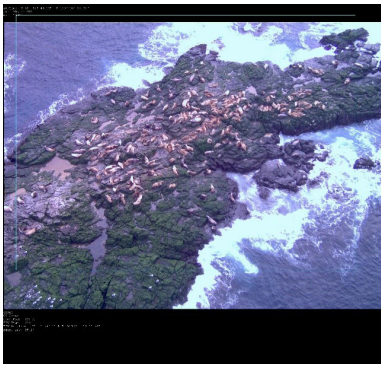
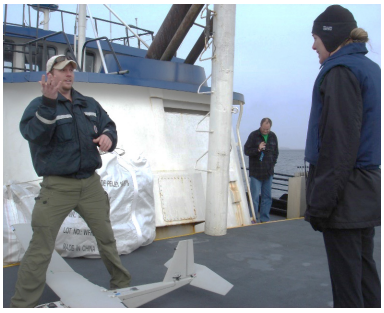


Photo taken of Stellar sea lions by Puma I, March 2012.



AeroVironment's Taylor Nobles demonstrates to a NOAA scientist how to hand-launch Puma. Photo credit: NOAA

The AeroVironment team and a NOAA scientist hold Puma during a stop at an unknown location on the ice Feb. 1, 2016. Left to right: Sean Colvin, Kris Waters, Kevin Vollbrecht, and a NOAA scientist. Photo credit: NOAA.

operations in the treacherous waters of the Ross Sea," said Colvin. "Using Puma for this task ensured a safe passage without putting pilots and costly helicopters at risk."

While Puma provided aerial intelligence for ice breaking, it was also available for scientific tests and for any search and rescue missions, if needed.

The Coast Guard conducted several tests with Puma during their stay in Antarctica. The imagery fed back to the ship allowed the crew to build two and three-dimensional maps and mosaics of the ice, and it provided aerial footage that helped scientists onboard better understand ice thickness, age and other conditions.

"Just like in the Hawaiian Island missions, we still needed to improve our research techniques," Jacobs commented. "Here, we definitely needed net retrieval for the Puma aircraft because we couldn't stop the ship, and in these extreme conditions, we needed to think about de-icing capabilities for future missions."

Investigating Oil Spill Damage at Refugio State Beach, Calif.

In May 2015, NOAA was tasked to respond to the Refugio oil spill to provide damage assessment data. Once again, NOAA's Todd Jacobs was on the scene along with an AeroVironment team to fly Puma from shore and from the NOAA ship R/V Shearwater to survey the damage.

"Deploying UAS in a timely manner to disasters is extremely important," said Jacobs, "and we had to cut response time from days down to hours. The key was a rapid response and integration with other emergency response personnel."

Left to right: AeroVironment's Kris Waters, John Ferguson and Kevin Vollbrecht assist NOAA with the oil spill assessment, May 2015.

Puma imagery of the Refugio oil spill, May 2015.

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Puma provided important surveillance imagery and data that was fed back to the emergency response command center teams, and the exercise was deemed successful by all involved, including the AeroVironment team — Kris Waters, John Ferguson and Kevin Vollbrecht.

Waters summarized the exercise this way, "It was an honor to get the opportunity to provide a rapid response to our partner/customer NOAA and be able to have our team arrive at an emergency scene within hours of the request on a holiday weekend. It's a testament to AV's preparation and 'can do!' attitude in that we had the properly trained people and quality equipment available to perform in a capacity that hadn't been done before. Using Pumas in a flight restricted emergency zone had never been done. We were able to provide high-value, live video to the emergency command center and VIPs during an active emergency with multiple response agencies actively working. We were able to deconflict with helicopter pilots that were making numerous flights as we were conducting our operations from the NOAA Shearwater ship. Despite all the challenges, we were successful."

Tracking a Simulated Oil Spill in the Arctic Ocean

A series of exercises was conducted in the Arctic Ocean in the years 2013-2015 — known as Operation Arctic Shield — aboard USCGC Healy (a polar icebreaker). These exercises included using Puma for detection and monitoring of simulated oil spills. The U.S. Coast Guard, NOAA and an AeroVironment team tested Puma AE for use as an oil spill tracking tool using a net recovery system, beyond-line-of-sight capability, real-time communications with two manned helicopters and testing of ice-sensing and de-icing technology. The scientists used an oil simulant (fluorescein dye) for purposes of tracking and monitoring by the aircraft.

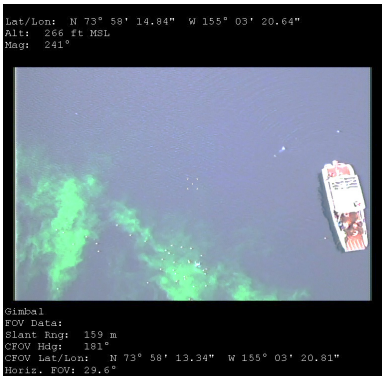
The AeroVironment team included Chris Thompson, John Ferguson and Derek Lisoski who worked with the crew and scientists to confirm Puma's value for monitoring oil spills.

"Using the Puma to monitor the oil spill provided an advantage that wasn't available in the past," Thompson stated. "With Puma, the oil spill response team had an overhead view and was able to monitor the spill pattern in real time."

Wrap Up

AeroVironment's application of UAS for the advancement of scientific research, environmental exploration and disaster response has significantly impacted the evolution of UAS technology for missions beyond the battlefield.

Puma is launched from a vessel during Operation Arctic Shield. Photo credit: NOAA.



Puma captures the simulated oil spill during a training exercise for Operation Arctic Shield.