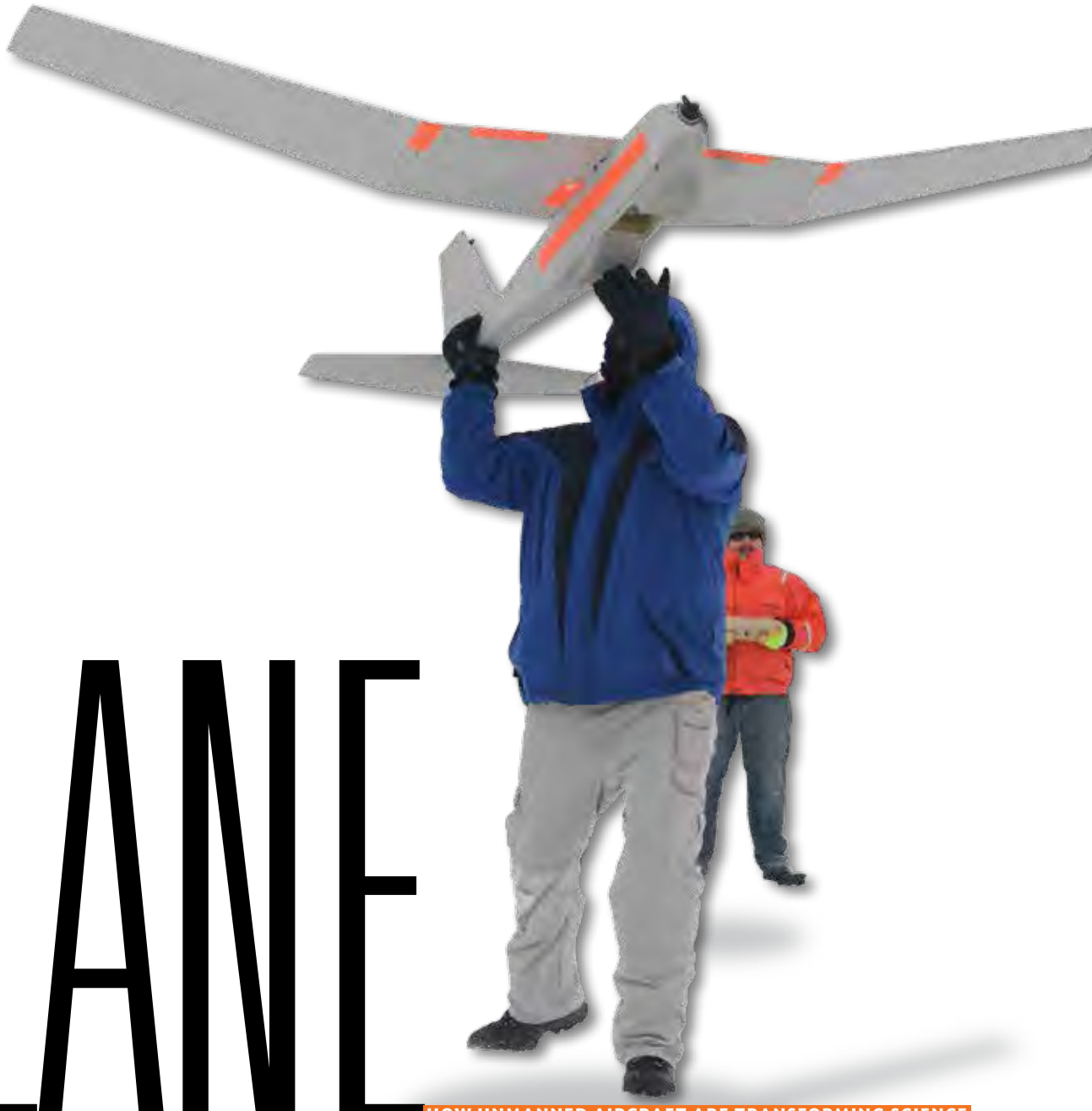
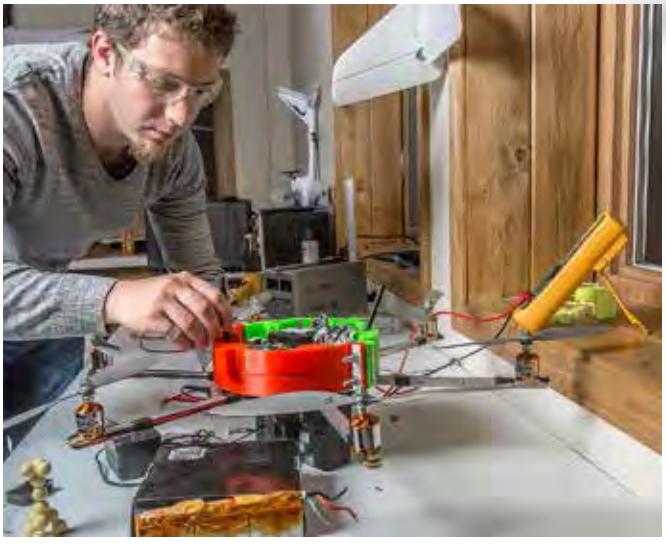
IN PLANE SIGHT



