Satellite data helps migrating birds survive

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A rice field in California's Central Valley is shallowly flooded to provide habitat and feeding grounds for migrating shorebirds, as part of the BirdReturns program. Credit: Paul Spraycar/The Nature Conservancy

This fall, birds migrating south from the Arctic will find 7,000 acres of new, temporary wetland habitat for their stopovers in California. The wetlands — rice fields shallowly flooded for a couple weeks after the harvest — are courtesy of a project that combines citizen science, conservation groups and imagery from Landsat satellites, a joint NASA and U.S. Geological Survey program.

The problem — more than 90 percent of the natural wetlands in the Central Valley of California have been lost to development, agriculture and other land use changes, said Mark Reynolds, lead scientist for The Nature Conservancy California Migratory Bird Program. The organization operates the BirdReturns program, with partners including Point Blue Conservation Science, Audubon California and the Cornell Lab of Ornithology.

"The challenge is how do you help wildlife that move around and create habitat in places that may only be important for a few weeks or a few months out of the year?" Reynolds said. "We'd long been searching for spatial data that could help us."

Pop-up habitat

The solution involves big data, binoculars and rice paddies. The Cornell Lab of Ornithology's eBird program collects on-the-ground observations, including species and date spotted, from bird watchers nationwide. With a recent NASA grant to Cornell, scientists created computer models to analyze that information and combine it with satellite remote sensing imagery from Landsat and the Moderate Resolution Imaging Spectroradiometer instruments on NASA's Terra and Aqua satellites. With these models, they could identify areas in the Central Valley where birds flocked to during the spring and fall migrations, as well as estimate the number of birds making the journey.

"The challenge then was to better understand the status of the habitat, where the models were predicting we should have birds," Reynolds said. Some of his colleagues had been using Landsat images to look at where — and when — there was standing water, to assist with surveys of shorebirds.

Matthew Reiter, a quantitative ecologist with the conservation science nonprofit Point Blue, based in Petaluma, California, worked on developing models that can classify habitats based on Landsat imagery. For the BirdReturns project, the team analyzed 1,500 Landsat scenes between 2000 and 2011, and then additional images from Landsat 8 after its 2013 launch. For each area not blocked by clouds, they classified whether there was surface water.

"We can show patterns of how there's changing habitat availability through the year, and that the timing may vary year to year," Reiter said.

Matching the location and timing of surface water from Landsat with the route and timing of migrating shorebirds from eBird, the BirdReturns program looks for those key sites where extra water would
make a difference for the birds, which forage for food in the wetland areas.

That's where farmers come in. Rice farmers in California's Central Valley flood their fields post-harvest, to soften the stubble and make it easier to clear for the next year. Using a reverse-auction, the farmers submit bids to The Nature Conservancy, stating how much money per acre it would take for them to shallowly flood their fields for a few weeks to create these pop-up wetland habitats. The BirdReturns team examines the bids, compares them to the priority habitats, and then makes selections, paying farmers to flood fields for specific two-week periods.

This fall, 30 farmers applied water on approximately 7,000 acres of rice fields. It's the fourth round of auctions; about 30,000 acres of cumulative habitat was created earlier through auctions in Spring 2014, Fall 2014 and Spring 2015. In Spring 2014, the group surveyed the participating fields, as well as control fields where the water wasn't left on. They found that more than 180,000 birds of over 50 different species used the 10,000 acres of pop-up wetlands – 30 times more than counted on the dry fields.

"It's been a pretty astonishing success," Reynolds said. "Farmers participated, and we were able to put habitat out there at a fraction of the cost to purchase that land or put an easement on it."

Mapping water

With Landsat's free archive of decades of land cover information, the mission has often been used for habitat and biodiversity studies, said Jeff Masek, project scientist for the upcoming Landsat 9 mission. With the currently in orbit Landsat 7 and Landsat 8 capturing more images per day than previous satellites, scientists have more information to draw on to study the timing of the ephemeral lakes, rivers and wetlands that only appear certain times of year.

"There's been more and more work with the water mapping," Masek said. "You can start to do much more detailed studies of the seasonality of water – when these lakes fill in, and when they dry up."
The freely available satellite imagery from Landsat, and other satellite instruments such as the Moderate Resolution Imaging Spectroradiometer, are invaluable data resources to see how birds and other animals are affected by landscape changes, Reiter said.

"With applied conservation programs, we're using that imagery to say here are the areas that we can prioritize for conservation management, and here are areas that maybe we can let go," he said. "It's a very powerful tool for getting conservation to happen."

**More information:** For more information on Landsat, visit: Landsat.gsfc.nasa.gov, www.nasa.gov/landsat or landsat.usgs.gov

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