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High-Resolution Digital Imagery Applied to Ecosystem Management

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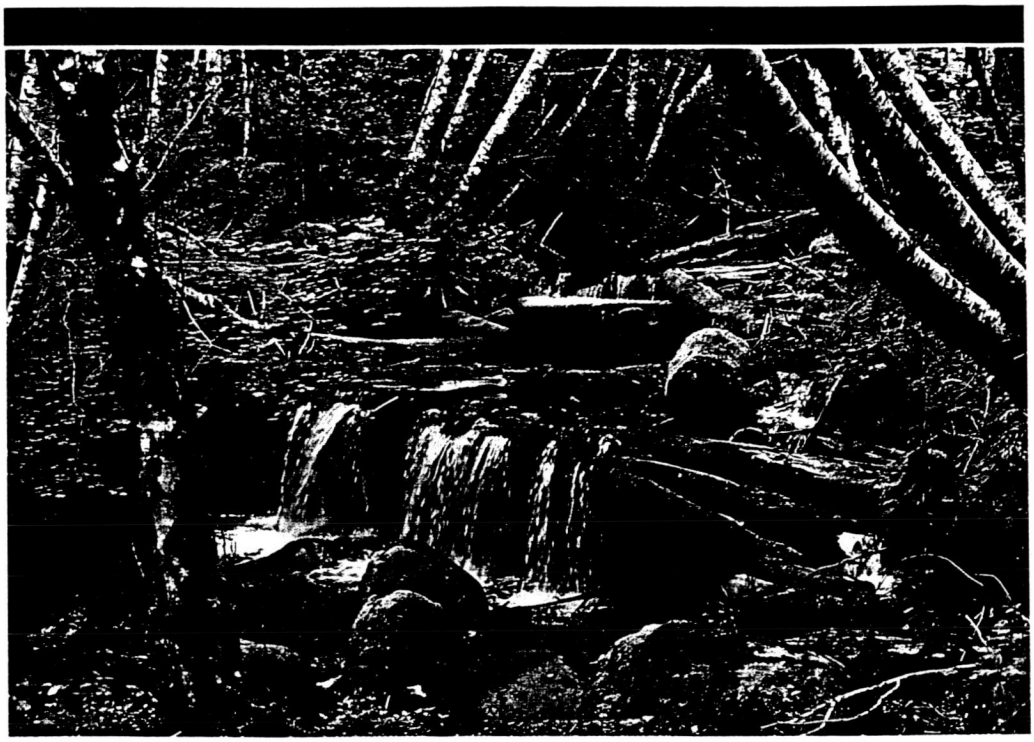
The Siuslaw National Forest in western Oregon was once abundant in old-growth vegetation and provided habitats for such animals as marbled murrelets, spotted owls, and several salmon species. A combination of catastrophic fires in the mid-1800s and intensive timber harvest in the Oregon Coast Range during the past several decades has reduced and fragmented the older forest habitats to the point that the owls and murrelets were listed as threatened under the Endangered Species Act. Listing also appears imminent for several salmon species. Lawsuits by citizens' groups concerned with the drastic reduction in old-growth habitats led to injunctions that brought timber harvest to a virtual halt on much of the federal land in western Oregon and Washington.

In an effort to protect and restore ecosystem health in the Northwest, while also minimizing the negative economic impacts to timber-dependent communities, President Clinton held a forest conference in Portland, Oregon, USA, soon after taking office. The result was the "President's Plan for Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Spotted Owl." In this project, the Forest Service is using airborne and satellite imagery to provide information for watershed analysis, the primary tool for implementing the president's plan.

An important habitat for anadromous fish, the Drift Creek watershed (Siuslaw National Forest) was designated a key watershed in the president's plan. Positive Systems, Inc. (Whitefish, Montana, USA), was contracted to collect high-resolution, multispectral, digital imagery of the watershed and mainstem of Drift Creek. Digital airborne imagery of approximately 82,000 acres of the Siuslaw National Forest, south of Toledo, Oregon, was captured by the Airborne Data Acquisition and Registration System 5500 (ADAR, Positive Systems) at a resolution of approximately 2.6 meters per pixel. The multispectral imagery was mosaicked and delivered to the forest service in a raw data composite (RDC) format.

RDC is a process that was developed by the TRIFID Corporation (St. Louis, Missouri, USA) to automatically mosaic ADAR System images. RDC was selected because the data could be quickly processed and delivered for rapid analysis of large project areas. Figure 1 shows the color infrared RDC of the Drift Creek drainage.

By conducting watershed analysis and quickly implementing the president's plan, the Forest Service hopes to improve the chances for the survival of all species associated with old-growth forests. The spotted owl, for example, requires old-growth forest for nesting, foraging, and roosting. The marbled murrelet, a sea bird, flies inland to nest in old-growth trees. The Drift Creek drainage is also an important spawning area for various species of threatened salmon.



The project goal is to identify opportunities to improve endangered species' habitats by returning the forest — as much as possible — to its natural range of habitat conditions.

The Forest Service is using the imagery to conduct ecological assessment of the Drift Creek watershed. Included in the assessment are vegetation, streams, hydrology, and health of aquatic ecosystems and the general forest landscape. The imagery will also be classified to quantify riparian area vegetation, assess fish habitat and tree condition, and identify location and distribution of old-growth forests.

Using ERDAS (Atlanta, Georgia, USA) software, the Forest Service is analyzing and comparing ADAR imagery. Several strategies are being explored. One such strategy is to begin with an unsupervised classification to identify such basic scene components as open conditions (for example, cleared areas, roads, and streams); grass, forbs, and herbaceous plants; brush; hardwood trees; and conifer trees. The classification is then verified by extensive field checking.

The next step is to run a texture algorithm to show the spatial variability. Then the classification and the texture image, with topography variables derived from the algorithms, will be overlaid to define vegetation polygons and identify homogeneous features.

Within each polygon, a semivariogram will be used to identify the size of homogeneous features within the polygons, such as tree crowns and clumps of brush. After additional calculations are completed for each polygon, statistical models will be developed to predict tree size and density and model species and leaf area for each variable in each polygon. These findings will also be verified with ground truthing. The results from each data set will be compared to determine what was gained or lost by analyzing the imagery down to final pixel size.

Landsat imagery is also being evaluated, and the results from the Landsat analysis will be compared with those of the ADAR analysis to determine the relative information content for the two types of imagery, with respect to forest structures and composition. Vegetation maps created from Landsat and ADAR System imagery will be delivered to the interdisciplinary team who will conduct the Drift Creek watershed analysis.

After the assessment is complete, projects to improve and enhance fish and other threatened wildlife habitats will be proposed. The long-range goal is to allow the forest to return to its natural conditions, while still providing sustainable levels of commodity outputs. ■

Figure 1 (bottom). Color infrared raw data composite of Drift Creek drainage

Drift Creek (top), located in Oregon's Siuslaw National Forest, was designated as a key watershed in President Clinton's "Plan for Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Spotted Owl" project.