HOW UNMANNED AIRCRAFT ARE TRANSFORMING SCIENCE



By Amanda Bohman

Bits of Styrofoam, plastic bottles, driftwood and fishing nets litter the Pacific Ocean by the ton. "We still don't know how much is floating out there," said Bill Pichel, a scientist with the National Oceanic and Atmospheric Administration. "There has been a lot of debris coming up on Alaska coastlines."

UAF is helping develop a way of identifying marine debris using small robotic aircraft outfitted with cameras. Some are launched by hand and guided using a tablet computer.

The Alaska Center for Unmanned Aircraft Systems Integration, an arm of the Geophysical Institute, uses remote-controlled aircraft to advance science in various ways, including studying volcanoes, surveying glaciers, mapping archaeological sites, measuring sea ice, monitoring wildfires and counting Steller sea lions. The program's mission is broad — to explore ways unmanned aircraft can be used for science or the public good — and is carried out all over the world.

Pichel became interested in unmanned aircraft after meeting Greg Walker, who founded UAF's program and is now its chief technology officer, at a conference in Anchorage in the early 2000s. They agreed to collaborate. The project grew more urgent after the 2011 tsunami that washed out entire communities along Japan's eastern coastline. Scientists think most of the millions of tons of rubble probably sank. NOAA tracked the rest of the debris using satellite images until it dispersed in the vast Pacific Ocean.

"The resolution from the satellites isn't good," Pichel said. "The resolution isn't good enough to know if you are looking at a piece of debris or a wave breaking."

He is working with UAF to determine if and how unmanned aircraft can be launched from marine vessels and flown over the ocean to identify debris.

"Manned aircraft are very expensive," the scientist said. In contrast, unmanned aircraft can fly low, fly in dangerous conditions, and take high-quality video and photographic images.

"We are experimenting with cameras and techniques in searching," Pichel said.

That means determining which unmanned aircraft and cameras work best, which search patterns are effective, and at what altitude the aircraft should be flown.

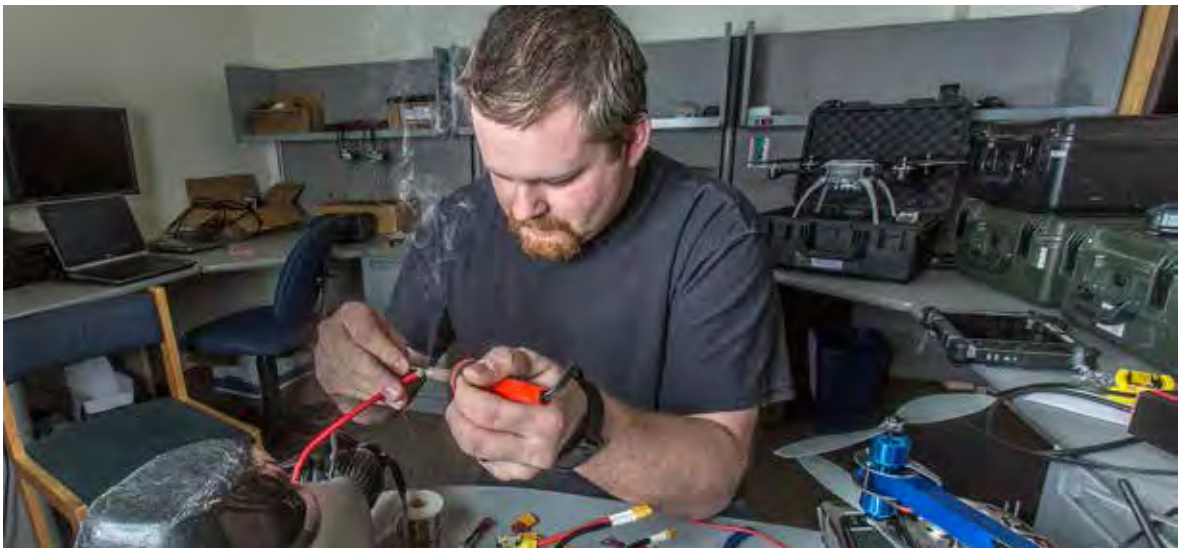
Marine debris damages habitats. Animals can eat it or become tangled up in it and die. The debris also carries invasive species. A large commercial fisheries dock broke loose during the tsunami in Japan and floated across the ocean, washing up on an Oregon beach more than a year later. The highly invasive Asian brown seaweed and the Asian shore crab were found on the dock.

NOAA is considering outfitting all of its marine vessels with unmanned aircraft for various projects, according to Pichel.

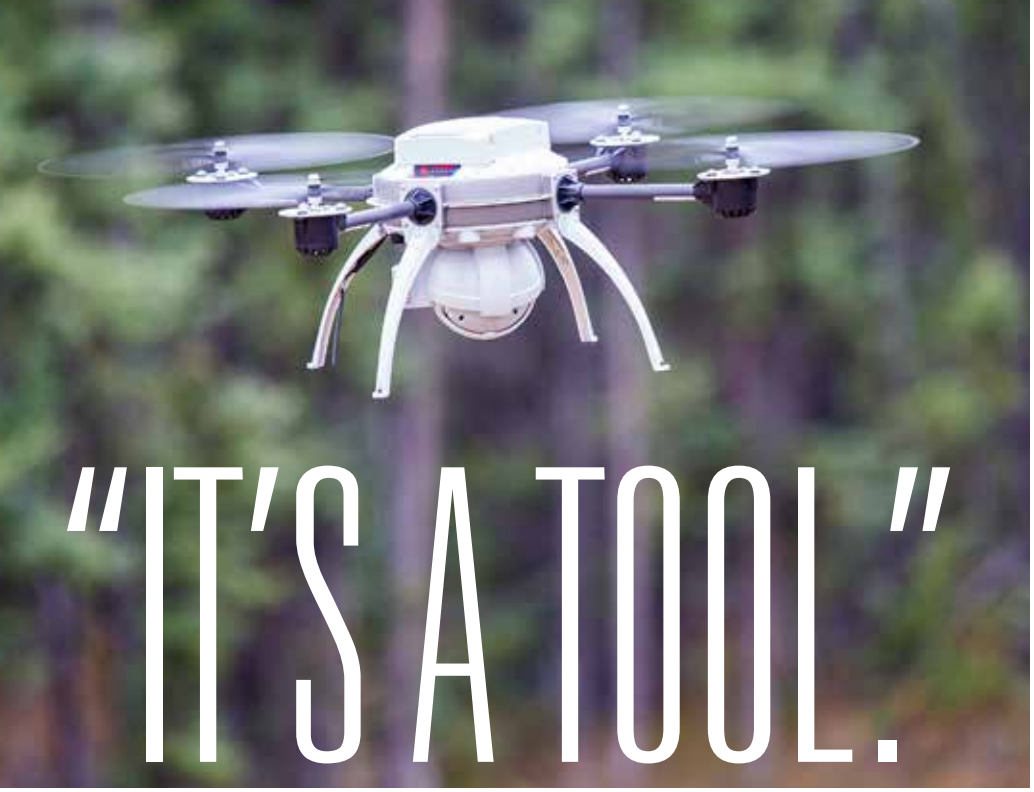
"It's a tool," Pichel said.

The Idaho Power Co. decided to try unmanned aircraft for monitoring the fall chinook salmon run on the Snake River after a 2010 helicopter crash killed a pilot and two biologists. The utility called on UAF for help.

It was the second helicopter to crash while conducting the salmon-counting work. "That really threw up the red flag to us as to how dangerous it was to do this work," said Phil Groves, senior fisheries biologist with Idaho Power.



UAV operator Mike Cook (right) and graduate student Sam Vanderwaal (opposite, bottom) work on components of aircraft they're building. Vanderwaal's device is built primarily from plastic parts generated from a 3-D printer housed in the ACUASI lab in Fairbanks.



"IT'S A TOOL."

The Federal Aviation Administration designated UAF as one of six UAV test sites in the country. UAF will manage the Pan-Pacific UAS Test Range Complex, working with partners in Oregon and Hawaii. The Aeryon Scout (above) is one of several UAVs being studied for their potential uses in national airspace.

Groves contacted the unmanned aircraft testing center. In 2012, the facility used an Aeryon Scout quadcopter — essentially a flying camera — to get images of the oval, bed-sized salmon nests, which are easy to see from the air.

The salmon, protected under the Endangered Species Act, spawn downstream of three hydroelectric dams in Hells Canyon. Idaho Power monitors the salmon run, along with government agencies and a tribal agency.

Flying the canyon is challenging because of wind and unpredictable weather. "I've had some really freaky flights," Groves said.

Flying unmanned aircraft allowed biologists to view live video of the spawning salmon from a safe location.

They later used the recording from the Scout to count the nests. They also counted the nests from a helicopter and compared the results with the unmanned aircraft. Using the video, they counted 1,316 nests. From the helicopter, the

The Alaska Center for Unmanned Aircraft Systems Integration

The unmanned aircraft testing center at UAF is the largest research facility of its kind in North America, with about 150 small robotic aircraft and a staff who travel the world demonstrating what the aircraft can do.

"We are not using the aircraft for spy purposes," said Greg Walker, chief technology officer of the testing center, known as the Alaska Center for Unmanned Aircraft Systems Integration.

Walker helped UAF launch its unmanned aircraft program in 2001. The first project was a high-altitude, long-endurance test flight to Alaska from the Southwest United States. The former U.S. Army officer has been working with unmanned aircraft since graduate school.

Formerly located at the Poker Flat Research Range, offices are now situated in an industrial area in south Fairbanks. The center has a staff of about 15, with half the workers employed by UAF and half working as contractors.

The testing center flew more than 150 missions in 2012, according to Walker. The center bills clients for its services. All missions are for research or humanitarian purposes.

One humanitarian mission helped get a much-needed fuel tanker to Nome. A storm caused the town in western Alaska to miss its fall fuel delivery, so a Russian tanker wound up supplying Nome the following January. UAF dispatched an Aeryon Scout unmanned aircraft to collect images of sea ice to assist ships approaching the Port of Nome.

The aircraft can be flown using a mouse, stylus, keyboard or touch screen, or they can be programmed.

The university has special permission from the Federal Aviation Administration to fly unmanned aircraft.

Some of the aircraft owned by UAF were donated by the U.S. Air Force; the rest were bought by the university. Each piece of equipment is valued between $300 and $100,000. One model is gas-powered, while the others are electric.

UAF owns nine different models of unmanned aircraft. The largest aircraft in UAF's collection has a 10-foot wingspan and weighs about 40 pounds. The smallest aircraft is about the size of a smoke detector and weighs 2 ½ pounds.

"The little ones are as useful as the big ones," Walker said. "It depends on what problems you want to solve."

It also depends on the payload, the cameras and sensors attached to the aircraft. The payload is what brings home the data.

"What's important is the data. The data is what drives everything," said Rayjan Wilson, an aerospace engineer for UAF who works with the testing center.

Wilson's job is to determine which kinds of cameras and sensors are needed for a project. Sometimes engineers design and fabricate the payload. Sometimes they purchase the cameras and sensors and modify them to suit the situation.

"We've gotten a lot of success out of using a GoPro camera," Wilson said.

GoPro cameras are small, lightweight and cost only a few hundred dollars. They mount easily to unmanned aircraft and produce high-quality video and still images.

Wilson said lasers on unmanned aircraft are also used to gather information such as

count was 1,375 nests. The difference between the two numbers is insignificant, according to Groves. He suspects the count from the unmanned aircraft is more reliable than the one from the helicopter but said further study is needed.

"We had fantastic success," Groves said. "It's been great working with them. It's amazing what they are doing with these things."

In Iceland, UAF used unmanned aircraft for a project to survey a Viking settlement. In South Africa, UAF tested unmanned aircraft as a tool for wildlife management. In Chile, the testing center used the aircraft to map a glacier.

In Alaska, the center is looking at ways the oil and gas industry can use unmanned aircraft. The center collaborated with the U.S. Coast Guard to experiment with using unmanned aircraft for oil spill response. Oil companies are looking at using the aircraft to detect pipeline leaks, survey roads and locate polar bear dens, according to Marty Rogers, director of the unmanned aircraft testing center.

The aircraft can be flown over roads so builders can get images showing the road conditions. Using the photographs, they can decide what materials are needed to make repairs, Rogers said.

Infrared cameras can be attached to unmanned aircraft to locate polar bear dens. The U.S. Fish and Wildlife Service monitors polar bears on Alaska's North Slope. Oil companies are required to be aware of dens and avoid disturbing them.

Unmanned aircraft work well in locating wildlife because the aircraft can fly low, and they don't seem to bother animals. "The aircraft can go out and look for where the bears are denning without actually disturbing the bears," Rogers said.

The testing center carried out a highly successful Steller sea lion count in the western Aleutian Islands, flying unmanned aircraft low enough to get high-resolution images without spooking the animals. Scientists are studying the sea lions to learn why their populations appear to be on the decline.

The sea lion count also provides a glimpse of how the testing center might fly unmanned aircraft from marine vessels over the open seas to detect marine debris.

Pichel, the NOAA scientist, said he expects field testing for the marine debris project to take place during the first half of 2014.

"We want to get the technology to the point where it can be operationally used," he said.

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Web extra: Learn more about UAF's unmanned aerial vehicles and the Alaska Center for Unmanned Aerial Systems Integration at **www.uaf.edu/aurora/**.

pipeline leaks. When air moves through a small sensor attached to the aircraft, lasers inside the sensor dim when hydrocarbons, such as methane, are present. The data are then transmitted to researchers on the ground.

The next step for the testing center is refining how it provides data to its clients. Currently, the center provides the raw data and the client must synthesize the information. Wilson said the center is looking into ways to process the data and package it. "We're trying to provide an end-to-end solution," he said.

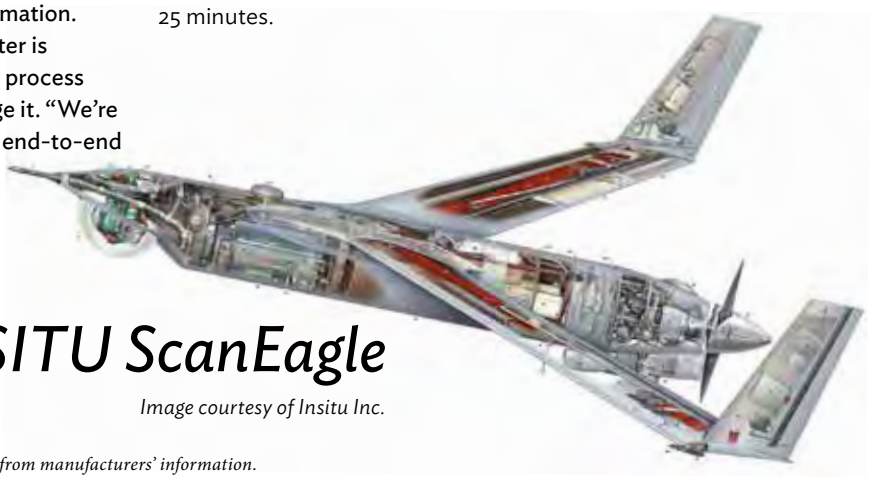
UAVs

Aeryon Scout — Manufactured in Canada, this tiny helicopter is 8 inches tall and 32 inches in diameter. Powered by a lithium polymer battery, its top speed is 30 mph with a ceiling of 1,500 feet. Made of carbon fiber, this aircraft has a flight duration of 25 minutes.

Raven A — This fixed-wind aircraft is built in California and weighs a little more than 4 pounds. With a 4-and-½-foot wingspan and Kevlar wing construction, the aircraft can fly up to 500 feet in altitude and for up to 90 minutes. The operational speed for this battery-powered aircraft is 34 mph.

ScanEagle — This fixed-wing aircraft of carbon-fiber construction weighs about 26 pounds and is 4 feet long with a 10-foot wingspan. Its maximum takeoff weight is 44 pounds. The ScanEagle can fly for more than 20 hours. Its maximum speed is 95 mph. The aircraft is built by a subsidiary of the Boeing Co.

Puma — The Puma All Environment can be hand-launched quickly. It's rugged and suitable for land-based and maritime missions. This fixed-wing aircraft is quiet and stealthy at extremely low altitudes. It carries both video and still cameras. The aircraft is powered by lithium ion batteries. It has a range of 15 kilometers and a flight endurance of two hours. The aircraft weighs 13 pounds and has a 9-foot wingspan.



INSITU ScanEagle

Image courtesy of Insitu Inc.

UAV descriptions adapted from manufacturers' information.